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Biodiversity – Fauna and Threatened Species Report

Appendix N

Arafura Resources Limited

Nolans Project Environmental Impact Statement

Appendix N: Biodiversity - Fauna and Threatened Species Report

May 2016

Executive summary

Introduction

GHD was engaged by Arafura Resources Ltd to undertake a range of biodiversity assessments of the Nolans Rare Earths Study area. This report presents information pertaining to fauna within and surrounding the Study area. The main objective of this report is to address the biodiversity assessment requirements (fauna component) of the Terms of Reference set by the Northern Territory Environment Protection Authority (NT EPA) for assessment of the Nolans Rare Earths Project. These Terms of Reference take into account formal assessment and approval under the Commonwealth *Environment Protection and Biodiversity Conservation* (EPBC) *Act 1999*, by way of the NT/Commonwealth bilateral environmental assessment process.

This report describes the methods used and results obtained from desktop and field surveys spanning two main periods: late 2010 and early 2011, and mid-2015. The assessed area included the proposed mine site, processing site, accommodation facility, access roads, haul route, utilities corridor (potable water pipeline, water supply pipeline, power line corridor) and borefield area. The assessed area in 2010/11 also included a proposed haul route that has since been removed from the area of investigation. However, results from surveys in that area are discussed where relevant, because that area contained habitats that are similar to those in the current footprint.

During the course of the assessments for this project, the Commonwealth Department of the Environment made changes to the threatened species lists considered under the EPBC Act. Two of these changes concern species identified for this project (Crest-tailed/Brush-tailed Mulgara and Southern Marsupial Mole). Accordingly, information in this report pertaining to those species was updated in May 2016 in an effort to keep the information as current and accurate as possible. This is discussed in section 1.5.

Methods

This assessment involved desktop and field methods. Desktop methods included reviews of Commonwealth and Northern Territory government database information relating to fauna, use of aerial imagery, and review of information and reports from earlier reviews and field assessments.

Field methods were intensive and varied. In both 2010 and 2015, a range of sites was selected for sampling in a representative range of vegetation/habitat types. The choice of sites was made in an effort to maximise the likelihood of detecting fauna, including threatened species. Twelve sites were sampled in September 2010 and an additional 13 sites were sampled in April/May 2015.

Survey methods follow the standard terrestrial vertebrate survey methods used by the Department of Land Resource Management (Appendix A in NT EPA 2013). At sites, and across the broader Study area, survey methods included the use of:

- Habitat assessment, baited Elliot-type traps, pitfall bucket traps, funnel traps, Anabat bat call detection, bird surveys (including instantaneous bird count), active search (diurnal), active search (nocturnal), motion-sensing cameras, opportunistic (incidental) observations and opportunistic snail searches.
- In December 2011, a targeted survey for Black-footed Rock-wallaby habitat within the mine site was conducted to address one of the project's EPBC requirements. This survey

was conducted using specific methods, as described in the report. Additional targeted fauna surveys will be undertaken in 2015 and reported separately.

- During the 2010 survey, 124 indigenous terrestrial fauna species were recorded including 16 mammals, 78 birds, 27 reptiles, two frogs and one invertebrate.
- During the 2015 survey, 130 indigenous terrestrial fauna species were recorded, including 21 mammals, 78 birds, 28 reptiles, two frogs and one invertebrate.
- Three introduced fauna species (all mammals) were also recorded in 2010 and five species (all mammals) in 2015.
- With both surveys combined, a total of 174 native terrestrial fauna species were recorded, including 25 mammals, 103 birds, 41 reptiles, three frogs and two invertebrates, and five introduced fauna species (all mammals).

Compared with previous information from the area, the species counts from this assessment closely match those that have been recorded historically in the local area (DLRM database), suggesting that the survey methods and effort were effectively at sampled sampling the region's fauna (acknowledging that more species would be detected with greater survey effort).

Mammals

Across both surveys, 25 native and five non-native mammal species were identified within the Study area. This is more than twice the number of native mammals that had previously been recorded on the DLRM list. The small list of mammalian fauna on the current DLRM database for this region suggests that insufficient fauna survey has occurred in the area, particularly in recent times.

Four mammals recorded during the surveys are listed as threatened species. One is listed as *Vulnerable* under the EPBC Act (Black-footed Rock-wallaby, *Petrogale lateralis*), and four are listed as *Near Threatened* or *Vulnerable* under the Northern Territory's *Territory Parks and Wildlife Conservation* (TPWC) *Act* (the Black-footed Rock-wallaby; and Brush-tailed Mulgara, *Dasycercus blythi*; Spectacled Hare-wallaby, *Lagorchestes conspicillatus*; and Northern Nailtail Wallaby, *Onychogalea unguifera*). The hare-wallaby and nailtail wallaby were detected as tracks and/or scats only – no individuals were seen.

Birds

Across both surveys, 103 native bird species were identified within the Study area. Each survey (i.e. 2010 and 2015) resulted in the detection of 78 bird species, but there was only 68% overlap in species detected. The survey results represent approximately 85% of species recorded historically within 20 km of the Study area (DLRM database).

Four bird species recorded during the surveys are currently listed as threatened. All four are listed as *Near Threatened* under the TPWC Act. These are two large ground birds (Australian Bustard, *Ardeotis australis*, and Emu, *Dromaius novaehollandiae*), one small ground bird (Bush Stone-curlew, *Burhinus grallarius*), and one pigeon (Flock Bronzewing, *Phaps histrionica*).

Reptiles

Across both surveys, 41 native reptile species were identified within the Study area. Each survey (i.e. 2010 and 2015) resulted in the detection of similar reptile species numbers (27 and 28 respectively). The total across the two surveys appears to closely match the reptile species that are recorded for the 20 km area on the DLRM list. However, 20 reptile species in the DLRM list were not detected during this assessment, and 18 species detected during this assessment are not in the DLRM list. This suggests that the DLRM database inadequately describes the reptile fauna in this area, and that more survey work would be likely to result in the detection of more reptile species.

One reptile recorded in 2015 is currently listed as threatened: Great Desert Skink (*Liopholis kintorei*) - *Vulnerable* EPBC Act and *Vulnerable* TPWC Act. While no individuals were seen, a communal burrow system and reptile latrine was found that can only have been made by the Great Desert Skink. This was verified by identification of scats collected and by ecologists experienced with this species including Dr Rachel Paltridge (Desert Wildlife Services) and Dr John Read (Ecological Horizons) who both visited the warren and observed the collected scat.

Frogs

Three native frog species were identified within the Study area. Detecting frogs in arid country is highly seasonal, and typically, higher numbers are recorded in warm and wet conditions. For the 2015 survey, the conditions were cool and dry and not conducive to the detection of large numbers or high diversity of frogs. In 2010, a 24-hr period of heavy rainfall brought out small to moderate numbers of frogs, of a small number of species.

No frog species that are known to occur in the vicinity of the Study area are currently listed as threatened species.

Invertebrates

Invertebrates are poorly known fauna. No invertebrate species are included in the DLRM list for the area. However, one species of snail listed as threatened under the TPWC has the potential to occur within the Study area. Targeted searches for snails and snail shells in apparently suitable habitat failed to detect the threatened species.

Patterns of species richness and habitat specificity

The native vegetation across the Study area can be broadly grouped into six fauna habitat types:

- Mulga woodland
- Spinifex-dominated grassland on sandplain
- Rocky rises
- Acacia and mallee shrubland/woodland
- Riparian woodland
- Non-spinifex grassland (occasionally with sparse open woodland).

Three of these habitats dominate the area: Mulga woodland, Spinifex grassland sandplain and Rocky habitats.

Overall, mulga woodland was the most species rich of the fauna habitats. This species richness was influenced by a high diversity of mammals and birds.

Spinifex-dominated grassland on sandplain was also species-rich fauna habitat, with species richness influenced by high overall diversity of mammals and reptiles. However, the richness detected was inconsistent between surveys, with nearly twice the number of species detected in 2015 than in 2010, most likely resulting from survey effort and environmental conditions. Sandplain spinifex habitat clearly supports a high diversity of fauna, but detecting that fauna is likely to depend on specific location and environmental conditions. A very high proportion of fauna detected in sandplain spinifex habitat was found only in that habitat. Nearly one-third of the fauna in that habitat was found only in that habitat; many of these were reptiles.

Rocky habitats were moderately species-rich. Reptiles in particular were relatively species rich in rock habitats, particularly in 2010. To some degree, higher richness in 2010 reflects the type of rocky habitat that was sampled in each survey. The rocky habitat sites in 2010 were associated with far larger rocky areas than the sites used for 2015, which were both on

relatively small outcrops of rocks. Larger rocky rises and ranges are more likely to support rocky habitat specialists (e.g. Black-footed Rock-wallaby, *Petrogale lateralis*). A reasonably high proportion of fauna detected in rocky habitat was found only in that habitat (20.2%). This indicates a relatively high degree of specificity among fauna that use rocky habitats, particularly reptiles.

Overall, nearly 40% of fauna species were detected in one habitat only. This represents very high overall habitat specificity for fauna in the area. Of all the species groups, reptiles showed the strongest association with specific habitats: 63% of species were found in one habitat only. Fourteen of these were associated with sandplain spinifex and seven with rocky habitats. Mammals also tended to be strongly aligned to specific habitats, but birds tended to be little aligned to specific habitats; ~70% of birds were found across multiple habitats.

Threatened species

Forty-nine fauna species are listed under one or more category of threat (i.e. vulnerable, extinct, near threatened) under the EPBC Act and/or the TPWC Act. More than half (25) are mammals, and of those, 11 species are listed as extinct in the Northern Territory or across Australia. The other threatened species are made up of birds (20 species) and reptiles (4 species). No frogs in the area are currently listed as threatened.

On the basis of habitat requirements and geographic distribution, the Study area potentially provides at least some habitat for 27 of the 38 extant listed species. These species would be expected to use the study area in varying ways, from breeding residents to occasional, frequent, seasonal, irregular, rare or vagrant visitors.

Eleven threatened or Near Threatened fauna species warrant more detailed assessment. These species were either detected during this assessment within the Study area (nine species), or were not detected but are included because they are listed under the EPBC Act (i.e. are considered threatened at a national rather than Territory or regional scale), and therefore have consequences for the project if significant impacts upon them occur. These 11 species are shown in the table below with an indication of where they are predicted to occur within the Study area.

Species	EPBC	TPWC	Where detected? (GHD surveys)	Likely Extent of occurrence within the Study area
MAMMALS				
Brush-tailed mulgara *Dasycercus blythi*	-	VU	Borefield area	Likely to occur across much of the sandplain habitat in the south of the Study area (i.e. the borefield area).
Black-footed Rock-wallaby (MacDonnell Ranges race) *Petrogale lateralis*	VU	NT	Mine Site and Borefield	Mine site and scattered outcrops in the borefield. Species restricted to steep rocky habitats, particularly the larger rock outcrops and ranges.
Greater Bilby (Bilby) *Macrotis lagotis*	VU	VU	(Not detected)	Potentially suitable habitat occurs across much of the Study area, but particularly in the southern areas that are dominated by sandplain.

Species	EPBC	TPWC	Where detected? (GHD surveys)	Likely Extent of occurrence within the Study area
Spectacled hare-wallaby *Lagorchestes conspicillatus*	-	NT	Borefield area	Detected by tracks only, which require confirmation. May occur across much of the sandplain habitat in the south of the Study area.
Northern Nailtail Wallaby *Onychogalea unguifera*	-	NT	Processing Site	Detected by tracks and scats only, which require confirmation. Could occur anywhere in open woodland or shrubland.
BIRDS				
Princess Parrot *Polytelis alexandrae*	VU	VU	(Not detected)	Potentially suitable habitat occurs across much of the Study area, particularly in the southern areas that are dominated by sandplain.
Emu *Dromaius novaehollandiae*	-	NT	Borefield area	Detected by tracks. Likely to occur across the entire Study area.
Australian bustard *Ardeotis australis*	-	NT	Haul route (2010)	Seen in open grassland, but species known to use other habitats also. Likely to occur across the entire Study area.
Flock bronzewing *Phaps histrionica*	-	NT	Haul route (2010)	Seen in sandplain habitat along the haul route, but this is not necessarily its preferred habitat. May occur across the entire Study area.
Bush Stone-curlew *Burhinus grallarius*	-	NT	Processing site and Mine site	Suitable habitat occurs across much of the Study area.
REPTILES				
Great Desert Skink *Liopholis kintorei*	VU	VU	Borefield area	Detected as burrow/latrine system, with identification of scats verified. May occur across much of the sandplain habitat in the south of the Study area.

Potential impacts and mitigation

The study area supports a range of significant fauna that may be impacted by the proposal.
The major potential sources of impact are:

- Clearing of breeding and/or foraging habitat
- Dust generated by mining and processing activities
- Noise generated by mining and processing activities
- Artificial light generated by mining and processing activities
- Unplanned wildfire
- Introduction and/or spread of exotic plants (weeds) and animals (pests)
- Radioactivity exposed by mining and processing activities

- Poisoning of fauna drinking contaminated water
- Lowering or contamination of the water table
- Injury and death from collisions with vehicles.

Survey results

The study area supports a range of habitats and fauna. Four fauna habitats dominate the study area: Mulga woodland, Spinifex grassland on sandplain, Rocky rises, and Acacia and mallee shrubland/woodland. All of these habitats had diverse fauna.

Mulga had the largest species count, influenced by large species numbers of mammals and birds in particular. Spinifex grassland on sandplain was also species rich, influenced by relatively high diversity of mammals and reptiles. Rocky habitats were moderately species-rich for fauna.

A large proportion of fauna, particularly reptiles and mammals, in the study area are highly specific to particular habitats. Spinifex grassland on sandplain and rocky habitats had the highest levels of habitat specificity, particularly with reptiles.

Twenty-seven threatened fauna species (as listed under the EPBC Act and/or TPWC Act) do or could occur within the Study area. Nine of these were recorded in the Study area. Among the threatened species are habitat specialists and habitat generalists. All habitats are likely to support threatened fauna species.

Four of the threatened species that do or could occur within the Study area are listed as *Vulnerable* under the EPBC Act:

- **Four mammals** –
  - Black-footed Rock-wallaby, *Petrogale lateralis MacDonnell Ranges race* (Vulnerable)
  - Greater Bilby, *Macrotis lagotis* (Vulnerable).
- **One bird** - Princess Parrot, *Polytelis alexandrae* (Vulnerable)
- **One reptile** - Great Desert Skink, *Liopholis kintorei* (Vulnerable).

Two of these (Black-footed Rock-wallaby and Great Desert Skink) were detected during this assessment.

If the project results in significant residual impacts on any of these species, then compensatory offsets may be considered under the EPBC Act, in accordance with DSEWPaC (2012). According to the EPBC Act website, offsets are ‘measures that compensate for the residual impacts of an action on the environment, after avoidance and mitigation measures are taken’.

To minimise or avoid significant impacts, mitigation measures (see Section 6) will need to be implemented during all construction and operations activities in habitats that are most likely to support these species.

One of these species (Black-footed Rock-wallaby) is typically restricted to rocky habitats, which occur mainly in the Mine Site area.

One species (Great Desert Skink) is restricted to sandy habitats, which occur throughout the borefield area and along the southern extent of the proposed water supply pipelines.

Two species (bilby and Princess Parrot) are more general in their habitat use across arid Australia, and could occur in any part of the study area. That said, the bilby (a burrowing species) is probably more likely to use sandy habitats (rather than rocky habitats or habitats with heavier clay soils), which are more conducive to digging. Therefore, both the bilby and also the Princess Parrot are more likely to occur within the sandy habitats of the borefield.

Minimising impacts on all these species and their habitats will serve to minimise impacts on most if not all other threatened and near threatened (i.e. as listed under the TPWC Act) species also.

Impact assessment results

Risk assessments were conducted for Black-footed Rock-wallaby, Great Desert Skink, bilby and Princess Parrot.

A risk assessment conducted for Black-footed Rock-wallaby indicates that the most serious risk to this species is likely to come from unplanned wildfire and exotic flora/fauna. Both have the potential if unmitigated to exert a **High** risk on population size, critical habitat, breeding cycles, and lead to population decline and inhibit species recovery. However, the implementation of mitigation and management measures presented in Section 6 would reduce these impacts to a point where the residual risk would remain **Low** to **Medium**.

A risk assessment conducted for threatened species present within the borefield (in particular the Great Desert Skink) indicates that the most serious risk is from unplanned wildfire and exotic flora/fauna. Both have the potential if unmitigated to exert a **High** risk on population size, critical habitat, breeding cycles, and lead to population decline and inhibit species recovery. There is also a **Medium** risk posed by vehicle strike for vehicles travelling around the borefield at night (due to the nocturnal habits of these species). However, the implementation of mitigation and management measures presented in Section 6 would reduce these impacts to a point where the residual risk would remain **Low** to **Medium**.

In summary, the implementation of mitigation/management measures would allow impacts to be managed to the point where a significant impact on the threatened species that are known or have the potential to occur on the Nolans site would be unlikely.

Recommendations

This assessment resulted in the detection of two EPBC Act-listed fauna species in the study area, and identified two others that could occur there also. Recommendations made here focus on those species. In particular, they focus on the mitigation and management of impacts to these species during the construction and operation of the proposed mine.

We recommend the following:

- Prepare a Biodiversity Management Plan that documents possible sources of impact on fauna, mitigation efforts required to avoid or minimise impacts, and monitoring required to demonstrate that the project does not result in significant impacts on threatened fauna. Specific species to be addressed include Black-footed Rock-wallaby and Great Desert Skink
- Given the potential for all habitats within the Study area to support threatened fauna species, construction and operation of the mine across the entire Study area must be kept within the minimal possible area, and not extend into habitat areas that were not already disturbed. If additional space is required, previously disturbed areas should be considered before undisturbed habitats in all instances.

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Scope and limitations

This report has been prepared by GHD for Arafura Resources Limited and may only be used and relied on by Arafura Resources Limited for the purpose agreed between GHD and the Arafura Resources Limited as set out in section 1.3 of this report.

GHD otherwise disclaims responsibility to any person other than Arafura Resources Limited arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by Arafura Resources Limited and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of services, vegetation, access and sacred sites. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

1. Introduction

Previous fauna surveys conducted by GHD (2010, 2011 and 2015) have included assessments of the proposed mine site, processing site, accommodation facility, access roads, borefield area and utilities corridor including potable water pipeline, water supply pipeline and power line corridor. Assessment also included a proposed haul route (2010) that is no longer being considered as part of the current Project infrastructure.

A map of the proposed mining infrastructure and the fauna Study area is provided in Figure 1.

1.1 Background

Arafura Resources Limited proposes to develop the Nolans Rare Earths Project (the Project), located approximately 135 km north west of Alice Springs, Northern Territory (NT). The Project would target the Nolans Bore mineral deposit for rare earth elements.

Project activities include construction, mining, intermediate processing, rehabilitation and decommissioning of an open-cut mine and associated infrastructure. Mining operations would be undertaken using conventional open pit methods (drill, blast, load and haul) to recover up to 1,000,000 tonnes of ore per annum. Ore would be beneficiated at the mine before a rare earths concentrate slurry is pumped approximately 8 km south to an intermediate processing plant. Rare earth product would then be transported by road then rail to East Arm Port (Darwin) for export. Further processing of the concentrate would occur at an offshore rare earths separation plant in an established chemical precinct.

The Nolans Bore deposit contains phosphate and uranium, which will be removed and stored in a waste disposal facility following processing. The operational life of the Project is expected to be greater than 23 years.

1.2 Scope

This report presents the methods and results of a fauna assessment process at the Study area including a description of:

- Desktop searches of government database and literature review relating to fauna distributions, fauna survey of the Study area using a range of sampling techniques designed to maximise the understanding of the relationships between fauna and the available habitats on site
- Baseline fauna surveys
- Fauna surveys specifically targeting species listed as threatened/migratory under the EPBC and/or TPWC Act
- The regional and national significance of the fauna and any populations of threatened species
- Potential impact on fauna and threatened species
- Mitigation measures to reduce the risk
- The residual risks to fauna including threatened species.

1.3 Objectives of the assessment

GHD was engaged by Arafura Resources Ltd to undertake a fauna and habitat assessment, of the Nolans Rare Earths Study area, including assessment of listed threatened fauna species.

The primary objective of this report is to address the terrestrial fauna component of the biodiversity values assessment, as required in the Terms of Reference (ToR) for the preparation of an environmental impact assessment issued by the Northern Territory Environment Protection Authority (NT EPA) for the Nolans Rare Earths Project.

In addition, the delegate of the Commonwealth Minister has determined that the Proposal is a controlled action as the Project has the potential to have a significant impact on listed threatened species and communities (section 18 & section 18A). Therefore, this report will also address Matters of National Environmental Significance (MNES), with the understanding that the project be assessed under the Bilateral Agreement between the NT and Commonwealth Governments.

This report will address the following matters with regard to biodiversity values at the Study area:

- Describe and map fauna and habitats occurring in the Nolans Study area including habitat that is suitable for species of conservation significance
- Identify threatened fauna species and/or populations listed under the Commonwealth *Environment Protection and Biodiversity Conservation* (EPBC) *Act 1999* and/or Northern Territory's *Territory Parks and Wildlife Conservation* (TPWC) *Act 2000* that are present or considered likely to occur within the study area, including, but not being limited to, fauna species identified by the Commonwealth Department of the Environment (DotE) in the EPBC referral decision
- Provide a detailed assessment of Matters of National Environmental Significance i.e. species and communities listed under the EPBC Act including, but not limited to:
  - Listed threatened species (including the Black-footed Rock-wallaby MacDonnell Ranges race, Great Desert Skink and Greater Bilby) and their habitat
  - The quality and quantity of available habitat within the vicinity of the Study area (identified and mapped)
  - The potential impact of the project on these species and their populations.
- Identify the potential for the Project to impact on biodiversity values including ecosystems and listed threatened species including:
  - Assessing the regional and national significance of populations of threatened species
  - Determining ways in which the proposed Project might impact on threatened species
  - Assessing the levels of risk to threatened species posed by sources of potential impact
  - Proposing mitigation measures to reduce the risk of impacts that may be significant
  - Determining the residual risks to threatened species.

1.4 Definitions

For the purposes of this assessment, the following definitions are employed:

Site – refers to the Nolans project site including all components - mine site, processing site, accommodation village, access roads, utilities corridors (potable water pipeline, water supply pipeline, power lines), and borefields area as shown in Figure 1.

Study area – refers to the area that was surveyed for this assessment. It included the mine site, processing site, the accommodation village as well as a 200 metre wide corridor along the proposed access roads and 100 metre corridor along the potable water pipeline and water supply pipeline. It also includes an approximately 65,000 ha area in the Reynolds range, Hann Range (both ranges are far larger than the area assessed) where targeted threatened species

surveys were carried out for Black-footed Rock-wallaby and 41,568 ha of the broader borefield area. The entire area assessed on foot, vehicle and helicopter covered approximately 150,000 ha (see Figure 2).

1.5 Changes to the EPBC threatened species lists

During the course of the assessments for this project, the Commonwealth Department of the Environment made changes to the threatened species lists considered under the EPBC Act. Two of these changes concern species identified for this project, as discussed below. Information in this report pertaining to these species and these changes was updated in May 2016 in an effort to keep the information current and accurate.

1.5.1 Brush-tailed Mulgara / Crest-tailed Mulgara (*Dasycercus cristicauda*)

Up to December 2013, two species of mulgara were listed as threatened under the EPBC Act: the Brush-tailed Mulgara (*Dasycercus cristicauda*) and the Ampurta (*D. hillieri*). The distribution identified for *D. cristicauda* covered a large part of central and northern arid Australia, from western Qld, through northern SA and southern NT, across to the Pilbara region in WA. The distribution identified for *D. hillieri* covered a small area of central arid Australia, centred on the area where Qld, SA and NT meet. The distribution identified for *D. hillieri* did not include the Study area, while the distribution identified for *D. cristicauda* did. Because its distribution included the study area, the 'Brush-tailed Mulgara' (*D. cristicauda* or *D. blythi*) was included as a focal threatened species during the site assessments.

In December 2013, the EPBC species listings for mulgaras were revised to align with taxonomic work on the mulgara species by Woolley (2005). Woolley concluded that there were indeed two species of mulgara, but that those species did not align with the existing species identification.

Woolley concluded that *D. hillieri* is a synonym of *D. cristicauda* (i.e., that they are one and the same), and that species is now classified as the Crest-tailed Mulgara (*D. cristicauda*). The Crest-tailed Mulgara (*D. cristicauda*) is listed as Vulnerable under the EPBC Act and Vulnerable under the TPWC Act. The Crest-tailed Mulgara (*D. cristicauda*) is now reported to occupy an area of central arid Australia, centred on and extending west from the area where Qld, SA and NT meet. It occurs in sand dunes that have a sparse cover of Sandhill Canegrass (*Zygochloa paradoxa*). This habitat does not occur within the Study area. The Crest-tailed Mulgara (*D. cristicauda*) was not identified by the PMST search for the Study area, and is considered unlikely to occur within the Study area.

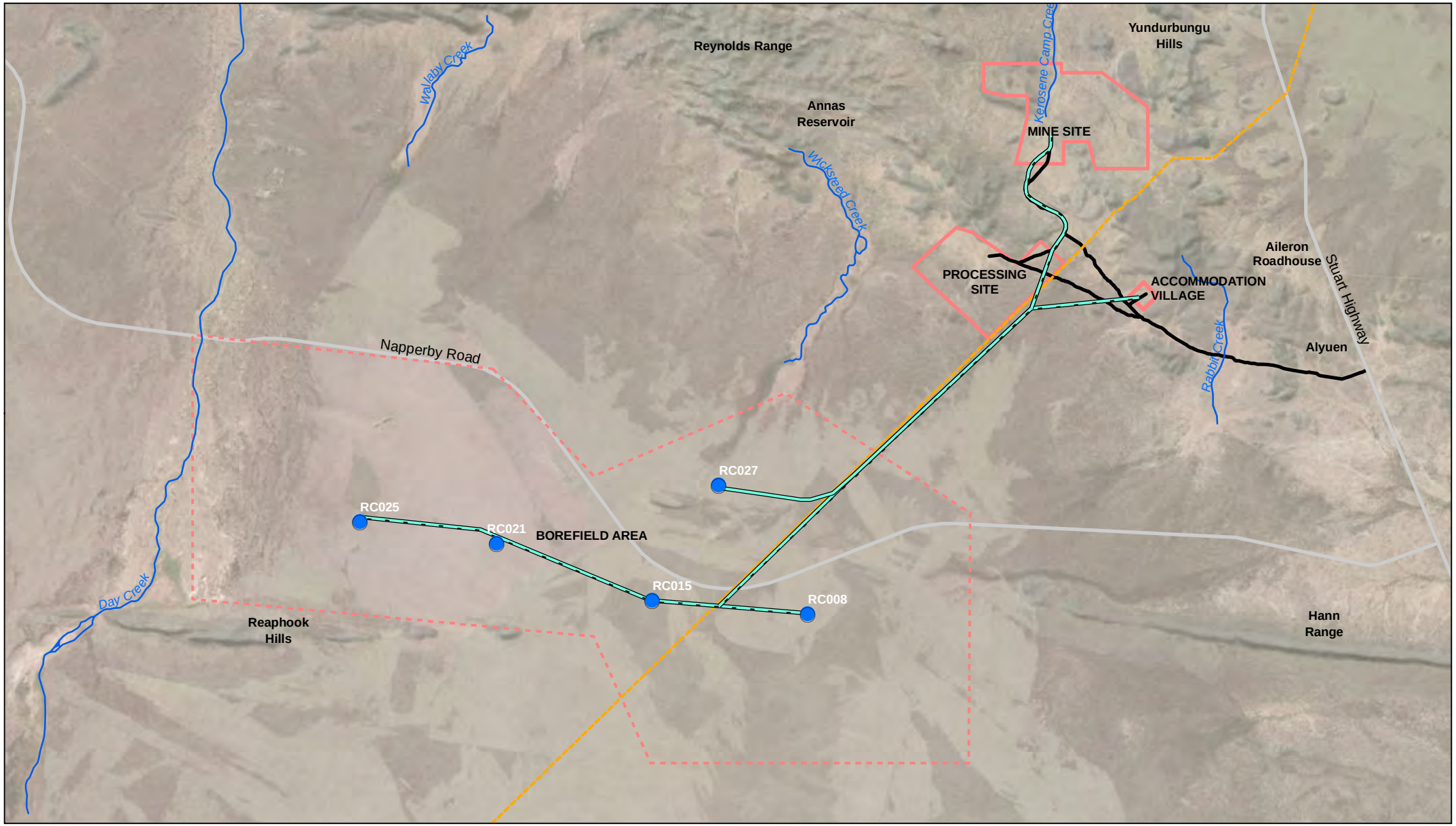
Woolley concluded also that the mulgara species originally (i.e., pre-2013) referred to as Brush-tailed Mulgara (*D. cristicauda*) is really the Brush-tailed Mulgara (*D. blythi*). This species is not currently listed as threatened under the EPBC Act, but it is listed as Vulnerable under the TPWC Act. This species is reported to occupy sandplain habitats across a large part of central and northern arid Australia, from western Qld, through northern SA and southern NT, across to the Pilbara region in WA. This species occurs within the Study area.

The name *D. hillieri* has been removed from the EPBC Act threatened species list (December 2013). The name Ampurta was used by Aboriginal people (Woolley 2005), and Woolley notes that it is impossible to tell which species was known as Ampurta.

1.5.2 Southern Marsupial Mole (*Notoryctes typhlops*)

The Southern Marsupial Mole (*Notoryctes typhlops*) was listed as Endangered under the EPBC Act up to December 2015. In December 2015, an approved Commonwealth Listing Advice for the species resulted in the species being de-listed from the EPBC Act threatened species list. The species is still listed as Vulnerable under the TPWC Act.

This species was not recorded during the targeted surveys and no historical records exist for the Study area; however it is a poorly known species and rarely seen/reported because of its subterranean habits. This species was originally included in the assessment as a focal threatened species due to its conservation status under the EPBC Act. Since the species was de-listed from the EPBC Act, it has been excluded from the short list of threatened fauna species considered in detail for this assessment. The sandplain habitat in the southern part of the Study area is potentially suitable for this species, but provides marginal rather than high quality habitat.



1:225,000 @ A4

0 2 4 6 8

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

N

LEGEND

- Water Bores
- Proposed Powerline
- Proposed Pipelines and Easement
- Existing Gas Pipeline and Easement
- Waterways
- Existing Roads
- Existing Access Track
- Borefield Area
- Site Boundaries

Arafura Resources Limited
Nolans Project

Job Number	4322301
Revision	0
Date	18 Mar 2016

Nolans site

Figure 1

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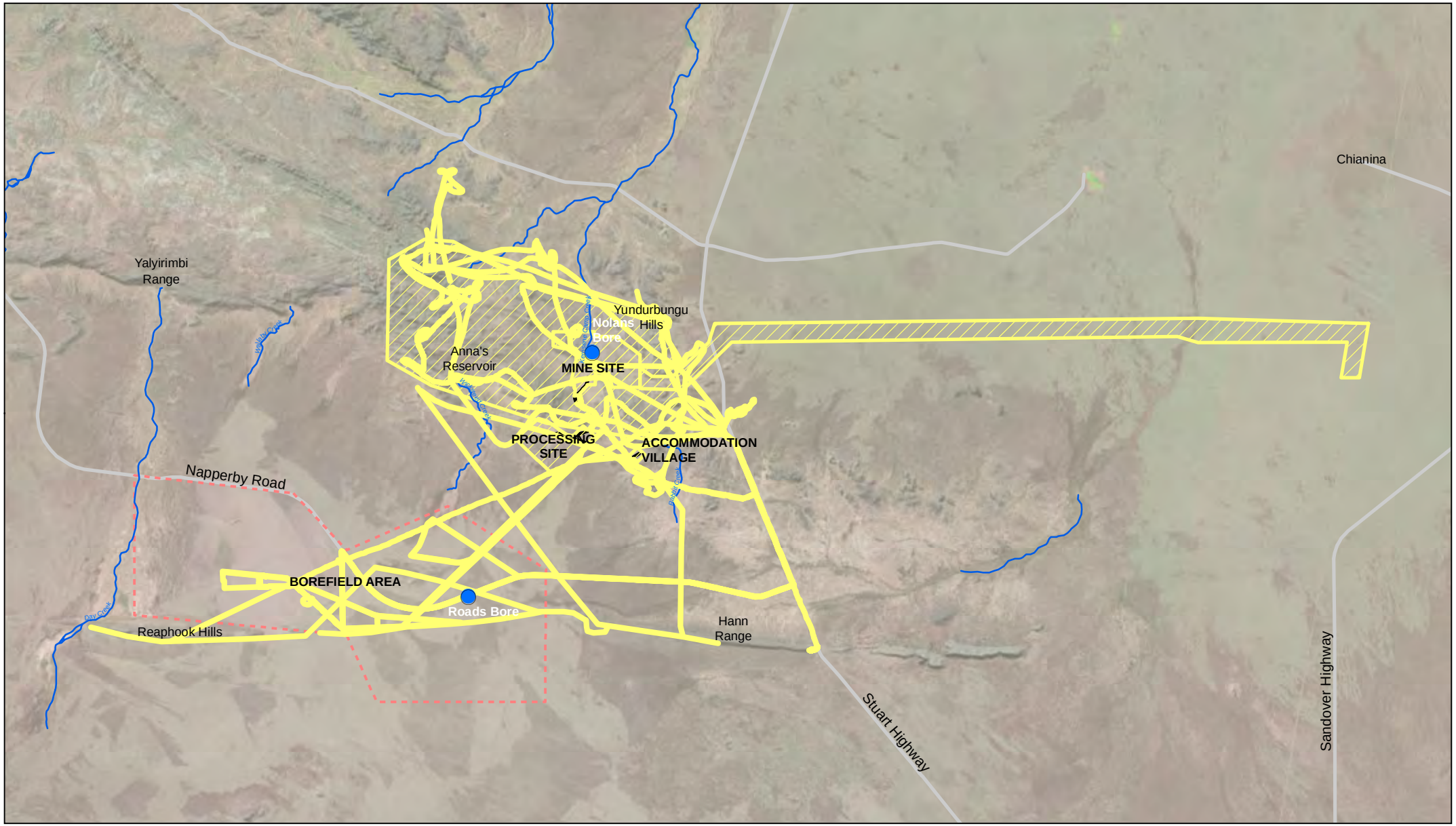
Level 5 66 Smith Street Darwin NT 0800 Australia **T** 61 8 8982 0100 **F** 61 8 8981 1075 **E** drwmail@ghd.com **W** www.ghd.com

Data source: GA - Imagery (2008), Roads, Waterways, Placenames (2015). ESRI - Shaded Relief (2009). ARL - Water Bores, Proposed Pipelines, Borefield Area, Proposed Mine Site, Treatment Plant and Accommodation Village (2015). Created by: CW, CM



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0 2.5 5 7.5 10

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

N

LEGEND

- Water Bores
- Existing Roads
- Existing Access Track
- Waterways
- Study Area
- Borefield Area

Arafura Resources Limited
Nolans Project

Job Number	4322301
Revision	0
Date	18 Mar 2016

Nolans study area

Figure 2

G:\43\22301\GIS\Maps\4322301_218_StudyArea.mxd

Level 5 66 Smith Street Darwin NT 0800 Australia **T** 61 8 8982 0100 **F** 61 8 8981 1075 **E** drwmail@ghd.com **W** www.ghd.com

Data source: GA - Imagery (2008), Roads, Waterways, Placenames (2015). ESRI - Shaded Relief (2009). ARL - Water Bores, Proposed Pipelines, Borefield Area, Proposed Mine Site, Treatment Plant and Accommodation Village (2015). Created by: CW, CM

2. The Nolans Site

2.1 Climate

The Study area experiences hot and arid conditions. The hottest months are November to March, with the monthly mean of daily maximum temperatures above 35 ^{o}C, and monthly mean of daily minimum temperatures not dropping below 18 ^{o}C (Table 1). The coolest months are May to August, with the monthly mean of daily maximum temperatures remaining at or below 25.5 ^{o}C, and monthly mean of daily minimum temperatures not rising above 9.5 ^{o}C.

The mean annual rainfall is approximately 319.1 mm, with a seasonal pattern of more summer rainfall than winter rainfall. Average monthly rainfall totals range from 4.7 mm in August to 65.8 mm in February (Table 1). Average three-monthly rainfall totals range from 18.3 mm in June/July/August to 178.7 mm in December/January/February. However, any month can receive relatively large rainfall totals, or little or no rain at all.

Table 1 Rainfall and temperature statistics (BoM 2015; Territory Grape Farm NT 1987-2014)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall (mm)												
Highest	280.4	342.2	109.2	151.7	136.3	53.8	34.2	39.4	96.6	56.8	119.2	119.2
95th %ile	159.0	244.2	96.9	89.9	100.1	48.7	21.3	26.9	41.7	51.3	81.4	109.9
Mean	62.4	65.8	21.9	18.0	23.3	8.7	4.9	4.7	10.3	15.3	30.9	50.5
5th %ile	3.8	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	8.9
Lowest	2.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0
Temp (°C)												
Maximum[1]	37.3	36.2	34.3	30.5	25.5	22.2	22.5	25.3	30.5	33.3	35.6	36.3
Minimum[2]	21.9	21.6	19.5	14.6	9.5	6.2	5.2	7.1	12.1	15.6	18.8	21.1

Notes: [1] Monthly mean maximum temperature is the average of the available daily maxima for that month.

[2] Monthly mean minimum temperature is the average of the available daily minima for that month.

2.2 Bioregional description

The Site lies in the Burt Plain Bioregion. This bioregion covers an area of 73,605 km^2, which represents approximately 5% of the Northern Territory (NRETAS 2005). It is characterised by arid to semi-arid plains and low rocky ranges with some of Australia's best established and most extensive mulga (*Acacia aneura*) and other acacia woodlands (NRETAS 2005). Geologically the bioregion lies over the Arunta Province, Tennant Inlier, and small areas of Georgina, Wiso and Ngalia Basins, with metamorphic, plutonic, and sedimentary rocks of Precambrian age.

Soils are generally comprised of shallow sands and massive earths. Landforms range from undulating plains to rocky ranges, with elevations of 350 to 1,100 m respectively. The undulating plains are intermittently interrupted by major drainage lines associated with terraces and levees, and sporadic hills and rocky ranges (DNREA 2006). Several ephemeral rivers drain the rocky ranges, flowing in a northerly direction into the Tanami Desert.

Wetlands do occur within the Burt Plain Bioregion, but none is listed in the 'Directory of Important Wetlands in Australia' (DIWA) or under the 'Convention on Wetlands of International Importance' (Ramsar Convention). Some potentially significant wetlands such as Stirling

Swamp, and the springs and waterholes of the Dulcie Ranges are not directly associated with the Nolans Bore study area or immediate surrounds.

There are five broad vegetation types (BVTs) that have been mapped within the bioregion (Wilson *et al.* 1990), the most abundant being Acacia Woodland. Other BVTs recorded within the bioregion include Eucalyptus low woodland with tussock grass understorey, Eucalyptus woodland with Hummock grass understorey, Hummock Grassland and Tussock Grassland (NRETAS 2005).

The Burt Plain Bioregion is known to contain more than 1000 flora species and 350 fauna species. However, the bioregion is one of the most poorly documented bioregions in the Northern Territory in terms of its biodiversity values (Neave *et al.* 2006), and it is consequently recognised as a national priority bioregion for conservation planning.

Pastoralism (mainly cattle grazing) is the major industry in the bioregion, with 37 pastoral leases within or intersecting the boundary of the bioregion and occupying approximately 82 percent of the land area (Neave *et al.* 2006). This industry has been operating in the area since the early 20th century (PWCNT 1999).

Potential and existing threats to biodiversity that have been identified within the bioregion include exotic flora, introduced animals, fire, erosion, land clearing, pastoralism and mining (Neave *et al.* 2006). Much of the bioregion has been impacted by a range of broadscale processes such as grazing by livestock and/or feral animals, feral predators and weed infestations.

Exotic species are widespread and there are fifteen declared weed species currently listed under the *Northern Territory Weeds Management Act 2001* known to occur in the Burt Plain Bioregion. Other exotic plants species, most notably buffel and couch grass, also pose significant threats to some habitats.

2.2.1 Burt Plain Bioregion - Fauna and Habitat Characteristics (Neave *et al* 2006)

The fauna and fauna habitat of the Burt Plain Bioregion are characterised by the following:

- Vegetation is predominantly mulga and other acacia woodlands with short grasses and forbs, and spinifex grasslands
- Much of the Burt Plain Bioregion was burnt in the summer months in 2001 and 2002. This wildfire period followed very wet years in 2000 and 2001. Fire appears to have been insignificant at other times i.e. between 1997 and 2005. Major fires in this period occurred between April and November and were probably less intense. As with other central Australian bioregions, the overall condition of the Burt Plain Bioregion is masked by a very strong rainfall effect, with degradation sometimes difficult to detect following a series of good seasons. Much of the bioregion has been impacted by grazing livestock and/or feral animals, feral predators and weed infestations. There are 19,500 records for 359 vertebrate species for the Burt Plain Bioregion. The majority of these are:
  - Birds (16,341 records and 183 species; 51.0% of all species)
  - Mammals (1,643 records and 63 species; 17.5% of species)
  - Reptiles (1,436 records and 104 species; 29.0% of species)
  - Frogs (80 records and 9 species; 2.5% of species).
- Although this species list appears comprehensive, the animals of the Burt Plain Bioregion are relatively poorly known and documented. Furthermore, an understanding of the habitat requirements of many species and species assemblages is limited

- From a national and Northern Territory perspective, no extant vertebrate species are considered endemic to the bioregion
- The Burt Plain Bioregion has suffered a substantial reduction in its mammal fauna over the last century. There are ongoing declines of some bird and mammal populations. Introduced predators are widespread. At least 15 of the 54 indigenous mammal species recorded from the bioregion are extinct or no longer occur in the bioregion. Several others have suffered population declines. Between two atlas projects conducted by Birds Australia (in the late 1970s and early 1980s, and again in the late 1990s and early 2000s), the Hooded Robin was found to have suffered a substantial decline. Several other birds are suspected to have undergone significant declines in the bioregion since European colonisation
- Predation is likely to be an important threat to threatened species in the bioregion, such as the Brush-tailed Mulgara, Southern Marsupial Mole, Common Brushtail Possum and Black-footed Rock-wallaby
- Changed fire regimes are likely to be an important threat to threatened species in the bioregion, such as the Australian Bustard, Emu, Princess Parrot, Brush-tailed Mulgara and Common Brushtail Possum
- Grazing by livestock and/or feral animals is likely to impact on threatened species in the bioregion, such as, Emu, Princess Parrot, Brush-tailed Mulgara, Common Brushtail Possum and Black-footed Rock-wallaby.

2.3 Previous disturbance and site history

The local area around the Site has been used as grazing land for many years. There is evidence of clearing and disturbance associated with livestock primarily in the vicinity of Nolans Bore. This bore, including cattle yards, was for a long time the only stock watering point in a 15 km^2 area. As a consequence, vegetation in and around the bore has suffered significant long term degradation.

Vegetation clearing within and surrounding the Nolans Site also has been associated with construction of a gas pipeline, the development of the Stuart Highway and a range of other roads and tracks.

An abrupt tree-line surrounding the paddock north-east of Nolans Bore suggests that that area (~20 ha) has been cleared for grazing. Mineral exploration activity has also contributed to localised losses of native vegetation, in association with drilling, vehicle access etc.

3. Methods

3.1 Previous Survey

Fauna assessments for the Nolans Study area have been undertaken over a period of 9 years from 2006 to 2015. Table 2 summarises these assessments.

This report limits the description of survey methods and results to survey carried out by GHD in 2010/11 and 2015.

Table 2 Summary of fauna assessment at the Nolans Site 2006 to 2015

Date	Reference	Description
4 – 7 May 2006	Low Ecological Services	Landscape flora and fauna survey of mine site only.
21 – 24 November 2006	Low Ecological Services	Landscape flora and fauna survey of mine site.
30 August – 8 September 2010	GHD	Fauna survey of mine site and a proposed haul route (note: haul route no longer included in proposed project footprint).
8 – 9 December 2011	GHD	Targeted Black-footed Rock-wallaby (MacDonnell Ranges race) survey of mine site only.
27 April – 3 May 2015	GHD	Fauna survey of current Project Area incl. mine site, processing site, accommodation facility, access roads, utilities corridor (potable water pipeline, water supply pipeline, power line corridor) and borefield area
23 – 26 July 2015	GHD	Targeted surveys for Black-footed Rock-wallaby in the eastern end of the Reynolds Range, Hann Range, Reaphook Hills and outcrops in between.
21 – 23 July 2015.	GHD	The borefield area surveys were undertaken to detect presence of any threatened species including the Great Desert Skink, Brush-tailed Mulgara and Greater Bilby

3.2 Baseline fauna assessment

3.2.1 Desktop assessment

Desktop reviews of government database information relating to fauna distributions were conducted at various stages of the project (i.e. 2010/11 and 2015). The most recent review was undertaken in early 2015, and drew on information from all earlier reviews and field assessments. The 2015 desktop review included the following:

- The Commonwealth DotE Protected Matters Search Tool (PMST) was used to identify Matters of national environmental significance potentially occurring in the Study area. The PMST considers fauna species and communities listed under one or more provisions of the EPBC Act, and is based on predicted distributions of fauna species and communities and/or their habitat, rather than known records. The PMST may predict the

occurrence of a species or community in an area when there are no documented records from the area. The PMST was used to identify matters of national environmental significance within 10 km of the Study area. Information was downloaded in February 2015 in the form of an Environmental Report from the website http://www.environment.gov.au/erin/ert/epbc/index.html

- The DLRM Fauna Atlas database was used to identify actual records of all fauna species known to occur (rather than predicted to occur) within 10 km of the Study area
- A fauna species list for the Burt Plain Bioregion (BPB)
- Past survey reports (see Table 2) were reviewed to identify additional fauna species records in or near the Study area since 2006.

3.2.2 Field assessment

Prior to the site visits, aerial imagery and maps were used as a basis for initial selection of sites for fauna survey. This allowed selection of sites in a representative range of vegetation/habitat types. Results from previous flora and vegetation survey, where available was used as a basis for preliminary selection of sites for fauna survey.

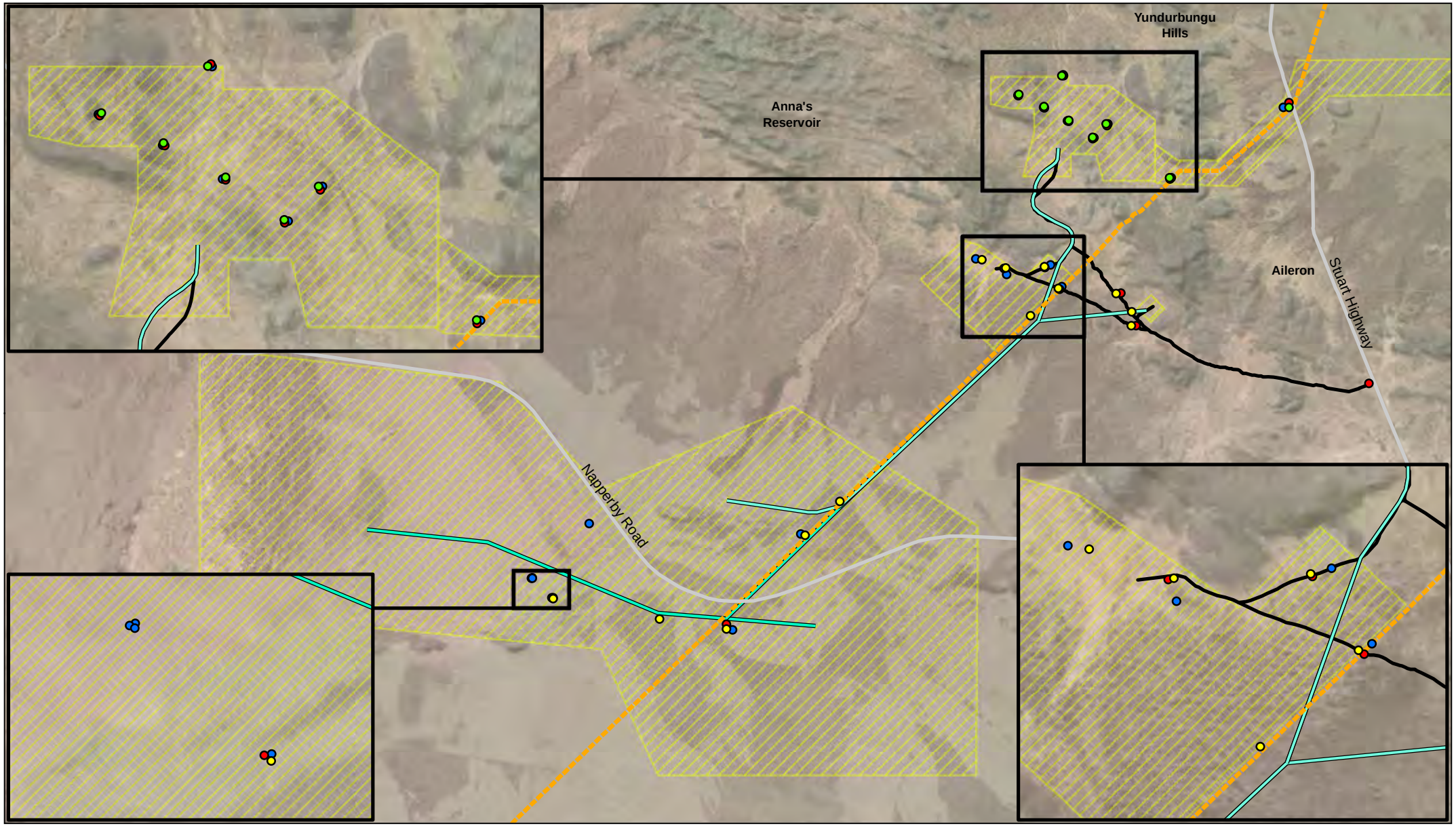
Sites were then ground-truthed on the first day at the site, to verify their vegetation/habitat characteristics, or to move them to more appropriate locations (e.g. away from heavily disturbed areas). Areas selected were those considered to provide higher quality habitat for fauna, based upon vegetation structure, topographic location, and habitat features (e.g. presence of rock outcrops, hollow-bearing trees, creeklines, long grass, leaf litter). The choice of sites was made in an effort to maximise the likelihood of detecting fauna, including threatened species.

Special consideration was given to habitats that were considered most likely to support threatened fauna species and/or populations listed under the EPBC Act and/or TPWC Act, in accordance with the NT EPA ToR. These included, but were not limited to Black-Footed Rock-Wallaby (*Petrogale lateralis* MacDonnell Ranges race), Great Desert Skink (*Liopholis kintorei*) and Greater Bilby (*Macrotis lagotis*).

Field assessment during the 2010/11 and 2015 surveys is summarised in Table 3 below. Baseline survey sites have been mapped in Figure 3.

Table 3 Baseline fauna survey schedule and brief description

Baseline fauna assessment			
Timing	**Team description**	**Extent of survey area**	**Brief Description**
27 April – 3 May 2015 Surveys were in accordance with a TPWC Act permit issued to GHD by the Northern Territory Parks and Wildlife Commission (Permit number 54773, expiry date 01 June 2015).	Eight zoologists (five from GHD and three from Low Ecological) and four Anmatyerr (Ti Tree) Rangers	The Nolans Site including the Processing site (~3,000 hectares). The Accommodation Village site (~100 hectares). Accessible and representative habitats within the Borefield area (~41,000 hectares). The utilities corridor adjacent/south of the existing gas pipeline route.	Thirteen survey sites were established in representative vegetation communities across the Site. In accordance with NTEPA Guidelines and survey standards (NTEPA 2013), each survey site was centred on a 50 m x 50 m area (0.25 hectares). Figure 3 shows the locations of the fauna survey sites and the vegetation types. Appendix A contains images of the survey sites.
August 30 - September 8 2010 Surveys were in accordance with a TPWC Act permit issued to GHD by the Northern Territory Parks and Wildlife Commission (Permit number 32827, expiry date 16 February 2011).	Four GHD zoologists	Mine site area (~1,400 hectares) and along the proposed haul route between the proposed mine site and the rail line to the east.	Twelve survey sites were established - Six general fauna survey locations were established in the proposed mine area, and an additional six sites were established along the proposed haul route (Figure 3). Opportunistic records were made in habitats between sites when time allowed (i.e. when traps were not being checked and other required survey effort was not being undertaken at designated sites).



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0 2 4 6 8

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

N

LEGEND

- 2010 Fauna Sites
- 2015 Fauna Sites
- Anabat locations
- Camera locations
- Roads
- Access Roads
- Gas Pipeline
- Railway
- Proposed Pipelines
- Study Area

1 2

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Nolans Project

Job Number	4322301
Revision	0
Date	30 Mar 2016

Baseline fauna survey sites 2010 and 2015 (Map 1 of 2)

Figure 3

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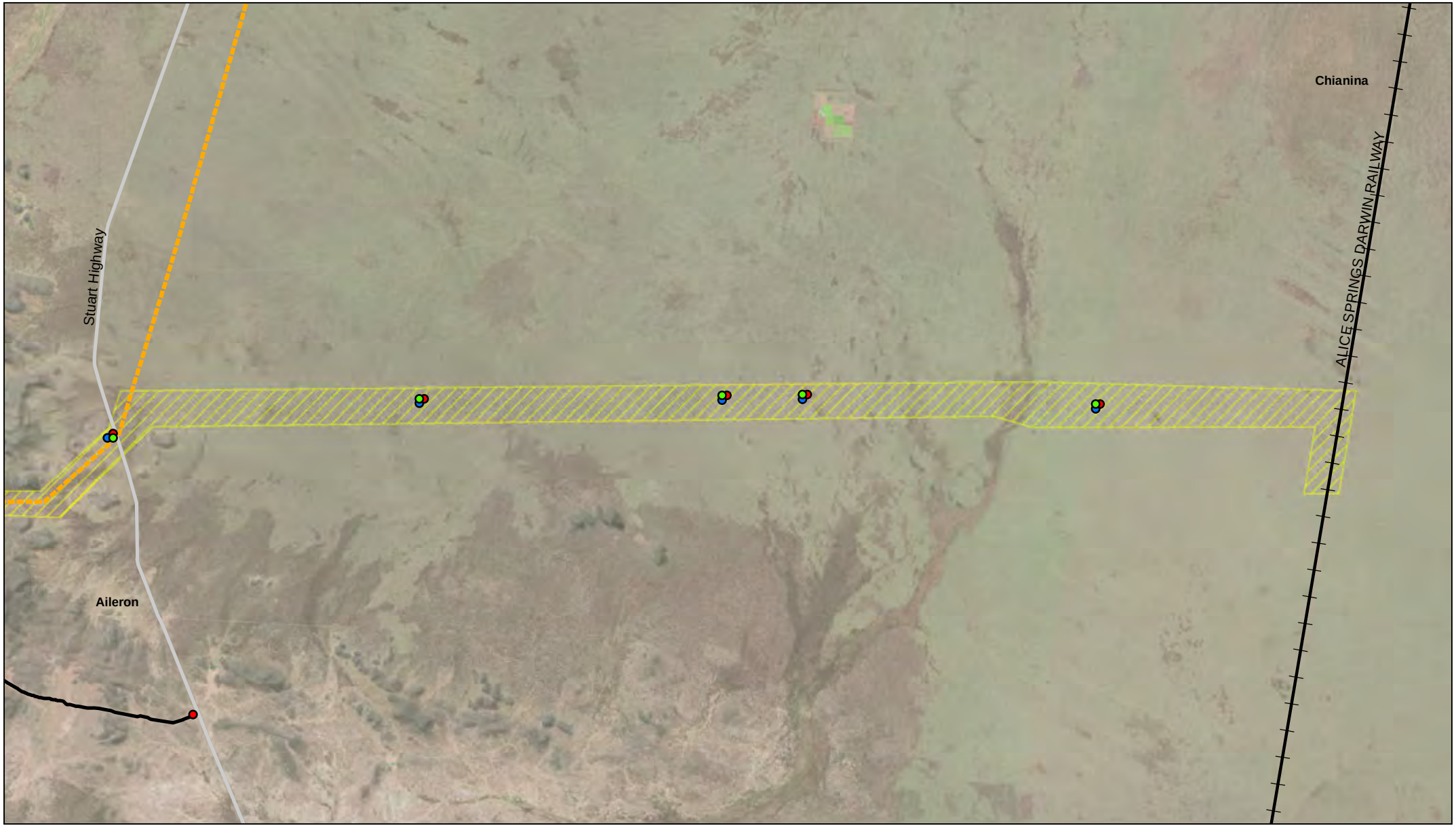
Level 5 66 Smith Street Darwin NT 0800 Australia **T** 61 8 8982 0100 **F** 61 8 8981 1075 **E** drwmail@ghd.com **W** www.ghd.com

Data source: GA - Imagery (2008), Roads, Gas Pipeline, Reserves (2015). GHD - Fauna Survey Sites, Study Area (2015). Created by: CM



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0 2 4 6 8

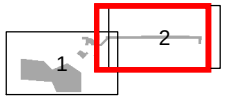
Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

N

LEGEND

- 2010 Fauna Sites
- 2015 Fauna Site
- Anabat locations
- Camera locations
- Roads
- Access Roads
- Gas Pipeline
- Railway
- Study Area



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Nolans Project

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Baseline fauna survey sites 2010 and 2015 (Map 2 of 2)

Figure 3

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Level 5 66 Smith Street Darwin NT 0800 Australia **T** 61 8 8982 0100 **F** 61 8 8981 1075 **E** drwmail@ghd.com **W** www.ghd.com

Data source: GA - Imagery (2008), Roads, Gas Pipeline, Reserves (2015). GHD - Fauna Survey Sites, Study Area (2015). Created by: CM

3.2.3 Weather

Weather observations during the survey periods were obtained from the Bureau of Meteorology Territory Grape Farm weather station: 015643.

Environmental conditions during the 2010 baseline fauna survey were variable. The daily average maximum temperature was 25.7 ˚C (range 22.1 ˚C to 31.8 ˚C) with an overnight average minimum of 10.4 ˚C (range 7.8 ˚C to 16.4 ˚C). Wind strength and direction were highly variable, as was cloud cover. Above-average rainfall fell during 2010 (>550 mm recorded between January and August 2010), with heavy rains over the 2-4 weeks prior to the survey. Heavy rain (51.8 mm) fell over a 24-hour period during the survey (3-4 September 2010). Many of the tracks were waterlogged, with extensive puddles across roads. Some ephemeral waterways flowed for a period of 1-2 days.

During the 2015 baseline fauna survey, environmental conditions were cool, dry and sunny. Maximum daily temperatures ranged from 22.4 to 28.2 ºC, and overnight minima ranged from 4.9 to 10.2 ºC. Conditions were windy, with average maximum wind gusts of 46 km/h in a SE/ESE direction. No rain fell during the six-day survey period.

In the months prior to the 2015 baseline survey, the area experienced hot and dry conditions. Mean daily maxima and minima between February and March were higher than the long-term averages, but much lower for April than the long-term average (Table 4). Only 18.6 mm of rain fell in the area in the month prior (Mar 27 – Apr 27). Rainfall during the preceding year (from May 2014 to the end of April 2014) totalled 332.2 mm, which was only 15.5 mm (4.89%) higher than the long-term (27-year) average for that period (316.7 mm). Between February and April, only 35.4 mm of rain fell, which represented 33.5% of the long-term mean rainfall (105.7 mm) for that period.

The conditions encountered during both surveys were generally acceptable for baseline fauna surveys, particularly daytime temperatures and conditions. However, the wet 24-hour period during 2010 and the relatively cool nights in the early part of the 2015 survey are considered likely to have resulted in less fauna activity than would otherwise be expected.

Table 4 Weather conditions experienced prior to and during the 2015 fauna survey (BOM; Territory Grape Farm NT)

Month / Day	Rainfall (mm)	Mean max. temp (oC)	Mean min. temp (oC)
Feb 2015	0.0	38.0	21.9
March 2015	16.8	36.7	19.2
April 2015	18.6	28.2	13.0
April 27	0.0	23.2	10.2
April 28	0.0	22.6	8.0
April 29	0.0	22.4	5.6
April 30	0.0	22.4	6.2
May 1	0.0	24.9	4.9
May 2	0.0	27.4	7.3
May 3	0.0	28.2	7.6

3.2.4 Survey techniques

Survey techniques followed the *Standard terrestrial vertebrate survey methods used by the Department of Land Resource Management* (Appendix A in NT EPA 2013). Table 5 provides a summary of survey effort at each site (focussed on a 50 m x 50 m survey area).

Sites N11, N12 and N13 did not follow the standard methods. The set up for these sites is discussed in the relevant sections below, along with additional explanatory notes.

Survey methods for 2010/11 differed slightly from those used in 2015, but still they effectively sampled a similar area of habitat at sites across the study area, with a comparable survey effort.

A detailed description of the survey methodology at each site is provided below.

Habitat Assessment

Vegetation characteristics across the Study area were formally assessed by botanists that were undertaking vegetation and flora assessment at the Site. Information collected by the botanists was further augmented during the fauna surveys with assessments of the fauna habitat features at each site.

Baited Elliot-type traps

Twenty Elliot-type box traps (size A) were placed around the perimeter of the 50 m x 50 m quadrat boundary at each site.

Traps were placed approximately 8 m apart in suitable microhabitats (e.g. with suitable cover and shade) and marked with a labelled piece of flagging tape attached to a nearby tree or shrub to assist with finding traps during the period of the survey and to ensure that all traps were accounted for at the end of the survey. Traps were baited with a suitably moist mixture of rolled oats, honey and peanut butter (widely used standard recipe for attracting small mammals). Every second trap was also baited with 'Good-O' dry dog food to attract carnivores. Traps remained open for four days and four nights (which exceeds the minimum period of three nights/days required by NT EPA). Traps were checked once each morning and once each mid-late afternoon. Bait was refreshed once during the survey period.

At sites N11, N12 and N13, ten Elliot traps were placed 8 m apart along a line through the middle of the quadrat.

During the 2010/11 survey twenty Elliot traps were placed 10 m apart along the length of a 200 m transect through each of the 12 sites, instead of being placed around the perimeter. Traps remained open for three nights at all sites except two: access difficulties after heavy rain resulted in one night of trapping at site T07 and four nights at site T08.

Pitfall bucket traps

Four pitfall traplines were established in the quadrat at each site. Each pitfall trap comprised a single 20-litre bucket dug into the ground such that its lip was flush with ground-level, and bisected by a firm but flexible (e.g. fly wire or stiff plastic sheeting) 'drift fence' (10 m long and 35 cm high) to direct animals into pits. Each bucket was supplied with approximately 3 cm of soil, a piece of bark (or other cover) and some leaf litter or dense grass in its base to provide protection for animals while in the trap.

Traps remained open for four days and four nights (which exceeds the minimum period of three nights/days required by NT EPA). Where possible, pits and drift fences were scattered through the different microhabitats in the quadrat (e.g. in open ground, in dense grass, close to trees, in rocky areas). Traps were checked once each morning and once each mid-late afternoon.

In an effort to increase the fauna capture rate, each pitfall trapline was also allocated two funnel traps, one at each end of the fence (see next section). This too exceeds the NT EPA survey guidelines. It was noted where fauna were captured in the additional traps as distinct from the pitfall buckets.

Pitfall buckets were not used at sites N11, N12 and N13.

In the 2010/11 survey, traplines were established along a 200 m transect, with one trap line in each 50 m section of the transect, instead of four traplines being established within a quadrat. Traps remained open for three nights at all sites except two: access difficulties after heavy rain resulted in one night of trapping at site T07 and four nights at site T08. The ground at Site M02

(in the mine site area) was too rocky to bury two of the pitfall buckets. Instead, funnel traplines (three funnels each) were installed at those locations.

Funnel traps

Two funnel traplines were established in the quadrat at each site. Each funnel trapline consisted of a firm but flexible (e.g. fly wire or stiff plastic sheeting) 'drift fence' (10 m long and 35 cm high) to direct animals into traps. Traps were placed on each side of the fence, mid-way along (two funnel traps per trapline). Each funnel trap was covered with a sheet of aluminium foil to protect and shade animals while in the trap. Traps remained open for four days and four nights (which exceeds the minimum period of three nights/days required by NT EPA). Funnel lines were placed in different microhabitats in the quadrat (e.g. in open ground, in dense grass, close to trees, in rocky areas). Traps were checked once each morning and again mid-late afternoon.

Funnel traps were added to pitfall traplines at Sites N01-N10 also (one at each end of the pitfall trapline fence) in an effort to increase the fauna capture rates (see previous survey technique).

Four funnel traplines were installed at each of sites N11, N12 and N13.

2010/11: During the 2010/11 survey funnel traps were used in conjunction with pitfall traplines only; two funnel traps were placed approximately midway between the bucket and the end of the fence (see Pitfall bucket traps above). Additional funnel-only traplines were not used.

Anabat® bat call detection

Anabat® bat call detection units were used to collect the high frequency calls of micro-chiropteran bats. Anabat® units were deployed overnight at representative sites. Units were placed in open areas (i.e. devoid of nearby vegetation to avoid interference and non-bat noise) with the microphone oriented upwards at 45^{o}. Units were set to operate at a sensitivity level of 7 (where the maximum is 10). Recordings were downloaded and referred to a bat specialist for analysis.

Anabat units were deployed for one night each at Sites N02, N03, N04, N05, N08, N11, N13, and at a waterhole near the Stuart Highway east of the Processing Site (Figure 4).

Bat calls were recorded using four Anabat detectors (Titley Scientific, Brisbane). Survey data were downloaded from the detectors and saved as zero-crossing (ZC) format call sequence files (i.e. "Anabat files"). The resulting data from 2015 were sent to Greg Ford, Balance! Environmental) for analysis.

All Anabat files were viewed by Balance! Environmental using AnalookW (Corben 2013), with species identification achieved manually by comparing the sonograms with those of reference calls from Queensland and the Northern Territory and/or with published call descriptions (e.g. Reinhold *et al*. 2001; Milne 2002; Pennay *et al*. 2004). Calls with fewer than four clearly-defined, non-fragmented pulses were excluded from the identification process. Species' identification was also guided by considering probability of occurrence based on general distribution information (Churchill 2008; van Dyck & Strahan 2008) and/or database records obtained from the Atlas of Living Australia (http://www.ala.org.au/ALA 2015).

During the 2010/11 survey the intention was to deploy Anabat units for two nights at each location, however one of the units was damaged by cattle on the second night. Consequently, one night of survey was achieved at sites T08 and T12. The 2010 data were sent to Ecological Management Services Environmental Consultants for analysis.

Bird surveys (including Instantaneous Bird Count)

Bird survey counts involved one zoologist compiling a complete list of all birds seen, heard or otherwise detected in the vicinity of the survey quadrat. GHD ecologists incorporated the standard NT 'instantaneous' bird count method from a single point, but then increased the

survey effort by walking slowly through and around the 50 m x 50 m quadrat area (also covering a width of around 25 m on all sides of the transect) to survey a 1 ha area (approximately) over an approximate 20-minute time period. Notes were kept on whether birds were inside or outside the 0.25 ha quadrat, and whether species were detected during the 'instantaneous' count or during the period that followed. Where possible, numbers of individuals were noted, along with any detected breeding activity, unusual habitat use or other specific interactions (e.g. potential predation). The surveys were mostly completed within two hours of sunrise and in the late afternoon when birds were most active.

During the 2010/11 survey the use of the 200 m transect rather than a 50 m x 50 m quadrat altered slightly the instantaneous bird count method to increase the survey effort. Rather than undertaking an 'instantaneous' count from a relatively static location, assessors moved gradually along the 200 m transect, also covering a width of around 50 m (i.e. approx. 25 m on either side of the transect) to achieve a 15-20 min survey over a 1 ha area. Bird counts at each site were done at least five times (and up to 11 times). At least one count at each site was made after sunset.

Active search (Diurnal)

Active searches involved one or more zoologist/s searching a site (e.g. 50 m x 50 m in 2015 and 200 m x 20 m in 2010/11) during daylight hours for the presence or signs of animals, usually over a period of approximately 20 minutes.

Active searching can be useful for detecting cryptic ground and tree-dwelling fauna, particularly reptiles that may not be captured in traps. It is also useful for detecting indirect evidence of fauna species (i.e. tracks, scats, bones, sloughed skin and hair samples).

Ground, rock and tree surfaces were scanned, and under surfaces of rocks, logs, bark, clumps of vegetation and other debris (if present) examined for presence or signs of animals. All vertebrate fauna detected were noted. Where possible, reptiles were captured or photographed for identification. Some species were identifiable without the need for capture. Indirect evidence of fauna was documented and/or collected for later identification (i.e. tracks, scats, bones, sloughed skin and hair samples). Diurnal active searches at sites were conducted opportunistically, but typically involved at least some searching each day during trap checking.

Active searching (diurnal) was also conducted at all times while driving around the Study area to/from/between sites and during incidental observations. Daily coverage of the Study area is shown in Figure 4.

Active search (Nocturnal)

During the survey nocturnal surveys were conducted at sites and at other locations throughout the Project footprint thought to be most likely to yield signs of threatened species (Figure 5).

Each nocturnal survey was undertaken by four teams of two people (four vehicles) using a combination of two methods: slow driving along formed tracks, to cover greater distance and to search for larger, fast-moving animals (e.g. Greater Bilby, *Macrotis lagotis*), and foot-based searches using strong head-torches, to search for smaller animals and to listen more to the night sounds.

Driving surveys were undertaken along access tracks and along the existing gas pipeline road. Foot-based searches were conducted at sites and in other topographic areas of interest (e.g. rocky outcrops, sandplain areas, creek-lines) by teams of two ecologists for at least 20 minutes, using strong head-torches to aid the detection and identification (and possibly capture) of fauna species. All vertebrate fauna detected by either method were noted.

Motion-sensing cameras

2015: In addition to the standard fauna survey techniques, motion-triggered trail cameras (e.g. ScoutGuard) were used opportunistically in an effort to gain more information on specific features that were found (e.g. areas that had active burrows). Motion-triggered cameras are used increasingly in surveys for fauna (particularly mammals) across Australia. They are now generally accepted as a viable and cost-effective means to test for presence of some animals within a study site, and can be used in larger numbers to obtain estimates of detection probabilities (i.e. occupancy) against other survey methods for cryptic species. Cameras used for this project were digital cameras triggered by a sensor that detects changes in motion and heat as an animal moves across the field of view. The camera and sensor are housed in a weatherproof case designed to allow operation in most field conditions. An in-built infrared flash allows the camera to photograph animals in darkness (i.e. without a detectable white-light flash).

A single camera was used at each survey site in 2010/11 and eleven units were deployed during the 2015 survey (Figure 3), with the main objective of detecting the Greater Bilby (*Macrotis lagotis*) and the Great Desert Skink (*Liopholis kintorei*), as these species can be difficult to detect, particularly when in small populations.

Cameras were secured to trees or stakes, with a clear line of sight towards the focal area. Cameras were deployed facing burrows, latrines, or towards a bait (peanut butter, honey, oats and sardines), which was buried shallowly within range of the camera's motion detector. Photos were downloaded and analysed after the survey.

Cameras were placed at Sites N05, N06, N08, N11 and N13, as well as three cameras at the burrow/latrine sites and one along the fence track in sandplain spinifex habitat.

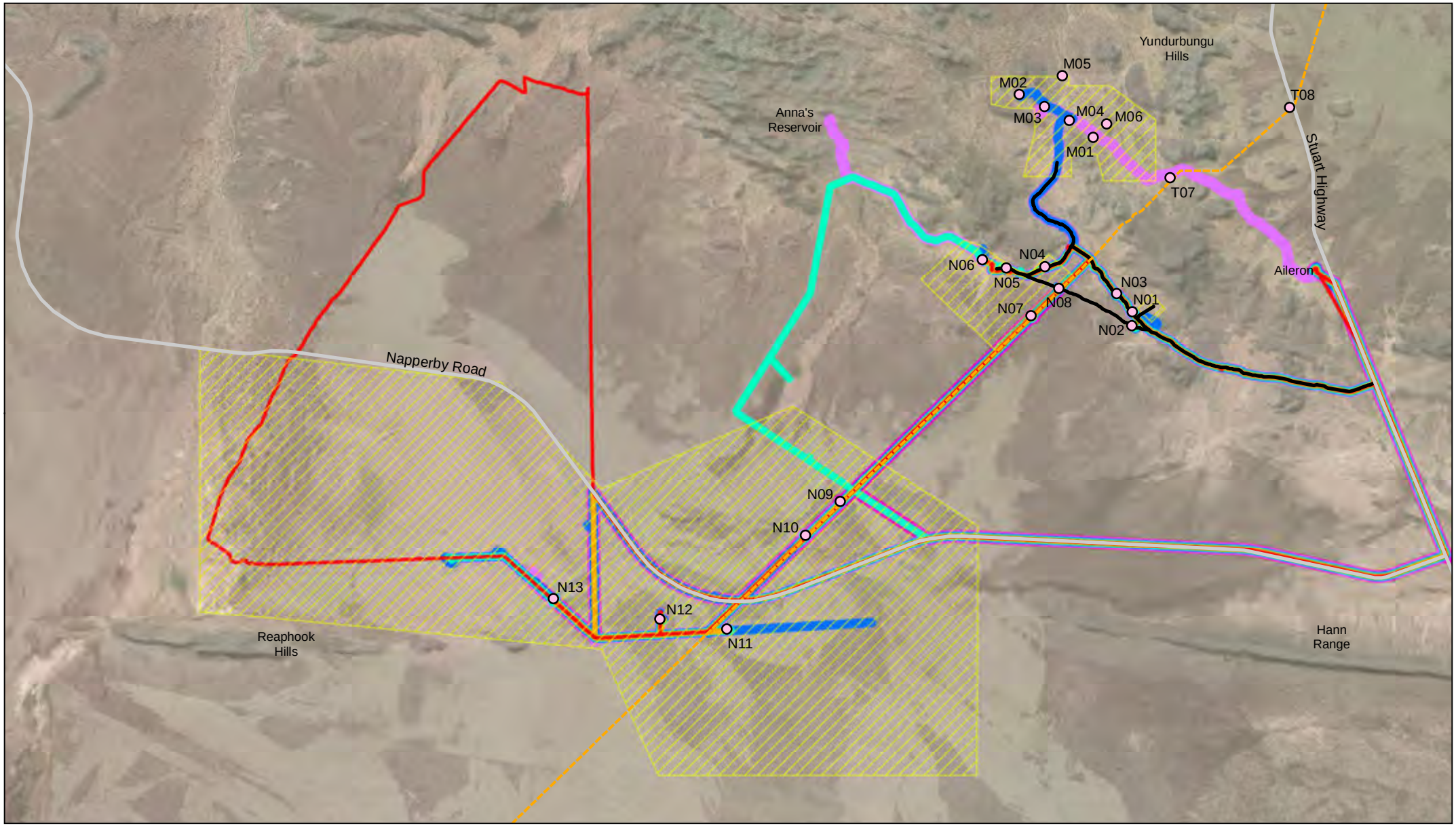
Opportunistic (incidental) observations

All observations of fauna made within and near the Nolans Site during the survey were recorded. These included observations by eight zoologists and four rangers over the entire survey period, including five x 12-hour days/nights (see Figure 4 and Figure 5 for diurnal/nocturnal coverage of Study area).

Opportunistic observations were documented while undertaking habitat assessments, when driving between parts of the study area, during on-site meetings and while installing, checking or collecting fauna traps. Incidental observations are important for documentation of less common fauna, particularly fauna that are not captured in traps (e.g. macropods, other larger mammals, most birds).

Snail searches

Habitats considered suitable for snails (rocky outcrops, particularly near the base of trees, in leaf litter and other damp areas) were searched for the presence of snails. Snail shells were collected for analysis. In accordance with permit conditions, single live snails were collected from locations where they were detected, and preserved in a 70% ethanol mix.



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Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

N

LEGEND

- Fauna Sites
- Roads
- Gas Pipeline
- Access Roads

Survey Tracks

- Day 1
- Day 2
- Day 3
- Day 4
- Day 5
- Day 6
- Day 7

Study Area

Arafura Resources Limited
Nolans Project

Job Number	4322301
Revision	0
Date	18 Mar 2016

2015 Baseline fauna survey effort diurnal coverage of study area

Figure 4

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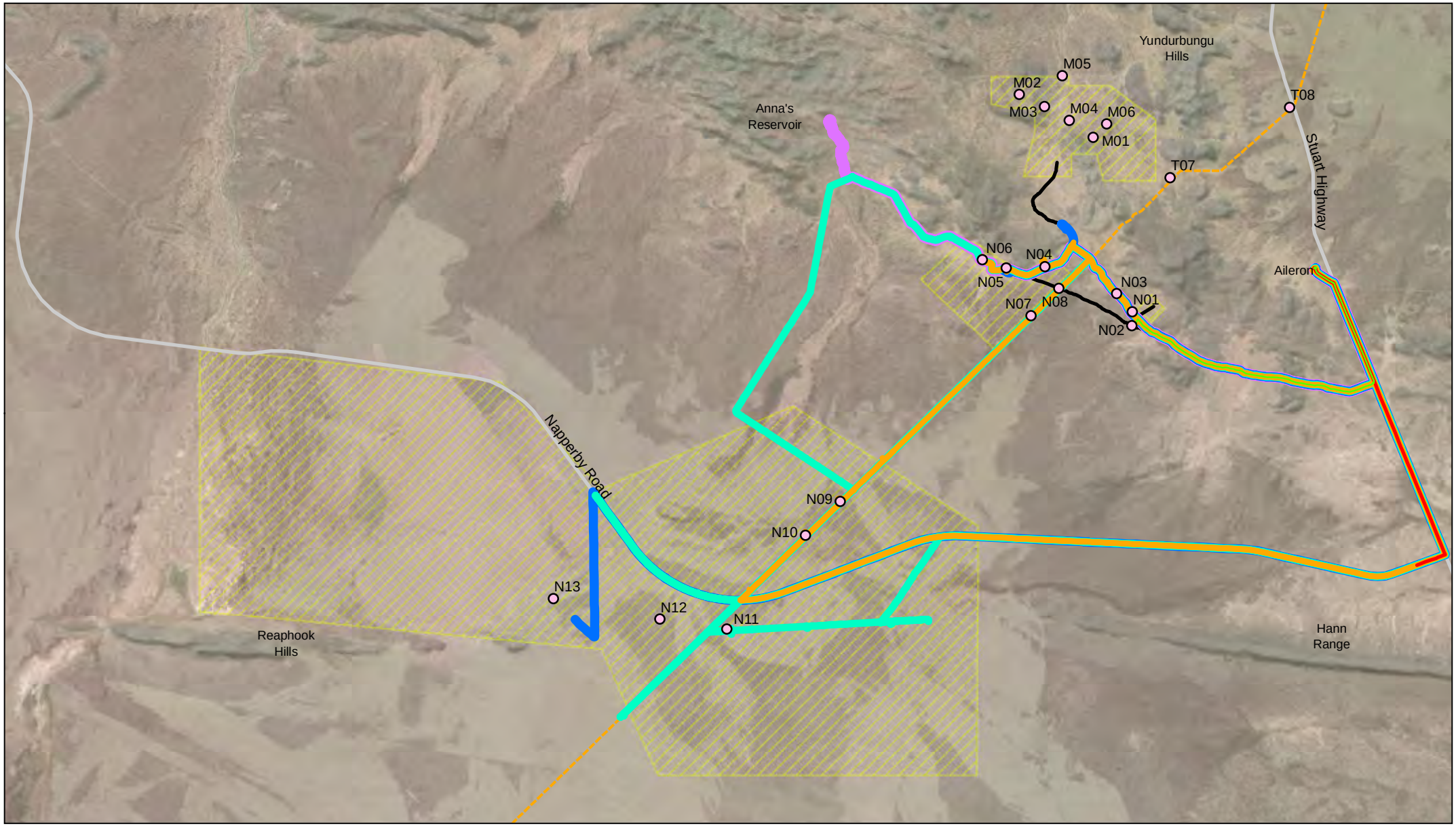
Level 5 66 Smith Street Darwin NT 0800 Australia **T** 61 8 8982 0100 **F** 61 8 8981 1075 **E** drwmail@ghd.com **W** www.ghd.com

Data source: GA - Imagery (2008), Roads, Gas Pipeline (2015). GHD - Fauna Survey Sites, Proposed Mine Site, Proposed Treatment Plant, Proposed Accommodation Village, Borefield Area (2015). Created by: CM



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0 2 4 6 8

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

N

LEGEND

- Fauna Sites
- Roads
- Gas Pipeline
- Access Roads

Survey Tracks

- Day 1
- Day 2
- Day 3
- Day 4
- Day 5
- Day 6
- Study Area

Arafura Resources Limited
Nolans Project

Job Number	4322301
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Date	18 Mar 2016

2015 Baseline fauna survey effort nocturnal coverage of project area

Figure 5

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Level 5 66 Smith Street Darwin NT 0800 Australia **T** 61 8 8982 0100 **F** 61 8 8981 1075 **E** drwmail@ghd.com **W** www.ghd.com

Data source: GA - Imagery (2008), Roads, Gas Pipeline (2015). GHD - Fauna Survey Sites, Proposed Mine Site, Proposed Treatment Plant, Proposed Accommodation Village, Borefield Area (2015). Created by: CM

Table 5 Summary of fauna survey effort at sites during the 2010 and 2015 baseline fauna surveys

Survey	2010: Mine Site Area	2010: Haul Route	2015 survey
Survey Type	**6 survey sites (M01 to M06)** **31 Aug – 8 Sept 2010**	**6 transects (T07 to T12)** **2 to 8 Sept 2010**	**13 survey sites (N01 – N13)** **27 April to 3 May 2015**
Habitat Assessment	Each survey site – ~1 hour ~25 km of driven tracks ~4 person hours investigating elsewhere	Each survey site – ~1 hour ~60 km of driven tracks ~4 person hours investigating elsewhere	Conducted over approximately two person-hours per site, investigating quadrat area through various survey methods.
Pitfall trapping	Sites M01, M04, M05, M06 – 3 nights, 4 trap lines each with one bucket Sites M02 & M03 – 3 nights, 2 trap lines each with one bucket 60 trap-nights	Site T07 – one night, 4 trap lines each with one bucket Site T08 – 4 nights, 4 trap lines each with one bucket 20 trap-nights	Four 10 m pitfall traplines, each with one bucket, for ten sites (N01 – N10), checked twice daily for four days and nights. 160 trap-nights
Funnel trapping	Sites M01, M04, M05, M06 – 3 nights, 4 trap lines each with 2 funnels (and one bucket) Sites M02 & M03 – 3 nights, 2 trap lines each with 2 funnels (and one bucket) Sites M02 & M03 – 3 nights, 2 trap lines each with 3 funnels 156 trap-nights	Site T07 – one night, 4 trap lines each with 2 funnels (and one bucket) Site T08 – 4 nights, 4 trap lines each with 2 funnels (and one bucket) Sites T09 to T12 – 3 nights, 4 trap lines each with 3 funnels 184 trap-nights	Ten sites (N01 – N10), each with four 10 m pitfall traplines, each trapline with two funnels (and one bucket), for four nights. Ten sites (N01 – N10), each with two funnel traplines (two funnels on each) over four nights. Four 10 m traplines (each with two funnel traps) for three sites (N11 – N13). 504 trap-nights in total
Elliot Trapping	Six sites (M01 – M06) - 20 traps at each, for 3 days and nights, checked twice daily 360 trap-nights	Site T07 - 20 traps for 2 days and one night Site T08 - 20 traps for 4 days and nights, checked twice daily Site T09 to T12 - 20 traps for 3 days and nights, checked twice daily 340 trap nights	Ten sites (N01 – N10), each with 20 baited Elliot traps for four nights. Three sites (N11 – N13), each with 10 Elliot traps for three sites, checked twice daily for four days and nights. 920 trap-nights

Survey	2010: Mine Site Area	2010: Haul Route	2015 survey
Survey Type	**6 survey sites (M01 to M06)** **31 Aug – 8 Sept 2010**	**6 transects (T07 to T12)** **2 to 8 Sept 2010**	**13 survey sites (N01 – N13)** **27 April to 3 May 2015**
"Anabat"®	All six sites (M01 – M06) – one unit for two nights 12 Anabat survey-nights in total	Sites T07, T09 to T11 – one unit for two nights Site T08 and T12 – one unit for one night 10 Anabat survey-nights in total	Eight sites, one survey-night at each (N02, N03, N04, N05, N08, N11, N13, waterhole near gate). 8 survey-nights in total
Remote Surveillance cameras	All six sites (M01 – M06) – one unit for three nights 18 camera survey-nights in total	Site T07 – one unit for one night Site T08 – one unit for four nights Site T09 to T12 – one unit for three nights 17 camera survey-nights in total	Eleven units were deployed during the survey, each for at least 30 days and nights (N05, N06, N08, N11 and N13, three cameras at burrow/latrine site, and one along Fence track). At least 330 camera survey-nights in total.
Active Searches (diurnal)	Each site – two diurnal searches of 10+ minutes each Minimum of 2 hours active searching 8+ scats and 1 bone sample collected and sent for analysis	Each site – two diurnal searches of 10+ minutes each Minimum of 2 hours active searching 3+ scats and one bone collected and sent for analysis	Conducted opportunistically by at least one ecologist at sites and other locations, depending on conditions Minimum of 1.5 hours active searching per site.
Active searches (nocturnal)	Each site – one nocturnal search of 10+ minutes each Minimum of 1 hour active searching	Each site – one nocturnal search of 10+ minutes each Minimum of 1 hour active searching	3 x three-hour nocturnal searches by four teams of two people at sites and other locations, including road spotlighting through Study area and along existing access tracks. Minimum of 72 person-hours active searching in total.
Instantaneous Bird Counts	Each site – one nocturnal bird count; Diurnal counts: M01 - 6; M02, M03, M05 & M06 – 8; M04 - 10;	Each site – one nocturnal bird count Diurnal counts: T07, T10 & T11 – 6; T08 – 8; T09 & T12 – 5	At least four 20-minute diurnal surveys at each site, incorporating 'instantaneous bird counts'.

Survey	2010: Mine Site Area	2010: Haul Route	2015 survey
Survey Type	**6 survey sites (M01 to M06)** **31 Aug – 8 Sept 2010**	**6 transects (T07 to T12)** **2 to 8 Sept 2010**	**13 survey sites (N01 – N13)** **27 April to 3 May 2015**
	54 instantaneous bird counts in total	42 instantaneous bird counts in total	52 bird counts in total.
Opportunistic (incidental) observations	Four zoologists over four 12 hour days during set-up and survey, total survey effort 192 hours 420+ observations recorded	Four zoologists over four 12 hour days during set-up and survey, total survey effort 192 hours 90 observations recorded	Eight zoologists and four rangers over the entire survey period (five 12-hour days during set-up and survey). Minimum of 720 person-hours of opportunistic observation.
Snail searches	Two zoologists targeting snail collection in areas of suitable habitat on two days (5-6 Sept 2010), plus opportunistically at other times. Minimum of 4 hours active searching	Four zoologists targeting snail collection in areas of suitable habitat on one day (7 Sept 2010), plus opportunistically at other times. Minimum of 4 hours active searching	Assessed / Collected opportunistically. Snails sent to NT Museum.

3.3 Targeted surveys for threatened fauna species

During baseline fauna survey, and/or during review of the Commonwealth DotE PMST data, a number of EPBC-listed fauna species were identified as being present or potentially present in the Study area including:

- Black-footed Rock-wallaby (*Petrogale lateralis* MacDonnell Ranges race)
- Brush-tailed Mulgara / Crest-tailed Mulgara (*Dasycercus cristicauda*) (but see discussion on these species in Section 1.5.1)
- Greater Bilby (*Macrotis lagotis*)
- Great Desert Skink (*Liopholis kintorei*).

These species are rare, cryptic and/or sparse, and require targeted and non-standard survey methods to maximise the chances of detection. Survey objectives and efforts for these species are described below.

3.3.1 Objectives of the Black-footed Rock-wallaby survey

The objectives of the Black-footed Rock-wallaby survey were to:

- Document known locations of Black-footed Rock-wallaby in the eastern Reynolds Range area and characterise their habitats
- Compare Black-footed Rock Wallaby habitat and populations in the vicinity of the mine lease with those in the broader survey sample area
- Predict possible locations of Black-footed Rock-wallabies in areas of eastern Reynolds range that were not sampled (e.g. determine other nearby suitable habitat based on current knowledge of habitat)
- Assess the likely local and regional impacts of the Project on the species in relation to the EPBC Act 'significant impact criteria', and using a 'risk based' approach
- Develop mitigation measures and a future monitoring framework for this species in order to monitor potential impact
- Provide advice on compliance with legislation and policy.

3.3.2 Objectives of the borefield area survey

- Document known locations of Great Desert Skink, Mulgara and Greater Bilby burrows in the proposed access roads, potable water pipeline and water supply pipeline
- Map burrows detected in the proposed access roads, potable water pipeline and water supply pipeline footprint and provide recommended alternative routes if necessary
- Discuss the potential impacts of the mining proposal on these species
- Assess the likely local and regional impacts of the Project on the species in relation to the EPBC Act 'significant impact criteria', and using a 'risk based' approach
- Develop mitigation measures and a future monitoring framework for this species in order to monitor potential impact
- Provide advice on compliance with legislation and policy.

3.3.3 Desktop Assessment

In addition to the desktop assessment process described in Section 3.2.1 above, the DLRM fauna database and the scientific literature were reviewed to provide background information on the biology and conservation status of each of the threatened species.

3.3.4 Field assessment

Table 6 provides a summary of the level of effort applied to targeted threatened species survey at the Nolans site in 2011 and 2015. See Figure 7 for a visual representation of survey effort.

Table 6 targeted survey schedule and brief description

Timing	Team	Extent of survey	Brief description
8 – 9 of December 2011	Two GHD zoologists	Diurnal surveys targeting Black-footed Rock-wallaby in and around the Nolans Bore Mine Lease area in areas of rocky habitat; Extensive and intensive spotlighting searches were undertaken in an effort to detect the Greater Bilby (*Macrotis lagotis*) in and around the Nolans Bore Mine Lease.	Investigating areas of potential rock-wallaby habitat, collecting potential rock-wallaby scat, and photographing suitable rock-wallaby shelter habitat using a GPS camera.
21 – 23 July 2015	Three to five ecologists/rangers including Dr Rachel Paltridge (Desert Wildlife Services)	Borefield area survey was undertaken to detect the presence of Great Desert Skink, Brush-tailed Mulgara and Greater Bilby in the proposed access roads and water pipeline corridor; The area included from the gas pipeline to SB027 following the proposed water pipeline, and along existing gas pipeline within the borefield area, and from SB025 to SB008 (Figure 11).	Daylight surveys walking along the transect corridor roughly 5-10 m apart scanning the ground for signs of the threatened species such as scat, burrows, diggings and/or latrines.
23 – 26 July 2015	Three GHD ecologists and Dr John Read (Ecological Horizons)	Targeted surveys for Black-footed Rock-wallaby over a 65,000 ha area in the eastern end of the Reynolds Range, Hann Range, Reaphook Hills and outcrops in between, targeting rocky outcrops, steep slopes, food plant areas.	Surveys were conducted on foot in teams of two during daylight hours. Teams were dropped onto rocky outcrops by helicopter and surveyed sites for approximately one hour at each site.

The borefield area survey was undertaken from 21-23 July 2015, to detect the presence of any threatened species in the proposed access roads and utilities corridor, in accordance with Commonwealth Government's survey guidelines. The survey was primarily targeting the Great Desert Skink, Brush-tailed Mulgara and Greater Bilby. A Great Desert Skink burrow system was found in the borefield area during the 2015 baseline fauna survey.

The survey was conducted during daylight hours, with three to five ecologists/rangers on foot traversing the disturbance corridor, roughly 5-10 m apart and scanning the ground for signs of the threatened species such as scat, burrows, diggings and/or latrines. The total length of corridor surveyed was 37.4 km (see Figure 7).

Any burrows or other signs of threatened species were recorded, including GPS coordinates. The following were also recorded for the pipeline walks:

- Evidence of grazing
- Fire history
- Vegetation cover (spinifex, acacia/mulga, buffel grass)
- Predator signs.

3.3.5 Weather

During the 2015 targeted threatened species survey, environmental conditions were cool, dry and sunny. Maximum daily temperatures ranged from 23.0 to 29.5 ^{o}C and overnight minima ranged from -1.2 to 15.5 ^{o}C (Table 7). Conditions were windy, with average maximum wind gusts of 28.8 km/h NNW for first few days then turning to a SE/ESE direction. No rain fell during the survey period.

In the months prior to the survey, the area experienced cool conditions (Table 7). Mean daily maxima and minima between April and June were lower than the long-term averages, but much lower for April than the long-term average (Table 7). No rain fell in the area in the month prior (June 20 – July 20). Rainfall during the preceding year (from July 2014 to the end of June 2015) totalled 341.1 mm, which was only 24.4 mm (7.58%) higher than the long-term (27-year) average for that period (316.7 mm).

Table 7 Weather conditions experienced prior to and during the July 2015 threatened species surveys (BOM; Territory Grape Farm NT)

Month / Day	Rainfall (mm)	Mean max. temp (^{o}C)	Mean min. temp (^{o}C)
April 2015	18.6	28.2	13.0
May 2015	0.0	25.9	8.9
June 2015	6.6	23.5	7.1
July 21	0.0	23.0	-1.2
July 22	0.0	27.1	7.3
July 23	0.0	29.5	8.2
July 24	0.0	28.6	15.5
July 25	0.0	25.7	10.5
July 26	0.0	25.4	9.4

3.3.6 Survey techniques

The following section describes the survey techniques that were utilised in targeted searches to detect presence of EPBC listed, threatened fauna species.

Targeted surveys for Black-footed Rock-wallaby (Petrogale lateralis MacDonnell Ranges race)

Surveys concentrated on rocky outcrops, crevices, caves and boulder piles where rock-wallabies typically shelter (Ward *et al*. 2011); and vegetated parts of hills and escarpments, particularly grassy areas, where rock-wallabies potentially forage (Ward *et al*. 2011).

Low densities of Black-footed Rock-wallabies can be difficult to detect using ground-based diurnal or spotlighting surveys. Searching for scats is considered a reliable and repeatable technique for detecting low density populations (Sharp 1999). Scats are deposited in the vegetated zones where they forage, on exposed boulders or ledges where they 'bask' and particularly in crevasses, caves or under boulder piles adjacent to secure refuges (Sharman and Maynes 2002). Macropod scats were collected for analysis.

During baseline fauna survey in September 2010, the survey team detected the Black-footed Rock-wallaby in the rocky habitats of the Mine Site area. In December 2011, diurnal surveys were undertaken by two ecologists over 2 days, in and around the Nolans Bore Mine Lease area.

The main activities undertaken were investigating areas of potential rock-wallaby habitat, collecting potential rock-wallaby scats, and photographing suitable rock-wallaby shelter habitat using a GPS camera.

Targeted surveys for Black-footed Rock-wallaby were undertaken by four ecologists on 23 – 26 July 2015. Survey sites were pre-selected over a 650 km^2 area in the eastern end of the Reynolds Range, Hann Range, Reaphook Hills and many small outcrops in between, using aerial imagery to select sites containing potentially suitable habitat (i.e. rocky outcrops, steep slopes and site supporting key food plants).

Sites were then ground-truthed by flying over in a helicopter to: i) exclude any sites not considered likely to support rock-wallaby; and ii) find additional areas that weren't identified using aerial imagery (this is particularly relevant for sites supporting food plants as they cannot be identified prior to aerial surveys). A total of 65 sites were chosen and surveyed.

Permission to conduct surveys and to access certain areas was sought and gained from Traditional Owners through consultation with the Central Land Council and the Aboriginal Areas Protection Authority.

Surveys were conducted on foot, in teams of two, during daylight hours. Teams were dropped into sites by helicopter. A habitat assessment was completed at each site, including qualitative notes on presence/abundance, likely shelter/refuge sites (e.g. caves, crevasses or large boulder piles), proximity to forage and vegetative cover (especially figs, spearbush and grassy patches).

Spearbush (*Pandorea doratoxylon*) and fig (*Ficus brachypoda*) (see plates 1 and 2 below) are important food plants for wallabies. A range of grasses and forbs, such as *Cymbopogon ambiguus*, *Digitaria brownii* and *Enneapogon polyphyllus*, are also key components of their diet (Geelen 1999).

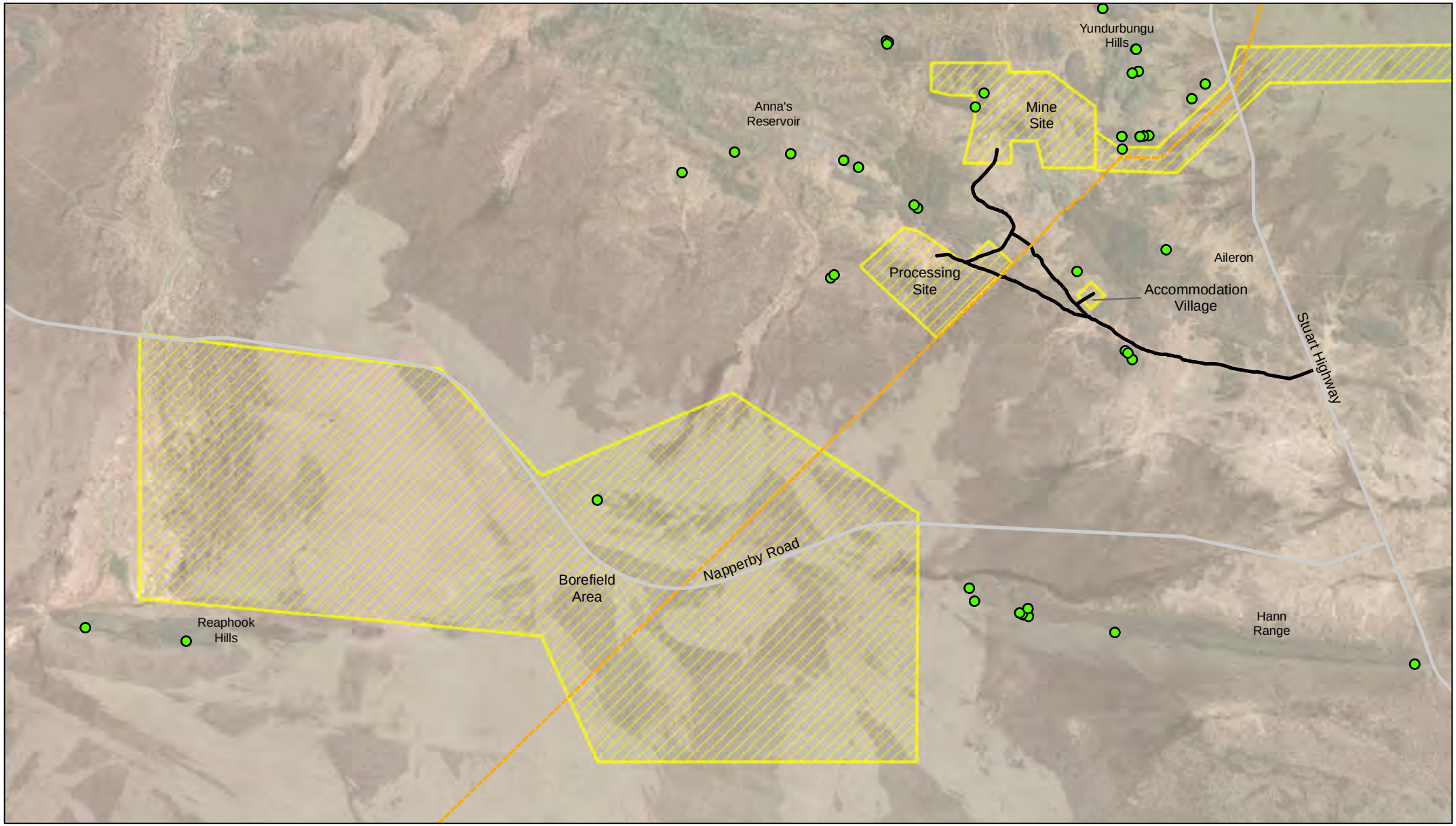
All scat identifications were verified by Dr John Read (Ecological Horizons) from the SA Warru Recovery Team. Scats collected were lodged at the Museum and Art Gallery of the Northern Territory.

The following were recorded at each site:

- Presence of scats
- Age of scats
- Relative abundance of scats (old vs. fresh, adult vs. juvenile)
- Predator signs
- Relative abundance of rabbit, cattle, camel and Euro
- Geological features (i.e. rock type, height, slope)
- Vegetation, particularly food plants (i.e. spearbush and fig).

Plate 1 Spearbush

Plate 2 Figs



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Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

N

LEGEND

- Black Footed Rock Wallaby Survey
- Roads
- Gas Pipeline
- Access Roads
- Study Area

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Black-footed Rock-wallaby survey sites

Figure 6

G:\43\22301\GIS\Maps\4322301_219_RockWallabySurveySites.mxd

Level 5 66 Smith Street Darwin NT 0800 Australia **T** 61 8 8982 0100 **F** 61 8 8981 1075 **E** drwmail@ghd.com **W** www.ghd.com

Data source: GA - Roads, Gas Pipeline, Imagery (2015). GHD - Study Area, Black-footed rock-wallaby data (2015). Created by: CM

Borefield area survey

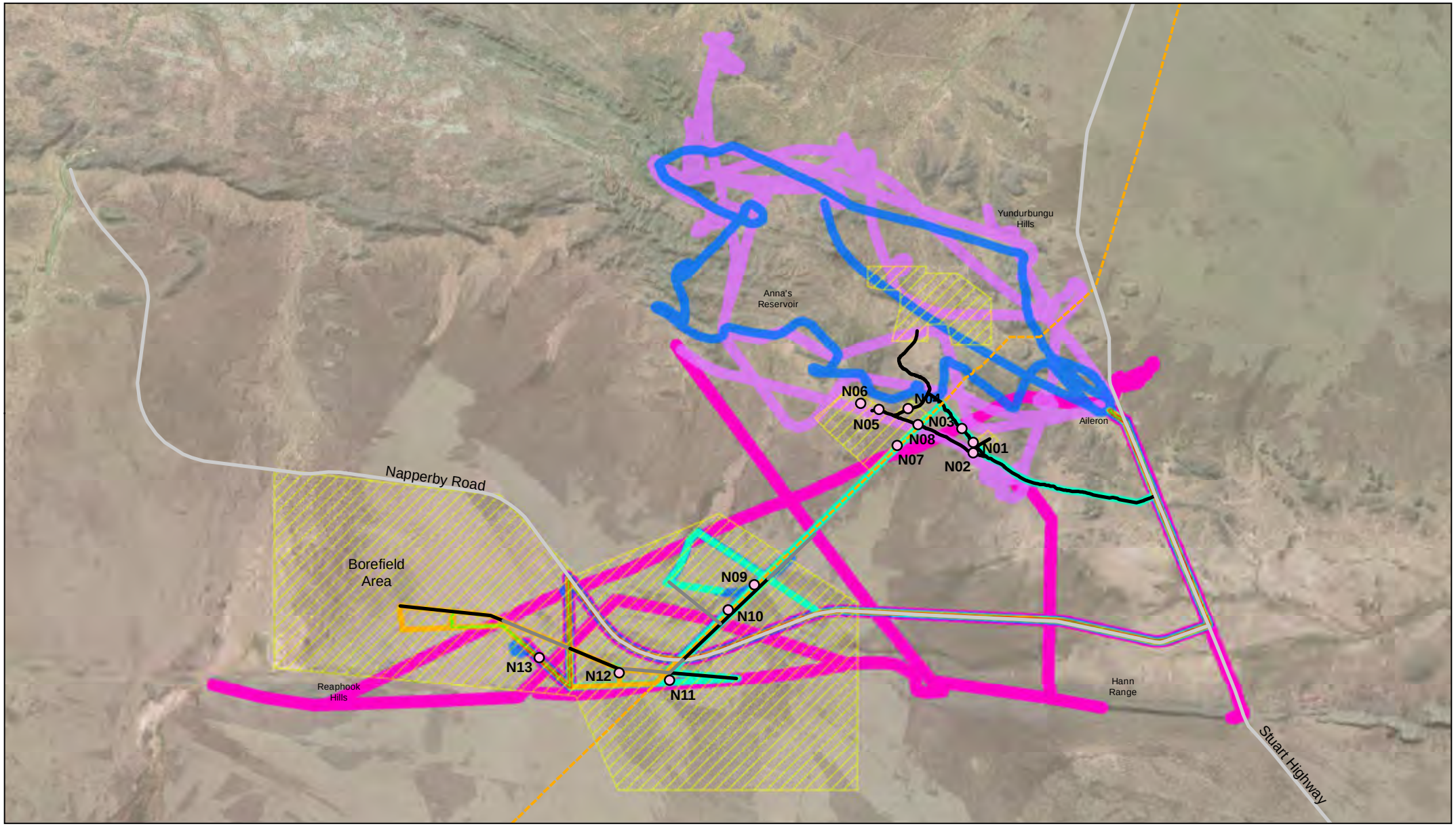
The borefield area surveys were undertaken to detect presence of any threatened species in the proposed access roads and water pipeline corridor, in accordance with Commonwealth Government's survey guidelines for the species (DSEWPaC 2011). The area included from the gas pipeline to SB027 following the proposed water pipeline, and along existing gas pipeline within the borefield area, and from SB025 to SB008 (Figure 7). The species targeted in this survey included Great Desert Skink, Brush-tailed Mulgara and Greater Bilby. Surveys were conducted during daylight hours from 21 – 23 July 2015.

Three to five ecologists/rangers walk along the transect corridor roughly 5-10 m apart scanning the ground for signs of the threatened species such as scat, burrows, diggings and/or latrines and tracks. The total length of corridor surveyed was 37.4 km (Figure 7).

Any burrows or other signs of threatened species were recorded, including GPS coordinates.

The following were recorded for the pipeline walks:

- Evidence of grazing
- Fire history
- Vegetation cover (spinifex, acacia/mulga, buffel grass)
- Predator signs.



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Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

N

LEGEND

- Fauna Sites
- Roads
- Gas Pipeline
- Access Roads
- Study Area
- Day 1
- Day 2
- Day 3
- Day 4
- Day 5
- Day 6
- Day 7

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Job Number 4322301
Revision 0
Date 18 Mar 2016

Survey effort for 2015 targeted fauna surveys

Figure 7

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Level 5 66 Smith Street Darwin NT 0800 Australia **T** 61 8 8982 0100 **F** 61 8 8981 1075 **E** drwmail@ghd.com **W** www.ghd.com

Data source: GA - Imagery (2008), Roads, Gas Pipeline (2015). GHD - Fauna Survey Sites, Proposed Mine Site, Proposed Treatment Plant, Proposed Accommodation Village, Borefield Area (2015). Created by: CM

Targeted surveys for Bilby (Macrotis lagotis)

Spinifex-dominated habitats within the Study area provide potential habitat, including areas with low shrub cover.

Recommended survey techniques include habitat assessments, searching for signs of activity, collection of predator scats and soil plot surveys (tracks). Spotlight or camera surveys at burrow entrances may be effective following detection of signs. Spotlight surveys from a vehicle allowing large distance to be covered through suitable habitat are also effective.

Extensive and intensive nocturnal (spotlighting) searches were undertaken on foot and from slow-moving vehicles to detect active individuals of this species in 2010/11 and again in 2015.

In 2015 Diurnal searches of the borefield area were also undertaken to locate potentially suitable habitat and signs of potential activity, including burrows, tracks, scats and diggings.

Motion-sensing cameras were used in selected locations of suitable habitat and where possible Bilby diggings/burrows were found.

Targeted surveys for Great Desert Skink (Liopholis kintorei)

The Great Desert Skink has a habitat preference for open sandplain within spinifex (*Triodia* spp.), which occurs extensively across the southern part of the Nolans Site.

The most effective survey technique is to locate burrow systems by walking along transects through suitable habitat, and then check the burrow entrances that show recent signs of activity (active latrine site, recently dug soil at entrances, fresh tracks at burrow entrance) for the possible emergence of animals. Great Desert Skinks are likely to be more active in warmer weather. Thus, watching burrow entrances may be more profitable in warmer months than in cooler months. Watching burrows in cooler times of the year may involve setting up motion-sensing cameras to 'watch' for longer periods. McAlpin (2001b) reports the optimum time of year for monitoring burrows as late summer and early autumn, before the lizards enter hibernation, at which time the maximum number of individuals are likely to inhabit the burrow systems.

A Great Desert Skink burrow system was identified during the 2015 baseline fauna survey of the borefield area, in habitat that appeared not to have been burnt very recently, but had been burnt recently enough that the spinifex tussocks were very large (perhaps burnt within the past 5-6 years).

Watching burrows in the cooler time of the year (i.e. July 2015 survey) required setting up motion-sensing cameras to 'watch' for longer periods (Plate 4).

Additional searches were also undertaken around the Great Desert Skink burrow that was previously recorded during the May 2015 baseline fauna survey. Four remote sensor cameras were setup, with the aim of obtaining images of the skinks when they become active again as the weather warms in September. Cameras were collected on the 22 October 2015 and found to contain numerous images of Great Desert Skink.

Plate 3 Great Desert Skink

Plate 4 Remote camera set up near Great Desert Skink burrows and latrine (April/May 2015)

3.4 Survey limitations

This fauna assessment has a focus on species of vertebrate terrestrial fauna (mammals, birds, reptiles and amphibians). Existing databases and species prediction tools are biased towards vertebrates and there are relatively few data or identification tools available for terrestrial invertebrates in the region. At least one species of threatened snail (*Sinumelon bednalli*; TPWC Near Threatened; EPBC Endangered) may occur in the vicinity of the Nolans Site, so some dedicated searches for snails were conducted.

- Weather conditions during the targeted threatened species survey were not ideal for locating active reptiles.
- Aquatic fauna (fish and aquatic invertebrates) were not assessed as part of this survey. Free standing water, other than at cattle watering points, was not present during the survey periods.
- The standard requirements for fauna surveys in the NT include three days/nights only for a trapping program (Elliot, cage, pitfall and funnel traps). This duration for trapping is likely to influence the numbers and diversity of fauna detected. Animals that visit the surveyed area only occasionally are less likely to be detected than animals that live within or near the surveyed area. Rare or less common animals are more likely to be detected with additional survey effort. GHD ecologists conducted the trapping programs (2010 and 2015) over five days and four nights.
- Anabat used a “zero crossing” processing method that tends to pick up the strongest sound at any one time. Bats with soft or whispering calls were generally not detected (e.g. *Nyctophilus* sp. and *Hipposideros* sp.). On most occasions, Anabat detectors and recorders gave “all night” recordings (i.e. no battery or other technical problems). Anabat failure in 2010 resulted in no data being collected from two sites (Sites 12, 13) and only a half-night of data from Site 9. Absence of bat data on one of the units over two nights in 2015 may have been a result of microphone failure, or may have been the result of zero bats detected.
- The hand-held GPS and Trimble units used to record site information are typically accurate to within 10 metres. Maps presenting site information and species records should not be relied on for detailed design during construction or operation of the mine.

3.4.1 Nomenclature

Common and scientific names for fauna follow the DLRM fauna database.

4. Results

4.1 Results of Baseline Fauna Survey

4.1.1 Review of the DLRM database records

At June 2015, the DLRM database (20 km search around the Nolans site) contains 1,656 records of 185 species, including:

- 17 mammals (9.2% of total)
- 121 birds (65.4%)
- 44 reptiles (23.8%)
- Three amphibians (1.6%).

These proportions differ slightly from those documented in the Burt Plain Bioregion: the DLRM list for the Site contains fewer than expected mammals, reptiles and frogs. Consequently, there are a higher proportion of birds.

Nearly all the DLRM records are dated between 1954 and 2012, except

- Two records of the Pig-footed Bandicoot, *Chaeropus ecaudatus*; now extinct and recorded in 1891
- Three others that have no date (single records of Chestnut Quail-thrush, Great Desert Skink and Malleefowl).

Table 8 shows the number of DLRM database records per species for each vertebrate fauna group, except amphibians for which there are only four database records of three amphibians. This data provides context for the relative likelihood of detecting species known to occur (or to have occurred historically) in the area.

Mammals

Of the 17 mammals recorded historically in the area (90 records in total), three of them have been recorded only once, and a further four have been recorded only twice. Only 8 mammal species have been recorded five times or more. In decreasing order of records, these are:

- Red Kangaroo (*Macropus rufus*)
- Euro (*Macropus robustus*)
- Cattle (*Bos taurus*)
- Camel (*Camelus dromedarius*)
- House Mouse (*Mus musculus*)
- Gould's Wattled Bat (*Chalinolobus gouldii*)
- Lesser Long-eared Bat (*Nyctophilus geoffroyi*)
- Short-beaked Echidna (*Tachyglossus aculeatus*).

This shortlist comprises two large and conspicuous macropods, two insectivorous bats, one iconic and readily identified species (echidna) and three non-native species, one of which is an agricultural animal. This indicates a relative lack of survey for mammals across the area, except perhaps for insectivorous bats.

Birds

Of the 121 bird species recorded historically in the area (1,416 records in total), 44 of them (36.4%) have been recorded ten times or more. This suggests a relatively low level of bird survey effort (or recorded effort) across the region, but it also reflects the sparse and nomadic nature of many bird species across arid habitats, particularly as seasonal conditions change habitats. In decreasing order of records, the five most commonly recorded bird species are:

- Spiny-cheeked Honeyeater (*Acanthagenys rufogularis*)
- Yellow-throated Miner (*Manorina flavigula*)
- Zebra Finch (*Taeniopygia guttata*)
- Singing Honeyeater (*Lichenostomus virescens*)
- Willie Wagtail (*Rhipidura leucophrys*).

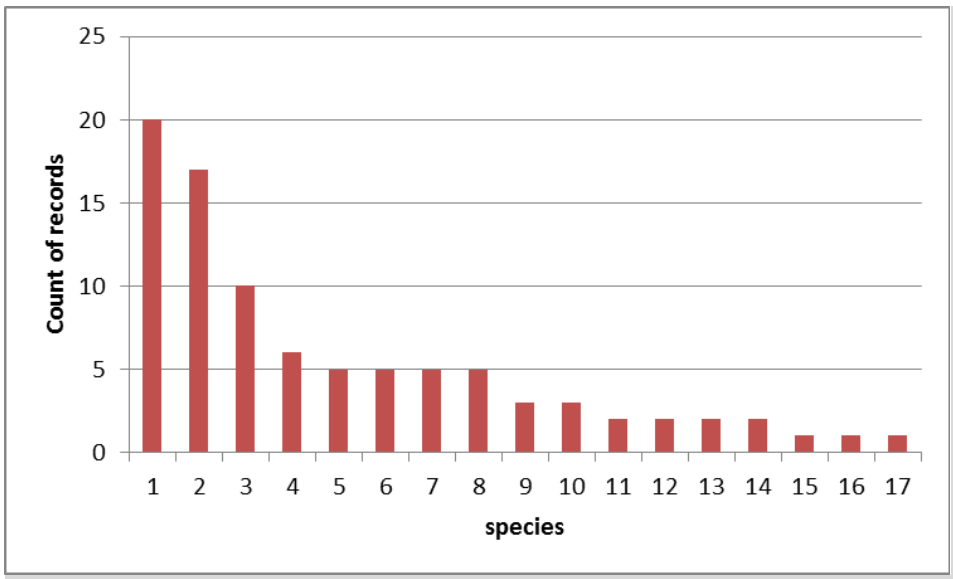
Reptiles

Of the 44 reptiles recorded historically in the area (146 records in total), 29 of them (65.9%) have been recorded twice or less, and 22 (50%) have been recorded only once. Only 9 reptile species (20.5%) have been recorded five times or more. In decreasing order of records, these are:

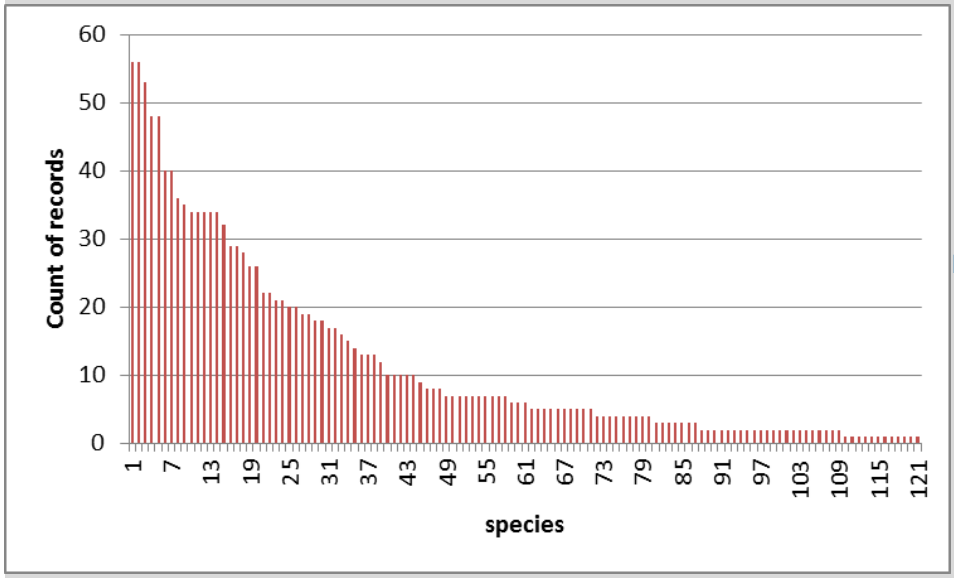
- Tree Dtella (*Gehyra variegata*)
- Northern Spiny-tailed Gecko (*Strophurus ciliaris*)
- Little Spotted Snake (*Suta punctata*)
- Bynoe's Gecko (*Heteronotia binoei*)
- Night Skink/Striated Egernia (*Liopholis striata*)
- Central Netted Dragon (*Ctenophorus nuchalis*)
- Inland Snake-Eyed Skink (*Cryptoblepharus australis*)
- Grey's Menetia (*Menetia greyii*)
- Leonhard's Ctenotus (*Ctenotus leonhardii*).

This shortlist comprises mostly small and nocturnal reptile species. This indicates that many of the reptile observations are likely to have been from targeted reptile surveys. However, the most-common-reptile list includes none of the larger, more obvious or more iconic species (e.g. Bearded Dragon, Black-headed Python, Thorny Devil), which suggests that many observations of more common fauna have not been included in the DLRM database.

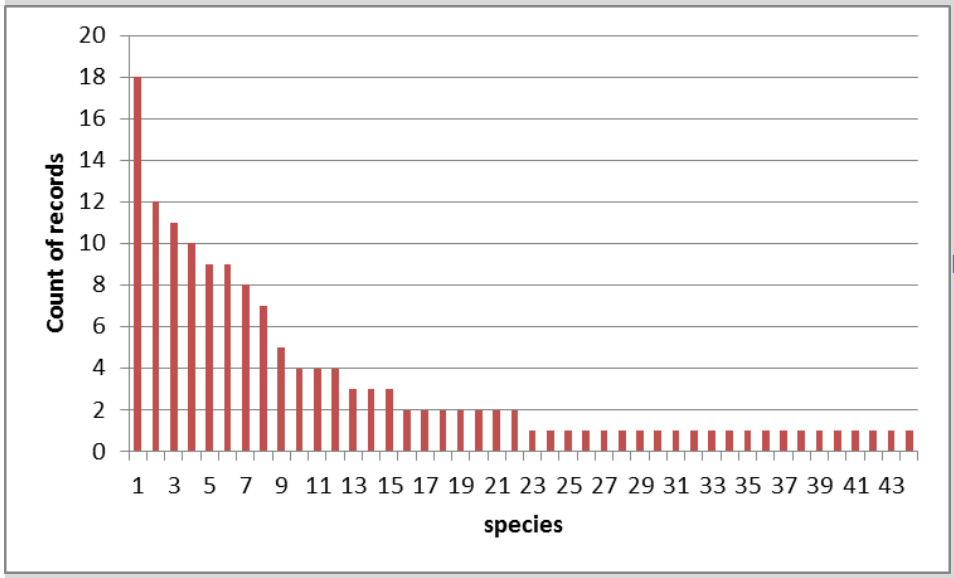
Locations of threatened species' records included in the DLRM Atlas in the vicinity of the Study area are presented in Figure 10.



Mammals



Birds



Reptiles

Figure 8 Apparent relative abundance of species within each group (mammals, birds, reptiles) based on numbers of records in the DLRM database

4.1.2 Overview of the results from baseline fauna survey –2010 and 2015 (GHD)

A total of 124 indigenous terrestrial vertebrate fauna species were recorded during the GHD 2010 baseline fauna survey, including 16 mammals, 78 birds, 27 reptiles, two frogs and one invertebrate (Table 8). Three introduced fauna species (all mammals) were recorded also.

A total of 130 indigenous terrestrial vertebrate fauna species were recorded during the GHD 2015 baseline fauna survey, including 21 mammals, 78 birds, 28 reptiles, two frogs and one invertebrate (Table 8). Five introduced fauna species (all mammals) were recorded also.

With both surveys combined, a total of 174 indigenous terrestrial fauna species were recorded, including:

- 25 mammals (14.3% of total)
- 103 birds (59.2%)
- 41 reptiles (23.6%)
- three frogs (1.7%)
- Potentially two invertebrates (0.2%) (snail species, which are poorly known) (Table 8).

4.1.3 Assessment of sampling effectiveness

Compared with the DLRM database, which is considered to accurately reflect the species that occur within the Nolans site, there is a higher than expected proportion of mammals, and similar proportions of birds and reptiles. The species counts (total, and by group), suggest that the survey methods and effort have effectively sampled the region's fauna, given how closely they match those that have been recorded in the DLRM database (Table 4 1).

The species counts (total and by group) from this assessment, other assessments (i.e. Low 2007, Milligan 1980) and the DLRM database fall short of those recorded for the Burt Plain Bioregion (Table 8). This is because the Burt Plain Bioregion covers an enormous area and spans a range of habitats that do not occur within the vicinity of the Study area. Thus, the Burt Plain list does not provide the most appropriate benchmark for fauna diversity for this assessment, but it provides useful context in some aspects of fauna diversity, and is referred to where appropriate.

There are varying levels of overlap in species detected for the different groups (i.e. despite similar aggregates, it is not necessarily the same species being detected).

Table 8 Overall counts of species (by group) detected

Group	2010 GHD survey	2015 GHD survey	Total (GHD)	Low Ecol 2007	DLRM database	Burt Plain Bioregion
Mammals	19 (3)	26 (5)	30 (5)	18 (3)	17 (5)	63 (9)
Birds	78	78	103	51	121	183 (1)
Reptiles	27	28	41	7	44	104 (1)
Frogs	2	2	3	0	3	9
Invertebrates	1	1	2?	1	0	0
Total	**127 (3)**	**135 (5)**	**179 (5)**	**77 (3)**	**185 (5)**	**359 (11)**

*Non-native species in parentheses, and included in cell totals.

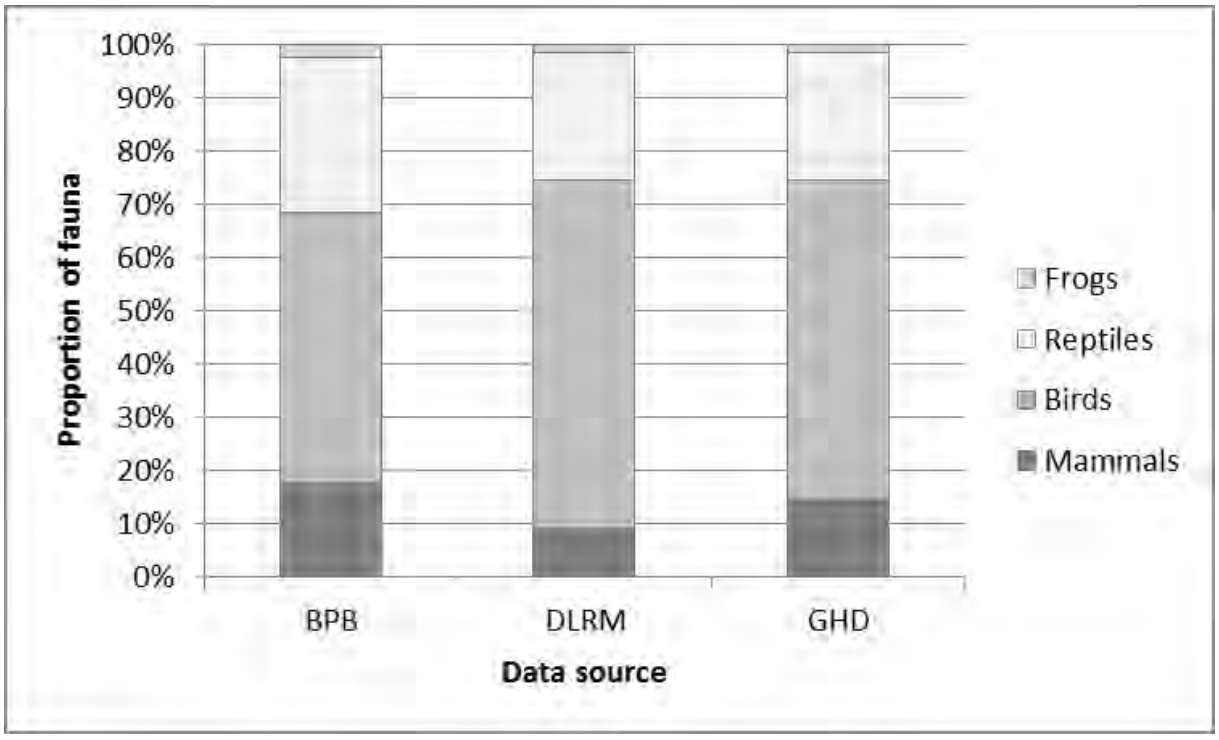


Figure 9 Proportions of fauna species in vertebrate groups (mammals, birds, reptiles, frogs), comparing Burt Plain Bioregion (BPB), NT Fauna Atlas list (DLRM) and information from this assessment (GHD)

4.1.4 Fauna Diversity and Abundance

Mammals

Across both of the surveys undertaken by GHD (2010 and 2015), 25 native and five non-native mammal species were identified within the Study area. These include:

- Short-beaked Echidna (*Tachyglossus aculeatus*)
- Dingo (*Canis lupus*)
- Five species of macropod [Black-footed Rock-wallaby (*Petrogale lateralis*), Euro (*Macropus robustus*), Red Kangaroo (*Macropus rufus*), Northern Nailtail Wallaby

(*Onychogalea unguifera*) (scats and tracks) and Spectacled Hare-wallaby (*Lagorchestes conspicillatus*) (tracks)]

- Seven species of native small mammal [Brush-tailed Mulgara (*Dasycercus blythi*), Fat-tailed Dunnart (*Sminthopsis crassicaudata*), Stripe-faced Dunnart (*Sminthopsis macroura*), Lesser Hairy-footed Dunnart (*Sminthopsis youngsoni*), Fat-tailed Pseudantechinus (*Pseudantechinus macdonnellensis*), Sandy Inland Mouse (*Pseudomys hermannsburgensis*) and Spinifex Hopping-mouse (*Notomys alexis*)]
- Potentially 11 species of microchiropteran (insectivorous) bat [Gould's Wattled Bat (*Chalinolobus gouldii*), Chocolate Wattled Bat (*Chalinolobus morio*), Hairy-nosed Freetail Bat (*Mormopterus eleryi*), Inland Freetail Bat (*Mormopterus petersi*), Lesser Long-eared Bat (*Nyctophilus geoffroyi*), Yellow-bellied Sheathtail Bat (*Saccolaimus flaviventris*), Inland Broad-nosed Bat (*Scotorepens balstoni*), Little Broad-nosed Bat (*Scotorepens greyii*), White-striped Freetail Bat (*Tadarida australis*), Inland Forest Bat (*Vespadelus baverstocki*), and Finlayson's Cave Bat (*Vespadelus finlaysoni*)]
- Five species of non-native mammals [Camel (*Camelus dromedarius*), Cat (*Felis catus*), European Rabbit (*Oryctolagus cuniculus*), House Mouse (*Mus musculus*) and Red Fox (*Vulpes vulpes*)]. Cattle (*Bos taurus* and *Bos indicus*) were also seen but not recorded.

Mammal species counts per survey are broadly similar to the numbers detected in previous surveys by Low 2007 (18 species) and Milligan 1980 (11 species). The overall total across the two surveys (2010 and 2015 combined) is considerably higher than the totals from either the Low or Milligan studies, and almost certainly reflects survey effort and time.

This assessment (2010 and 2015 combined) resulted in detection of more than twice the number of native mammals that have been recorded in the DLRM records. This reflects the specialised nature of mammal detection i.e. large mammalian fauna are readily detectable (e.g. kangaroos), but small mammalian fauna (e.g. microbats and small mammals) are detectable only using intensive and targeted trapping efforts, and these efforts are often successful only if conditions and habitats are suitable. Thus, the small list of mammalian fauna that is recorded on the current DLRM database for this region suggests that insufficient fauna survey has occurred in that area, particularly in recent times.

Two mammal species (one native and one non-native) on the DLRM database were not detected during this assessment (Pig-footed Bandicoot, *Chaeropus ecaudatus* and Horse, *Equus caballus*). The Pig-footed Bandicoot is now considered extinct.

A total of 54 native mammals are recorded from the Burt Plain Bioregion. Eleven of these species are now believed to be extinct in the Northern Territory, and seven of those are considered absolutely extinct (i.e. across Australia). Thus, the two GHD surveys resulted in detection of 58% of the possible 43 native mammal species. Note that at least some of those 43 species are likely to be characteristic of habitats not well represented in the Study area, and to occur in the vicinity of the Study area extremely rarely.

Table 9 presents the numbers of species of mammal sub-groups detected during the surveys compared with those detected by Low Ecological (2007) and those known to occur (or to have occurred historically) within the area (DLRM database) and within the Burt Plain Bioregion. Of the larger sub-groups, our surveys resulted in detection of good numbers of macropod species and insectivorous bats (compared with previous data, see Table 9). However, the count of small mammal species detected (7, which includes dasyurids) was far greater than those on the DLRM list (2) but far fewer than those on the Burt Plain list (23). A higher level of survey effort, conducted over a number of locations, seasons and years, would be expected to generate a larger list of small mammal species and a better understanding of the use of the Nolans site by those species.

Table 9 Comparison of mammal species (by sub-group) detected during the GHD (2010 and 2015) and Low (2007) surveys in the Study area, compared with the DLRM database and Burt Plain Bioregion lists

Sub-Group	Burt Plain list	DLRM database	Low 2007	This study (2010 and 2015)
Dingo	1	1	1	1
Echidna	1	1	1	1
Macropods	9	3	2	5
Bandicoots/bilbies	4	1	0	0
Possums	1	0	0	0
Small mammals and dasyurids	23	2	1	7
Fruit bats	1	0	0	0
Insectivorous bats	14	4	10	11
Non-native mammals	(9)	(5)	(3)	(5)
Total	**63 (9)**	**17 (5)**	**18 (3)**	**30 (5)**

*Non-native species in parentheses, and included in cell totals.

Four of the mammals recorded during the 2010 and 2015 surveys are currently listed as threatened species. One of these is listed as *Vulnerable* under the EPBC Act (Black-footed Rock-wallaby, *Petrogale lateralis*), and all four are listed as *Near Threatened* or *Vulnerable* under the TPWC Act (the Black-footed Rock-wallaby; Brush-tailed Mulgara, *Dasycercus blythi;* Spectacled Hare-wallaby, *Lagorchestes conspicillatus*; and Northern Nailtail Wallaby, *Onychogalea unguifera*). The hare-wallaby and nailtail wallaby were detected as tracks and/or scats only – no individuals were seen. Locations of threatened species' observations are presented in Figure 10.

Three mammal species reported here have not been previously recorded in the Burt Plain Bioregion. These are: Brush-tailed Mulgara (*Dasycercus blythi*), Northern Nailtail Wallaby (*Onychogalea unguifera*), and Yellow-bellied Sheathtail Bat (*Saccolaimus flaviventris*).

Birds

Across surveys undertaken by GHD (2010 and 2015), 103 native (and zero non-native) bird species were identified within the Study area. Each survey (i.e. 2010 and 2015) resulted in the detection of 78 bird species, with 68% overlap in species detected. These counts are similar but greater than the numbers of birds detected in previous surveys by Green 2010 (69 species), Low 2007 (50 species) and Milligan 1980 (62 species). The overall total across the two GHD surveys (103 species) is considerably higher than the totals from the other studies, which is likely to reflect survey effort.

Table 10 presents the numbers of species of bird sub-groups detected during the surveys compared with those detected by Low Ecological (2007) and those known to occur (or to have occurred historically) within the area (DLRM database) and within the Burt Plain Bioregion. In terms of counts, the GHD survey results represent approximately 85% of species recorded in the immediate area (DLRM) and 56% of the species known to occur (or to have occurred historically) in the bioregion. However, 26 bird species in the DLRM list were not detected

during this assessment, and 8 species detected during this assessment are not in the DLRM list. This suggests that the DLRM database list is relatively comprehensive for birds in this area.

Bird species that use the region can be grouped into a range of sub-groups, as shown in Table 10. This allows insights into which bird groups were most and least represented in the surveys when compared with the Burt Plain Bioregion, our surveys detected fewer than expected:

- Parrots/cockatoos (7 of 12)
- Raptors (12 of 19)
- Small ground birds (7 of 13)
- Waterbirds (8 of 46).

When compared with the DLRM list, the most obvious difference is again the fewer than expected waterbirds (8 of 16). Clearly, this absence of waterbirds reflects the seasonal or intermittent nature of wetlands and waterbird movements in arid Australia, and the fact that the surveys for this assessment were done at generally dry times of year. A higher level of survey effort, conducted over a number of locations, seasons and years, would be expected to generate a larger list of bird species and a better understanding of the use of the Nolans site by those species.

Table 10 Comparison of bird species (by sub-group) detected during the GHD (2010 and 2015) and Low (2007) surveys in the Study area, compared with the DLRM database and Burt Plain Bioregion lists

Sub-Group	Burt Plain list	DLRM database	Low 2007	This study (2010 and 2015)
Large ground birds (e.g. emu, bustard)	3	2	0	2
Bush birds (excluding honeyeaters)	30	29	18	24
Honeyeaters	13	12	5	11
Babblers	2	2	2	2
Bowerbirds	1	1	0	0
Cuckoos	5	3	1	2
Kingfishers	3	2	2	3
Magpies/ravens	6	5	4	6
Parrots/cockatoos	12	7	5	7
Pigeons	7 (1)	5	1	4
Raptors	19	12	4	12
Small ground birds (e.g. quail)	13	8	2	7
Woodswallows	5	4	2	4
Fairy-wrens and allies	8	5	3	5

Night birds	5	3	0	4
Waterbirds	46	16	0	8
Aerial specialists (swifts, swallows, etc.)	5	4	1	2
Total	**183 (1)**	**121**	**51**	**103**

*Non-native species in parentheses, and included in cell totals.

Active nests and other evidence of breeding activity were detected for many of these bird species in 2010 (e.g. Budgerigar, *Melopsittacus undulatus*; Black-faced Woodswallow, *Artamus cinereus*; Masked Woodswallow, *Artamus personatus*; Australian Owlet-nightjar, *Aegotheles cristatus*; Pied Honeyeater, *Certhionyx variegatus*) and for one species in 2015 (Banded Whiteface, *Aphelocephala nigricincta*).

Four of the bird species recorded during the surveys are currently listed as threatened species. All are listed as *Near Threatened* under the TPWC Act. These are two large ground birds (Australian Bustard, *Ardeotis australis*, and Emu, *Dromaius novaehollandiae*), one small ground bird (Bush Stone-curlew, *Burhinus grallarius*), and one pigeon (Flock Bronzewing, *Phaps histrionica*). Locations of threatened species' observations are presented in Figure 10.

All bird species recorded during the 2010 and 2015 surveys have been previously recorded in the Burt Plain Bioregion.

Reptiles

Across surveys undertaken by GHD (2010 and 2015), 41 native (and zero non-native) reptile species were identified within the Study area. Each survey (i.e. 2010 and 2015) resulted in the detection of similar reptile species numbers (27 and 28 respectively).

Reptile species counts from individual surveys are greater than the numbers of reptiles detected in previous surveys by Low 2007 (7 species), but less than those detected by Milligan 1980 (34 species). The overall total across the two GHD surveys (41 species) is higher than the totals from the other studies, which is likely to reflect survey effort.

The total across the two surveys (41 species) appears to closely match the reptile species that are recorded on the DLRM list. However, 20 reptile species in the DLRM list were not detected during this assessment, and 18 species detected during this assessment are not in the DLRM list. This suggests that the reptile records in the DLRM database do not yet fully describe the reptile fauna in this area, and that more survey work would be likely to result in the detection of more reptile species.

The sub-group that was obviously underrepresented during the 2010 and 2015 surveys was the elapid snakes. Only one small snake species was detected (Little Spotted Snake, *Suta punctata*), and no large snakes were detected, which is unusual for site visits involving multiple days, multiple teams, working across a large area with extended working hours. Low density of large snakes (and even all snakes) may reflect low abundance of their prey, such as small mammals, skinks, and larger invertebrates.

Table 11 presents the numbers of species of reptile sub-groups detected during the surveys compared with those detected by Low Ecological (2007) and those known to occur (or to have occurred historically) within the area (DLRM database) and within the Burt Plain Bioregion. A total of 104 reptile species are recorded from the Burt Plain Bioregion. Thus, the GHD surveys resulted in detection of approximately 39% of the species known to occur (or to have occurred historically) in the region. At least part of this is likely to be explained by the relatively cool and

wet conditions experienced during the 2010 survey, and the cool conditions at night during the 2015 survey.

Reptile species that occur in the region can be grouped into a range of sub-groups, as shown in Table 11. This allows insights into which reptile groups were most and least represented during the surveys. The baseline surveys resulted in the detection of fewer than expected reptiles in all seven sub-groups. In particular, our surveys detected fewer than expected geckos (6 of 21), skinks (19 of 37) and far fewer than expected snakes (2 of 18). These observations are likely to reflect the relatively cool conditions experienced during the survey periods. A higher level of survey effort, conducted over warmer periods, would be expected to generate a larger list of reptile species in the Nolans site.

Table 11 Comparison of reptile species (by sub-group) detected during the GHD (2010 and 2015) and Low (2007) surveys in the Study area, compared with DLRM database and Burt Plain Bioregion lists

Sub-Group	Burt Plain list	DLRM database	Low 2007	This study (2010 and 2015)
Legless lizards	7	2	0	2
Geckos	21 (1)	8	1	6
Skinks	37	16	3	19
Dragons	10	7	2	7
Varanids	6	3	1	5
Pythons	4	1	0	1
Blind snakes	5	1	0	0
Land snakes	14	7	0	1
Total	**104 (1)**	**44**	**7**	**41**

*Non-native species in parentheses, and included in cell totals.

One reptile species recorded during the surveys is currently listed as a threatened species. The Great Desert Skink (*Liopholis kintorei*) is listed as *Vulnerable* under the EPBC Act and under the TPWC Act. This is a large skink that creates characteristic communal burrows and latrines, and that is predominantly nocturnal, particularly in warm and hot weather. No individuals of this species were seen, but one site was found that had a communal burrow system and a reptile latrine that, given its size, location and layout, indicates it was made by the Great Desert Skink (Plate 5). Locations of threatened species' observations are presented in Figure 10.

Four reptile species recorded during the 2010 and 2015 surveys have not been previously recorded in the Burt Plain Bioregion: Round-headed Dragon (*Diporiphora lalliae*), Blue-tailed Ctenotus (*Ctenotus calurus*), Royal Ctenotus (*Ctenotus regius*) and Spinifex Snake-eyed Skink (*Proablepharus reginae*). Another species (Pygmy Mulga Monitor, *Varanus gilleni*) does not yet appear on the Burt Plain Bioregional list, but there is one record in the DLRM database (March 2003).

Plate 5 Left: Communal burrow system of Great Desert Skink. Right: Great Desert Skink scat within communal latrine.

Plate 6 Pygmy mulga monitor (*Varanus gilleni*), recorded for the first time in the Burt Plain Bioregion by GHD 2010

Frogs

Across surveys undertaken by GHD (2010 and 2015), three native (and zero non-native) frog species were identified within the Study area, all of which have been recorded historically in the Burt Plain Bioregion. Nine frog species are known to occur within the Burt Plain Bioregion (Table 12).

Two species detected during this assessment are included on the DLRM database (Spencer's Frog, *Platyplectrum spenceri*, and Red Tree-frog, *Litoria rubella*), while the third species (Northern Burrowing Frog, *Neobatrachus aquilonius*) does not. One species included on the DLRM database was not detected during this assessment (Water-holding Frog, *Cyclorana platycephala*).

Detecting frogs in arid country is highly seasonal, and typically most rewarding in warm and wet conditions. Both surveys were undertaken in relatively cool conditions, and while rain fell during the 2010 survey, resulting in the detection of two frog species, the conditions were generally not conducive to detection of large numbers or high diversity of frogs. A higher level of survey

effort, conducted during wet periods in summer, would be expected to generate a larger list of reptile species and a better understanding of the use of the Nolans site by those species.

No frog species that are known to occur in the vicinity of the Study area are currently listed as threatened species.

Table 12 Comparison of frog species (by sub-group) detected during the GHD (2010 and 2015) and Low (2007) surveys in the Study area, compared with DLRM database and Burt Plain Bioregion lists

Sub-Group	Burt Plain list	DLRM database	Low 2007	This study (2010 and 2015)
Ground frogs / Burrowing frogs	8	2	0	2
Tree frogs	1	1	0	1
Total	**9**	**3**	**0**	**3**

Invertebrates

Invertebrates are poorly known fauna. The TPWC Act list only five invertebrate species as threatened, including three species of snail. At least one of those species has the potential to occur within the Nolans site. As a result, targeted searches for snails and snail shells were undertaken in potentially suitable habitat.

No invertebrate species are included in the DLRM list for the area.

One species of snail was identified during the 2010 and 2015 surveys (and during the survey by Low Ecological 2007): the non-threatened Camaenid land snail (*Sinumelon expositum*).

4.2 Fauna habitats

4.2.1 General description of habitats

Native vegetation occurs across the vast majority of the study area. Historical clearing is localised and typically confined to relatively small pastoral infrastructure sites.

The native vegetation across the study area has been classified into numerous vegetation types that are technically different from each other botanically, but for fauna they can more broadly be grouped into six habitat types:

- Mulga woodland
- Spinifex grassland on sandplain
- Rocky rises
- Acacia and mallee shrubland/woodland
- Riparian woodland
- Non-spinifex grassland (occasionally with sparse open woodland).

These fauna habitats are described in Table 14, with a brief description of their occurrence within the study area, their habitat attributes and their relationship to the vegetation communities.

Note that there is much variation in habitat characteristics across the Study area. In many parts of the study area specific fauna habitats merge or form mosaics with other fauna habitats to some degree (e.g. areas of mulga woodland contain small treeless areas that are dominated by spinifex grassland).

Where possible, selected sites have attempted to keep sites in larger patches of more homogenous habitat, so that sites better represented the habitat they were sampling.

Mine site and haul route (2010)

Given the extent of the Study area at the time (i.e. the Nolans Bore Mine Site and the Haul Route, east and west of the Stuart Highway), the 2010 survey sampled all six habitat types (Table 13). Representative photos of habitats/sites are provided in Appendix A.

In 2010, survey effort was mostly similar for all sites. Road closures associated with heavy rainfall halted survey effort at site T07 after a single night (traps were subsequently removed because they could not be checked daily). Four sampling days/nights of most survey techniques were undertaken at site T08.

The Nolans site (2015)

Given the extent of the Study area, and the areas that had already been assessed during 2010, the 2015 survey was limited to the four habitat types that were expected to be subjected to the greatest area and level of impact (Table 13). Grassland (i.e. non-spinifex) and riparian habitats were not sampled in 2015. Photos of sites are provided in Appendix A.

4.2.2 Evidence of existing impacts on fauna habitats

Low-level grazing impacts were evident across much of the Study area, however, vegetation was generally healthy and active seedling recruitment was evident. Higher-level impacts from pastoral activities (trampling, grazing and weed invasion) were evident in localised areas, confined to watering points, ephemeral watercourses, and stockyards. Some modification to vegetation structure from fires was also evident within the Study area.

The impact of grazing on native fauna was not measured. Fauna sites were chosen for their likelihood of supporting native fauna species, particularly threatened species, so were generally chosen to be away from the influence of human and agricultural disturbance.

Table 13 Numbers of sampled sites per fauna habitat during the 2010 and 2015 surveys

Habitat	Survey period		
	2010	**2015**	**All**
Mulga woodland	4 (M01, M06, T08, T10)	4 (N01, N02, N07, N08)	8
Sandplain spinifex	3 (T09, T11, T12)	5 (N09, N10, N11, N12, N13)	8
Rocky rises	2 (M02, M03)	2 (N03, N05)	4
Shrubland/woodland	1 (M04)	2 (N04, N06)	3
Riparian woodland	1 (M05)	0	1
Grassland (non-spinifex)	1 (T07)	0	1
Total	**12**	**13**	**25**

Table 14 Description of fauna habitats and representative sites sampled in the study area

Fauna Habitat	Sites	Occurrence across the Study area	Description and General Fauna Habitat Attributes Recorded for each Vegetation Community
Mulga woodland 8 sites	2010: M01, M06, T08, T10 2015: N01, N02, N07, N08	Extensive across the proposed mine site, processing site, and accommodation area, but not on rocky outcrops. Relatively extensive between mine site and Stuart Highway, and along northern section of existing gas pipeline corridor within the Study area (i.e. adjacent to and for approximately 6 km southwest of the Processing Site).	• Dense tree/shrub vegetation • Occasional tree hollows (small only, <5 cm diam) • Numerous dead and living standing trees with exfoliating bark • Scattered woody debris • Sandy substrate, or alluvial fans containing clayey red earths • Patches of *Triodia* • Deep litter layers under denser shrubs • Occasional termite mounds
Sandplain spinifex grassland 8 sites	2010: T09, T11, T12 2015: N09, N10, N11, N12, N13	Extensive along southern section of the existing gas pipeline, and all through the proposed borefield area, except on rocky rises.	• Abundant *Triodia* tussocks, with varying density • Shrubby in patches (*Acacia*, *Senna*, mallee) • Occasional small trees with crevices and loose bark • Occasional dead standing trees • Occasional scattered woody debris, small only • Sandy substrate • Numerous termite mounds, generally small • Evidence of fire in most sections – varying recency.
Rocky rises 4 sites	2010: M02, M03 2015: N03, N05	Extensive and prominent rocky rises occur throughout the area surrounding the proposed mine site, particularly to the west. Rocky habitat also occurs in the area between the mine site and processing site. Several small isolated rocky patches (mainly at the base of larger rock outcrops) occur within the proposed mine site. Also at the northern boundary of proposed processing site and accommodation area.	• Rocky outcrops and stony substrates • Occasionally steep • Numerous rock crevices, cracks and small caves • Scattered flowering shrubs • *Triodia* tussocks common • Scattered larger trees (e.g. *Callitris*; *Ficus*), some with small hollows • Occasional termite mounds, mainly on lower slopes
Open shrubland/woodland 3 sites	2010: M04 2015: N04, N06	Distributed through the central, southern and eastern areas of the proposed mine site. Also along the northern boundary of the proposed processing site.	• Scattered trees with crevices and loose bark • Numerous shrubs, in patches of varying density • Occasional dead standing trees

Fauna Habitat	Sites	Occurrence across the Study area	Description and General Fauna Habitat Attributes Recorded for each Vegetation Community
			• Scattered woody debris, generally at base of shrubs and trees • *Triodia* tussocks common • Generally sandy substrates
Riparian woodland 1 site	2010: M05	A prominent ephemeral/intermittent waterway (Kerosene Camp Creek) and its tributaries run through the centre of the proposed mine site. Smaller ephemeral/intermittent waterways intersect the access road between Stuart Highway and the mine site, but these are generally too small to support riparian habitat.	• Scattered large hollow-bearing trees along watercourse • Occasional dead standing trees • Accumulated piles of woody debris beside watercourses • Dense, grassy ground-layer vegetation • Sandy substrates of stream and channel banks
Open grassland (non-spinifex) 1 site	2010: T07	Restricted to the far western end of the haul route, adjoining the mine site.	• Dense to sparse grass tussocks, mostly without *Triodia* • Sparse shrubby vegetation • Occasional large trees, with small hollows • Occasional dead standing trees • Sparse woody debris.

4.3 Patterns of fauna richness among habitats

Patterns of species richness i.e. species counts per habitat type, are described below and tabled in Table 15 for the different habitat types.

4.3.1 Mulga woodland

Overall, mulga woodland was the most species rich of the fauna habitats during the two survey periods, with 102 fauna species detected (including four non-native mammals). It was also consistently species-rich habitat, with 74 species detected across 4 sites in 2010 and 71 species detected across 4 sites in 2015. At least part of the apparently high species richness in mulga is due to relatively high survey effort in that habitat (8 sites).

Species richness in mulga was influenced by a relatively high diversity of mammals and birds. Both fauna groups had high proportional counts relative to overall richness for the Study area (i.e. 24 of the 30 mammal species and 64 of the 103 bird species were detected in mulga).

Of the reptiles detected in mulga, 12 species (a reasonably high proportion) were detected during the 2010 survey and only half that (6 species) were detected in 2015.

Of the total 13 reptile species detected in mulga, 12 were detected during 2010, with only one additional species detected in 2015. This suggests that reptiles in mulga may be distributed unevenly across the habitat, such that the location of sites partly determines the chance of detecting species – i.e. not all sites have equally high reptile diversity. Another factor that may have played a role in richness differences is weather – the night temperatures (which influence some reptilian activity) during 2015 were generally cooler than during 2010.

Frogs and invertebrates were detected in too few numbers to allow comments on patterns of richness.

4.3.2 Spinifex grassland on sandplain

Overall, spinifex grassland on sandplain was a species-rich fauna habitat, with 89 fauna species detected (including four non-native mammals) during the two survey periods. However, the richness detected was inconsistent between surveys, with 39 species detected in 2010 and nearly twice that (75 species) detected in 2015. It is noted that spinifex grassland on sandplain received a high overall level of survey effort across both surveys (8 sites; 3 in 2010 and 5 in 2015).

Species richness in spinifex grassland on sandplain was influenced by relatively high overall diversity of mammals (18 species, the second highest of all habitats) and reptiles (20 species, the highest of all habitats), and moderate diversity of birds (51 species, middle of the range across habitats).

As for mulga, the differences in spinifex sandplain results between the years are interesting. Spinifex sites in 2010 proved to be relatively species poor (39 species, the second lowest of all habitats, despite having 3 sites), while in 2015, different sites (and across a different sandplain) proved to be relatively species rich (89 species, the second highest of all habitats), with approximately twice the species counts in 2015 than in 2010 for mammals (16 versus 6), birds (42 versus 24) and reptiles (17 versus 9). The between-year difference for reptiles is probably not attributable to weather, given that the night temperatures (which influence some reptilian activity) during 2015 were generally cooler than during 2010.

Clearly, sandplain spinifex habitat supports a high diversity of fauna (particularly reptiles and mammals), but detecting that fauna is likely to be dependent on specific location of sites and environmental conditions encountered. It may also depend on factors such as time since fire,

as that can have a large influence on the vegetation structure, which in turn provides shelter and foraging opportunities for fauna.

No frogs or invertebrates were detected in spinifex grassland on sandplain habitat. Given the high proportion of burrowing frogs in the list of frog species known or expected to occur in this area, sandplain is likely to support large numbers and high diversity of frogs, but these would be detected only at the right time of year and under the right conditions (warmer months, after heavy rain).

At least part of the high species richness in spinifex grassland on sandplain habitat is due to relatively high survey effort in that habitat (8 sites).

4.3.3 Rocky rises

Rocky habitats were moderately species-rich for fauna, with 84 fauna species detected during the two survey periods. Interestingly, no non-native fauna were detected in the rocky habitats, but this is almost certainly due in part to the fact that tracks (e.g. cat prints) and signs of fauna are more difficult to find in rocky habitats (compared with sandplain, for example).

While no species group was found to be extremely diverse in rocky habitats, reptiles appeared to be relatively species rich (16 of the 41 species), particularly in 2010 (12 species, which was equal highest across all habitats).

For birds in particular, the richness detected was inconsistent between surveys, with 46 species detected in 2010 and only 28 species detected in 2015. A very high proportion of the rocky habitat birds were detected during 2010 (46 of 53; ~87%), and only 7 species were added to the list for this habitat in 2015.

To some degree, higher richness detected in 2010 than in 2015 reflects the type of rocky habitat that was sampled in each of the surveys (dictated to some degree by expected project footprint and impacted areas). The rocky habitat sites in 2010 were associated with far larger rocky areas than the sites used for 2015, which were both on relatively small outcrops of rocks. Larger rocky rises and ranges are more likely to support rocky habitat specialists (e.g. Black-footed Rock-wallaby, *Petrogale lateralis*).

Two species of frogs (Spencer's Frog, *Platyplectrum spenceri* and Red Tree-frog, *Litoria rubella*) and at least one invertebrate (Camaenid land snail, *Sinumelon expositum*) were detected in rocky habitats. The frogs were in an incised gorge section (Anna's Reservoir Conservation Reserve), where pools of water remained from earlier rains. The snails were found in association with fig trees (*Ficus* spp.) that tend to grow in the rock crevices.

4.3.4 Acacia and mallee shrubland/woodland

Despite only three sites being sampled across the two surveys (one in 2010 and two in 2015), shrubland/woodland was found to be a moderately species-rich fauna habitat. A total of 84 fauna species were detected (including one non-native mammal) in this habitat, and the overall richness was fairly consistent between surveys, with 47 species detected in 2010 and 57 species detected in 2015.

Species richness in shrubland/woodland was influenced by birds, with high proportions of the fauna in this habitat during each survey being birds (40 of 47 species in 2010; 41 of 57 species in 2015). The overall total species count for birds was 63, which was almost equal highest across all habitats.

Shrubland/woodland had consistently low diversity of reptiles, in particular, with 3 species recorded in 2010 and 5 in 2015 (7 species overall).

Shrubland/woodland habitat is likely to support a higher diversity of fauna than was detected here, but detecting that fauna is likely to be dependent on search effort, specific location of sites and environmental conditions encountered (e.g. flowering shrubs and trees).

No frogs were detected in shrubland/woodland habitat, and invertebrates were detected in too few numbers to allow comments on patterns of richness.

4.3.5 Riparian woodland

There are few watercourses within or through the Study area, so riparian woodland habitat is relatively poorly represented (one 2010 site only). However, watercourses in arid areas tend to support vegetation that is unable to survive away from the watercourse, and so they tend to provide a disproportionately important habitat for flora and fauna. This is the reason that this habitat was sampled at all for this assessment.

With only one site, riparian woodland was found to support a remarkably high richness of bird species (37 species), but low richness in other vertebrate groups: two species of mammal, two species of reptile, one species of frog. This may be due in part to this habitat's susceptibility to flooding. If a fauna species cannot move from the watercourse during high-flow periods, which in arid areas tend to be intermittent and largely unpredictable, then it is likely to be killed. If it is breeding in that habitat at the time of a flood, then its breeding effort is likely to fail also.

Birds, as a group, are particularly mobile, and with the ability of flight, are able to remain above the flood water if/when it arrives. The two mammals that were detected in riparian habitat during this assessment are the Dingo (*Canis lupus*) and a micro-chiropteran bat – both able to move out of riparian habitat if/when a flood occurs. The two reptiles consisted on one fast-moving skink (Robust Ctenotus, *Ctenotus robustus*) that would be able to flee a flood, and one small skink (Grey's Menetia, *Menetia greyii*) that would have to be considered vulnerable in a flood.

Other species of bird, mammal and reptile are likely to use riparian habitat, but perhaps only to forage or to move along or through, rather than to actually live in. These species would only be detected through surveys that spanned a longer period and a range of environmental conditions.

4.3.6 Non-spinifex grassland

Non-spinifex grassland (i.e. not dominated by shrubs and/or trees) is an uncommon habitat type in the Study area. Grassland areas tend to also support shrubs and trees, thus making it more aligned with shrubland/woodland. However, this habitat occurred near the mine site (western end of the haul route) and had the potential to support species of interest. For this reason, it was sampled for this assessment (one site in 2010 only).

Even considering the low survey effort given to this habitat (one 2010 site only), non-spinifex grassland was found to have a relatively low fauna species richness (24 species in total). More than 80% of species were birds (20 species), with two mammals and two reptiles. These counts were the lowest of all habitat types in the 2010 survey. Interestingly, one of the reptile species (Fat-tailed Gecko, *Diplodactylus conspicillatus*) was found only in grassland and in no other habitat type. All other species detected in grassland were found also in other habitats.

Table 15 Counts of fauna species (by group) detected during surveys in the sampled habitats

Habitat Group	Mulga woodland	Sandplain spinifex grassland	Rocky rises	Shrubland/ woodland	Riparian woodland	Open grassland (non-spinifex)	Total
2010 only							
No. sites	4	3	2	1	1	1	12
Mammals	14 (2)	6 (1)	7	3 (1)	2	2	19 (3)
Birds	47	24	46	40	37	20	78
Reptiles	12	9	12	3	2	2	27
Frogs	1	0	0	0	1	0	2
Invertebrates	0	0	1	1	0	0	1
Total	**74 (2)**	**39 (1)**	**66**	**47 (1)**	**42**	**24**	**127 (3)**
2015 only							
No. sites	4	5	2	2	0	0	13
Mammals	18 (2)	16 (4)	8	11	-	-	26 (5)
Birds	47	42	28	41	-	-	78
Reptiles	6	17	9	5	-	-	28
Frogs	0	0	2	0	-	-	2
Invertebrates	0	0	1	0	-	-	1
Total	**71 (2)**	**75 (4)**	**48**	**57**	**-**	**-**	**135 (5)**
Combined							
No. sites	8	8	4	3	1	1	25
Mammals	24 (4)	18 (4)	11	13 (1)	2	2	30 (5)
Birds	64	51	53	63	37	20	103
Reptiles	13	20	16	7	2	2	41
Frogs	1	0	2	0	1	0	3
Invertebrates	0	0	2	1	0	0	2?
Total	**102 (4)**	**89 (4)**	**84**	**84 (1)**	**42**	**24**	**179 (5)**

*Non-native species in parentheses, and included in cell totals.
Data includes incidental records that were made in a habitat type but that were not necessarily made at a specific site.

4.4 Habitat specificity of fauna

Patterns in specificity among fauna groups and habitat types is tabled in Table 15 and discussed below. This kind of analysis shows fauna species richness across the Nolans site.

Overall, a total of 71 of the 179 (39.6%) fauna species were detected in one habitat only. Acknowledging that some of these species would be likely to be found in other habitats with additional survey effort, this represents a very high overall habitat specificity for fauna in the area, and reflects the specialised adaptations that fauna have adopted to survive in the arid environment.

4.4.1 By species group

Mammals

Ten of the 30 species were found in one habitat type only and another ten were found in two habitats only. Ten were found across multiple habitats. Thus, mammals within the Study area tended to be strongly aligned to specific habitats. Mammals found in one habitat only include:

- Mulga woodland (Finlayson's Cave Bat, *Vespadelus finlaysoni*; Lesser Long-eared Bat, *Nyctophilus geoffroyi*; Northern Nailtail Wallaby, *Onychogalea unguifera*; and the non-native European Rabbit, *Oryctolagus cuniculus*)
- Sandplain spinifex (Brush-tailed Mulgara, *Dasycercus blythi*; Lesser Hairy-footed Dunnart, *Sminthopsis youngsoni*; Spectacled Hare-wallaby, *Lagorchestes conspicillatus*; and the non-native Red Fox, *Vulpes vulpes*)
- Rocky rises (Black-footed Rock-wallaby, *Petrogale lateralis*; and Fat-tailed Pseudantechinus, *Pseudantechinus macdonnellensis*).

Birds

Unlike mammals, birds within the Study area tended to be little aligned to specific habitats. Most birds (70 of 103) were found across multiple habitats. Thirty-three bird species were found in one habitat type only, but many of those are highly mobile species and known to occupy other habitats; they are therefore considered equally likely to occur in other habitats with additional survey effort. Eight of the 11 species reported only in shrubland/woodland are waterbirds that were seen visiting a dam in that habitat, so are not strictly woodland birds. Birds found in one habitat only include:

- Mulga woodland (Bourke's Parrot, *Neopsephotus bourkii*; Brown Goshawk, *Accipiter fasciatus*; Grey Fantail, *Rhipidura albiscapa*; Grey-fronted honeyeater, *Lichenostomus plumulus*; Little Eagle, *Hieraaetus morphnoides*; and Slaty-backed Thornbill, *Acanthiza robustirostris*)
- Sandplain spinifex (Australian Bustard, *Ardeotis australis*; Banded Whiteface, *Aphelocephala nigricincta*; Black-chinned Honeyeater, *Melithreptus gularis*; Emu, *Dromaius novaehollandiae*; Fairy Martin, *Petrochelidon ariel*; Flock Bronzewing, *Phaps histrionica*; Orange Chat, *Epthianura aurifrons*; and White-winged Fairy-wren, *Malurus leucopterus*)
- Rocky rises (Australian Raven, *Corvus coronoides*; Black Honeyeater, *Sugomel niger*; Dusky Grasswren, *Amytornis purnelli*; Painted Finch, *Emblema pictum*; Red-browed Pardalote, *Pardalotus rubricatus*; Spinifexbird, *Eremiornis carteri*; and White-fronted Honeyeater, *Purnella albifrons*)
- Shrubland/woodland (Banded Lapwing, *Vanellus tricolor*; Masked Lapwing, *Vanellus miles*; Sacred Kingfisher, *Todiramphus sanctus*; and eight species of waterbird)
- Riparian woodland (Collared Sparrowhawk, *Accipiter cirrocephalus*).

Reptiles

Of all the species groups, reptiles showed the strongest association with specific habitats. Twenty-six of the 41 reptiles (63%) were found in one habitat only, and 14 of these were associated with sandplain spinifex and a further 7 with rocky habitats. Reptiles found in one habitat only include:

- Mulga woodland (Pygmy Mulga Monitor, *Varanus gilleni*; Round-headed Dragon, *Diporiphora lalliae*; Striped Rainbow Skink, *Carlia munda*; and Tree Dtella, *Gehyra variegata*)
- Sandplain spinifex (Black-tailed Monitor, *Varanus tristis*; Blue-tailed Ctenotus, *Ctenotus calurus*; Centralian Blue-tongued Lizard, *Tiliqua multifasciata*; Grand Ctenotus, *Ctenotus grandis*; Great Desert Skink, *Liopholis kintorei*; Leopard Ctenotus, *Ctenotus pantherinus*; Long-nosed Water Dragon, *Lophognathus longirostris*; Night Skink / Striated Egernia, *Liopholis striata*; Pianka's Ctenotus, *Ctenotus piankai*; Royal Ctenotus, *Ctenotus regius*; Rusty Desert Monitor, *Varanus eremius*; Rusty-topped Delma, *Delma borea*; Sand Goanna, *Varanus gouldii*; and Thorny Devil, *Moloch horridus*)
- Rocky rises (Beaked Gecko, *Rhynchoedura ornata*; Burton's Legless Lizard, *Lialis burtonis*; Marbled Velvet Gecko, *Oedura marmorata*; Rock Ctenotus, *Ctenotus saxatilis*; Rock Skink, *Liopholis margaretae*; Spinifex Snake-Eyed Skink, *Proablepharus reginae*; and Three-Spined Rainbow Skink, *Carlia triacantha*)
- Grassland (non-spinifex) (Fat-tailed Gecko, *Diplodactylus conspicillatus*).

Frogs

So few species of frogs were detected that it is speculative to comment on habitat use.

4.4.2 By habitat

Mulga woodland

A moderate proportion of fauna detected in mulga woodland was found only in that habitat. Of the 102 species recorded in mulga, 15 (14.7%) were found only in that habitat, including 6 birds, 4 mammals, 4 reptiles and 1 frog.

Sandplain spinifex

A very high proportion of fauna detected in sandplain spinifex habitat was found only in that habitat. Of the 89 species recorded in sandplain spinifex, nearly one-third was found only in that habitat (26 species; 29.2%). These included 8 birds, 4 mammals and 14 reptiles. This number of reptiles is proportionally very large: 14 of 41 reptile species (34.1%) detected in the Study area were found only in sandplain spinifex habitat.

Rocky rises

A reasonably high proportion of fauna detected in rocky habitat was found only in that habitat. Of the 84 species recorded in rocky areas, 17 (20.2%) were found only in that habitat, including 7 birds, 7 reptiles 2 mammals, and 1 frog. This indicates a relatively high degree of specificity among fauna that use rocky habitats, particularly for reptiles (7 of 41 species; 17.1%).

Shrubland/woodland

Eleven of the 84 fauna species found in shrubland/woodland were found only in that habitat, and all were birds. However, eight of those were actually waterbirds that were visiting a dam in a woodland area – thus, they were not strictly woodland-specific fauna. With that in mind, the habitat specificity shown by fauna detected in shrubland/woodland was very low (3 of 84 species; 3.6%).

Riparian woodland

One of the 42 fauna species found in riparian woodland was found only in that habitat (a bird: Collared Sparrowhawk, *Accipiter cirrocephalus*). All other species found in riparian woodland

were also found in one or more other habitat. Thus, the habitat specificity shown by fauna detected in riparian woodland was very low (1 of 42 species; 2.4%).

Grassland (non-spinifex)

One of the 24 fauna species found in non-spinifex grassland was found only in that habitat (a reptile: Fat-tailed Gecko, *Diplodactylus conspicillatus*). All other species found in non-spinifex grassland were also found in one or more other habitat. Thus, the habitat specificity shown by fauna detected in non-spinifex grassland was very low (1 of 24 species; 4.2%).

Multiple habitats

Overall, a total of 108 of the 179 fauna species (60.4%) were detected in at least two habitats. Birds, in particular, used multiple habitats – 70 bird species were detected in two or more habitats, and approximately 30% of birds were found in four or more habitats, 20% in five or more habitats, and 10% in all six habitats.

Table 16 Counts of vertebrate fauna species (by group) found in the different habitats

Species group Habitat	Mammals	Birds	Reptiles	Frogs	Total (one habitat)	Total detected in habitat	% of total
Mulga woodland only	4	6	4	1	15	102	14.7
Sandplain spinifex only	4	8	14	0	26	89	29.2
Rocky rises only	2	7	7	1	17	84	20.2
Shrubland/woodland only	0	11*	0	0	11	84	13.1
Riparian woodland only	0	1	0	0	1	42	2.4
Grassland (non-spinifex) only	0	0	1	0	1	24	4.2
Two habitats	10	19	13	1	43	-	
Three habitats	5	18	0	0	23	-	
Four habitats	3	11	2	0	16	-	
Five habitats	2	12	0	0	14	-	
Six habitats	0	10	0	0	10	-	
Total	**30**	**103**	**41**	**3**	**179**	**179**	

*8 birds in shrubland/woodland were waterbirds visiting a dam.

4.5 Results of Targeted Threatened Species Survey

4.5.1 Results of the desktop assessment

Listed threatened fauna species are listed under one or more category of threat (i.e. vulnerable, extinct, near threatened) under the EPBC Act and/or the TPWC Act.

Counts of fauna species identified for the Nolans site are presented in Table 17.

More than half of the threatened species identified for the area are mammals (25 species), and of those, nearly half (11 species) are considered to be extinct in the Northern Territory or across the whole of Australia. The other threatened species are made up of birds (20 species) and reptiles (4 species). No frogs in the area are currently listed as threatened.

Twenty-three of the 49 species are listed under lesser categories of threat (Near Threatened or Data Deficient). These comprise 6 mammals, 14 birds and 3 reptiles.

Locations of threatened species' records included in the DLRM Atlas in the vicinity of the Study area are presented in Figure 10.

Table 17 Counts of fauna species (by group) identified for the Study area that are listed in categories of threat

Species group Threat category	Mammals	Birds	Reptiles	Frogs	Total
EPBC Act					
Extinct (EX)	7	0	0	0	**7**
Endangered (EN)	4	2	0	0	**6**
Vulnerable (VU)	5	3	1	0	**9**
Total (EPBC Act)	**16**	**5**	**1**	**0**	**22**
TPWC Act					
Extinct / Extinct in the Wild / Regionally Extinct (EX / EW / RX)	11	0	0	0	11
Critically Endangered (CR)	0	2	0	0	2
Endangered (EN)	3	0	0	0	3
Vulnerable (VU)	5	4	1	0	10
Near Threatened (NT)	6	12	2	0	20
Data Deficient (DD)	0	2	1	0	3
Total (TPWC Act)	**25**	**20**	**4**	**0**	**49**
Total (all)	**25**	**20**	**4**	**0**	**49**

Note that all species listed under the EPBC Act are also listed under the TPWC Act.

4.5.2 Threatened fauna species most likely to be impacted by the Project

There are a range of terrestrial habitats in the Study area, and each is mostly in good condition. Based on the typical habitat requirements and geographic distribution of the 38 extant listed species, the Study area is considered capable of providing at least some habitat for most of them. All 38 species are listed in Appendix D, along with their conservation status and a summary of their potential use of the study area (likelihood of occurrence). Note that threatened species would be expected to use the Nolans site in varying ways, from breeding residents to occasional, frequent, seasonal, irregular, rare or vagrant visitors.

Eleven threatened or Near Threatened fauna species are given special attention for this project based on the likelihood of occurrence assessment contained in Appendix D. These species are presented in Table 18. These species include:

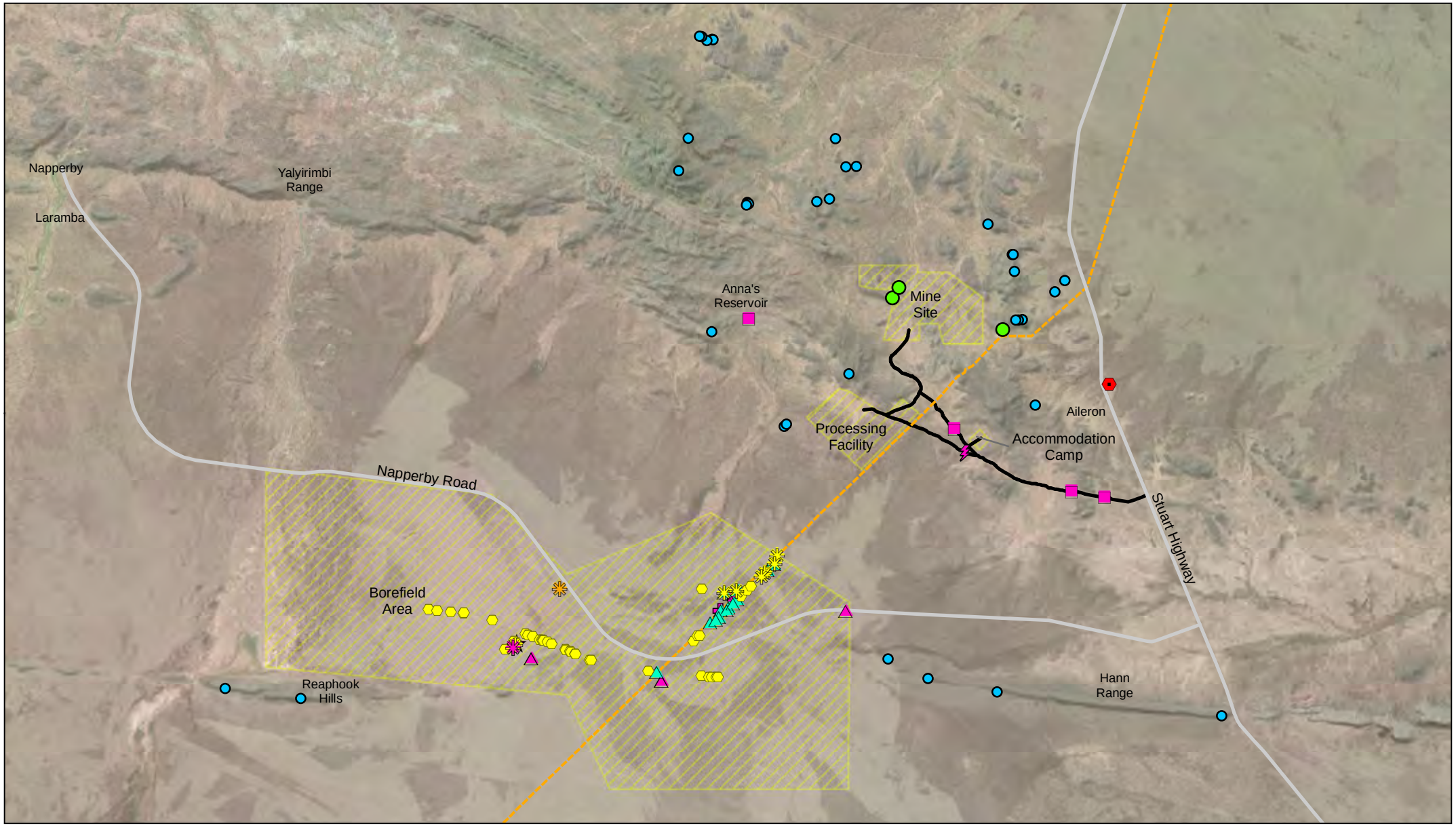
- Nine threatened species that are known to have occurred within the Study area recently (i.e. detected during this assessment)
- Two species that were not detected during the surveys (but that could occur within the Study area).

The two species that were not detected - (Greater Bilby, *Macrotis lagotis*; and Princess Parrot, *Polytelis alexandrae*) - are included because they are listed under the EPBC Act (i.e. are

considered threatened at a national rather than state or regional scale), and therefore have consequences for the project if significant impacts upon them occur.

Additional information for these 12 species is provided in sections below.

If the project results in significant residual impacts on any species listed as threatened under the EPBC Act, then compensatory offsets may be required under the EPBC Act, in accordance with DSEWPaC (2012). According to the EPBC Act website, offsets are 'measures that compensate for the residual impacts of an action on the environment, after avoidance and mitigation measures are taken.'



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0 2.5 5 7.5 10

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

N

LEGEND

- Australian Bustard, 2015
- Black-footed Rock-wallaby, 2010
- Brush-tailed Mulgara, 2015
- Bush Stone-curlew, 2015
- Emu, 2015
- Great Desert Skink, 2015
- Northern Nailtail Wallaby, 2015
- Spectacled Hare-wallaby, 2015
- Great Desert Skink (DLRM)
- Malleefowl (DLRM)
- Bustards
- Mulgara Burrows
- Emus
- Black-footed Rock-wallaby, 2015
- Roads
- Gas Pipeline
- Access Roads
- Study Area

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Threatened and Near Threatened fauna species observations (DLRM database and GHD 2010/11 and 2015)

Figure 10

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Level 5 66 Smith Street Darwin NT 0800 Australia T 61 8 8982 0100 F 61 8 8981 1075 E drwmail@ghd.com W www.ghd.com

Data source: GA - Imagery (2008), Roads, Gas Pipeline (2015). GHD - Fauna Survey Sites, Proposed Mine Site, Proposed Treatment Plant, Proposed Accommodation Village, Borefield Area (2015). Created by: CM

Table 18 Threatened, Near Threatened and Data Deficient fauna species of highest priority for the project

Key to Table:

EPBC Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*

TPWC *Territory Parks and Wildlife Conservation Act 2006*

EX	Extinct	EW	Extinct in the wild	CR	Critically endangered	NT	Lower risk - near threatened
EN	Endangered	DD	Data deficient	VU	Vulnerable	RX	Regionally extinct

PMST	Identified by the PMST search tool of the EPBC Act	GHD	Detected during 2010/11 or 2015 survey
DLRM	Recorded on the DLRM list (within 20 km of Study area)	BPB	Recorded on the list for the Burt Plain Bioregion

Likelihood of occurrence of fauna is assessed on a 4-tier scale:

1: **Present** – observed during the 2010 or 2015 baseline fauna surveys

2: **Possible** - suitable habitat occurs within the Study area, and site is within species' normal range

3: **Unlikely** - suitable habitat does not occur within the Study area, or suitable habitat present but substantially modified or degraded

4: **Highly unlikely** – no suitable habitat within the Study area and site is outside species' normal range.

Species	EPBC	TPWC	Source	Most recent record (DLRM or other)	Likelihood of occurrence within the study area	Comments
MAMMALS						
Brush-tailed mulgara *Dasycercus blythi*	-	VU	GHD 2015	2015 GHD	**Present** - Borefield area **Unlikely** - Mine site and Processing site	Detected in borefield area with motion-sensing cameras (May 2015) and field surveys (July 2015). All spinifex-dominated areas in the sandplain areas likely to support this species. Areas with spinifex occurring at the mine site are likely to be too rocky to support this species. Note: Similar species (Crest-tailed mulgara *Dasycercus cristicauda*) (Vulnerable EPBC; Vulnerable TPWC) also possible in the general area, but not detected, and considered unlikely to occur within the Study area on the basis of habitat. The two species can live in sympatry, but typically partition on the basis of habitat.

Species	EPBC	TPWC	Source	Most recent record (DLRM or other)	Likelihood of occurrence within the study area	Comments
Black-footed Rock-wallaby (MacDonnell Ranges race) *Petrogale lateralis*	VU	NT	GHD, DLRM, PMST, BPB	2011 GHD 1987 DLRM	**Present** - Mine site **Unlikely** - all other areas	Results from scat samples collected in 2011 suggest that this species occasionally passes through the Mine Site and follow up surveys confirmed that a reproductive population exists in the vicinity of the mine site and surrounding ranges, extending down to outcrops in the southern borefield area (e.g. Reaphook Hills). Suitable habitat for this species is present within the rocky outcrops of the mine site, with habitat connectivity to other ranges nearby, suggesting that a larger population persists in the Reynolds Range area. Two waste rock dumps at the west of the mine site will directly impact a small area of likely habitat. Most of the habitat in the area surrounding the Mineral Lease will not be directly impacted by the project.
Greater Bilby (Bilby) *Macrotis lagotis*	VU	VU	PMST, BPB	-	**Possible** – all areas, but particularly in sandplain areas in southern parts of Study area	Not recorded during the 2010 or 2015 surveys, and no records exist for the Study area, although suitable habitat is present. Spinifex-dominated habitats within the study area provide potential habitat, including rocky areas and areas with a low shrub cover. Species occupies vegetation types including open tussock grassland on uplands and hills, mulga woodland/shrubland growing on ridges and rises, and hummock grassland in plains and alluvial areas (Southgate 1990b). In favourable conditions, populations can expand rapidly in abundance and occupied area (Woinarski et al. 2007). Species once widespread across NT, but populations declined dramatically following European settlement. The Bilby is now generally reported from the western deserts region of NT, although other sightings occur occasionally. Species considered likely to still be present in this part of NT, albeit probably in small numbers. Species known from the Burt Plain Bioregion.
Spectacled hare-wallaby *Lagorchestes conspicillatus*	-	NT	GHD 2015, BPB	2015	**Present** - Borefield area (tracks found in the during the GHD 2015 survey.) **Possible** – other areas	Tracks found in the Borefield area during the GHD 2015 survey. No animals were seen. None others were recorded neither during the surveys, nor during previous field surveys at the site (Low Ecological Services 2007). Study area near southern limit of potential distribution (Menkhorst and Knight 2004). Although generally a low likelihood, there is a possibility of a population persisting at the site in spinifex-dominated areas, particularly areas with a dense mid-level, or sparse tree and shrub cover (Menkhorst and Knight 2004).

Species	EPBC	TPWC	Source	Most recent record (DLRM or other)	Likelihood of occurrence within the study area	Comments
Northern Nailtail Wallaby *Onychogalea unguifera*	-	NT	GHD 2015	2015	**Present** – Processing site (tracks and scats found during the GHD 2015 survey) **Possible** – other areas	Northern Nailtail Wallaby tracks and scats were recorded during the 2015 survey at a survey site around the processing site. Could occur anywhere across the Study area, but particularly in open woodland or shrubland.
BIRDS						
Princess Parrot *Polytelis alexandrae*	VU	VU	PMST, BPB	-	**Unlikely** – Mine site **Possible** – all other areas	Not recorded during the surveys and no records exist for the Study area, although suitable habitat is present. Species has patchy and irregular distribution in arid Australia. In NT, it occurs in the southern section of the Tanami Desert south to Angas Downs and Yulara and east to Alice Springs. The exact distribution within this range is not well understood. Few locations exist in the Northern Territory where the species is regularly seen, and even then there may be long intervals (up to 20 years) between records. Most records from the MacDonnell Ranges Bioregion are during dry periods (DLRM 2006). Species considered unlikely to use habitats within the mine site due to the absence of dune and swale habitats (although species has been recorded in riverine, woodland and shrubland habitat occasionally; Woinarski et al. 2007). Sandplain habitats in the borefield area provide potential foraging habitat for this species, with potential nesting sites also occurring in the sparse hollow-bearing trees. Possible occasional visitor.
Emu *Dromaius novaehollandiae*	-	NT	GHD 2015, BPB	2015	**Present** – Borefield area **Possible** - all other areas	Tracks recorded in sandplain spinifex habitat during the GHD 2015 survey. Potential habitat throughout all study area

Species	EPBC	TPWC	Source	Most recent record (DLRM or other)	Likelihood of occurrence within the study area	Comments
Australian bustard *Ardeotis australis*	-	NT	GHD 2010, 2015; DLRM, BPB	2015 GHD; 1985 DLRM	**Present/possible** – all areas	Three Australian bustards detected in open grassland along the haul route (GHD 2010), approximately 10 km west of the eastern extent. This habitat occurs sporadically in the area, and provides suitable habitat for this species (Woinarski *et al* 2007). After fire, the species may use a wide range of open habitats, even woodland areas (Woinarski et al 2007). Also recorded in the borefield area in 2015. Tracks were found and two birds were seen.
Flock bronzewing *Phaps histrionica*	-	NT	GHD 2010; BPB	2010	**Present/possible** – all areas	During GHD 2010 surveys, two flock bronzewings were observed in sand plain habitat at the far eastern end of the haul route. Similar habitats are common within the Study area. Spinifex-dominated grasslands and sparse mulga shrublands are amongst habitats known to be used by the species, but are probably not considered to be amongst the habitats in which the species is most commonly detected (Higgins and Davies 1996).
Bush Stone-curlew *Burhinus grallarius*	-	NT	GHD 2015, DLRM, BPB	2015 GHD 2006 DLRM; and Low 2007	**Present** - Processing site and Mine site **Possible** – all other areas	The Study area appears to support a persisting population. Detected during the GHD 2015 surveys and during previous survey by Low Ecological Services (2007). During the GHD 2015 survey, the species was observed in and near the Processing Site area, and a roadkilled animal (recent) was observed along the Stuart Highway near Ryan Well. Open woodland with scattered woody debris, preferred habitat for this species, is present within the Mine Site area and the Processing Site area, and other suitable habitats occur across much of the Study area.

Species	EPBC	TPWC	Source	Most recent record (DLRM or other)	Likelihood of occurrence within the study area	Comments
REPTILES						
Great Desert Skink *Liopholis kintorei*	VU	VU	GHD 2015; DLRM, PMST, BPB	2015 GHD; DLRM - no date	**Present** - Borefield area **Possible** - Processing site **Unlikely** - Mine site	Burrow/latrine system seen in Borefield area during GHD 2015 survey. NT Fauna Atlas indicates one undated record, also in the Borefield area (near Napperby Road). This species inhabits large complex burrows in a variety of desert habitats on sandy, clay and loamy soils (Cogger, 2000 cited in DotE 2015). It occurs on sand plains and on the flats between low sand dunes, preferring areas vegetated with spinifex clumps and scattered shrubs (Paltridge and McAlpin, 2002 cited in DotE 2015). Habitats for this species within the mine site are limited and this species is considered unlikely to occur there. However, sand plain habitats located in the borefield area and parts of the processing area support the preferred spinifex clumps with scattered shrubs occupied by this species in other areas.

4.5.3 Mulgaras

Two species of Mulgara occur in central Australia: Brush-tailed Mulgara (*Dasycercus blythi*) and Crest-tailed mulgara (*Dasycercus cristicauda*). Both species are listed as vulnerable under the TPWC Act, and the Crest-tailed mulgara (*Dasycercus cristicauda*) is listed as vulnerable under the EPBC Act. There has been much uncertainty surrounding their identification and distribution. Recent literature determines that the species that occurs in spinifex sandplain habitats in the vicinity of the Study area is the Brush-tailed Mulgara (*Dasycercus blythi*) (Woolley 2005; Van Dyck et al. 2013). Taxonomic and EPBC-list revisions relevant to the species are discussed in section 1.5.1. Because the confusion and uncertainty in mulgara species identification, the Brush-tailed Mulgara was included as a focal threatened species during this assessment.

While the Crest-tailed Mulgara can be sympatric with Brush-tailed Mulgara (Pavey *et al*. 2011), the habitats present in the Study area are far more likely to support the Brush-tailed Mulgara than the Crest-tailed Mulgara. The Crest-tailed Mulgara occurs only in the southern Northern Territory (including far south-western Queensland) and northern South Australia and tends to occur on sand dunes that have a sparse cover of sandhill canegrass, or in areas around saltlakes with nitrebush (Van Dyck *et al.* 2013).

No Crest-tailed Mulgaras were recorded for the Study area.

Brush-tailed Mulgara (Dasycercus blythi)

The Brush-tailed Mulgara is listed as vulnerable under the TPWC Act and occurs in isolated populations in the Northern Territory. This species occupies spinifex (*Triodia* spp.) grasslands, and burrows in flats between sand dunes. It is generally a solitary species that hunts at night, although it is not strictly nocturnal (Woolley 2008).

The Brush-tailed Mulgara has a relatively patchy distribution and sedentary lifestyle with home ranges of males (25.5 ha) significantly larger than those of females (10.8 ha) (Kortner *et al.* 2007). Its diet consists of insects, other arthropods and small vertebrates (Menkhorst and Knight 2011). Populations fluctuate with quality of seasons (Menkhorst and Knight 2011).

The Brush-tailed Mulgara has declined over 50–90% of its historical range (Maxwell et al. 1996). Its habitat has been adversely affected by the grazing of introduced species (e.g. camels, rabbits, cattle), and changes to the fire regime. Studies have shown that the abundance of Brush-tailed Mulgara is greater in areas of high *Triodia* cover compared with recently burnt areas with low *Triodia* cover (Masters 1993; Baker 1996).

Fire appears to have an impact on population size, with fewer animals found in the years after a burn (Masters 1993). Alteration of fire regimes following European settlement and appropriate use of fire management are potentially significant conservation issues. Predation by introduced feral cats and foxes may threaten this species. Climate change may pose a threat to this species in the future (Woolley 2008).

Survey records

No Brush-tailed Mulgara were captured during baseline fauna surveys, but numerous photographs were obtained following the 2015 baseline survey, on two of the motion-sensing cameras set up at a Great Desert Skink latrine site in the borefield area just west of Site N13 (Plate 7; Figure 3).

All spinifex-dominated areas on the sand plains within the Study area have the potential to support this species. Age of spinifex will likely have an influence, with patches of older, more established spinifex, and patches that have not been burnt recently may have a higher chance of supporting the species. Within the Borefield area, there was distinct patchiness in areas of spinifex and the mulgara observations came from an area of older spinifex but there were also observations of active burrows within burnt areas.

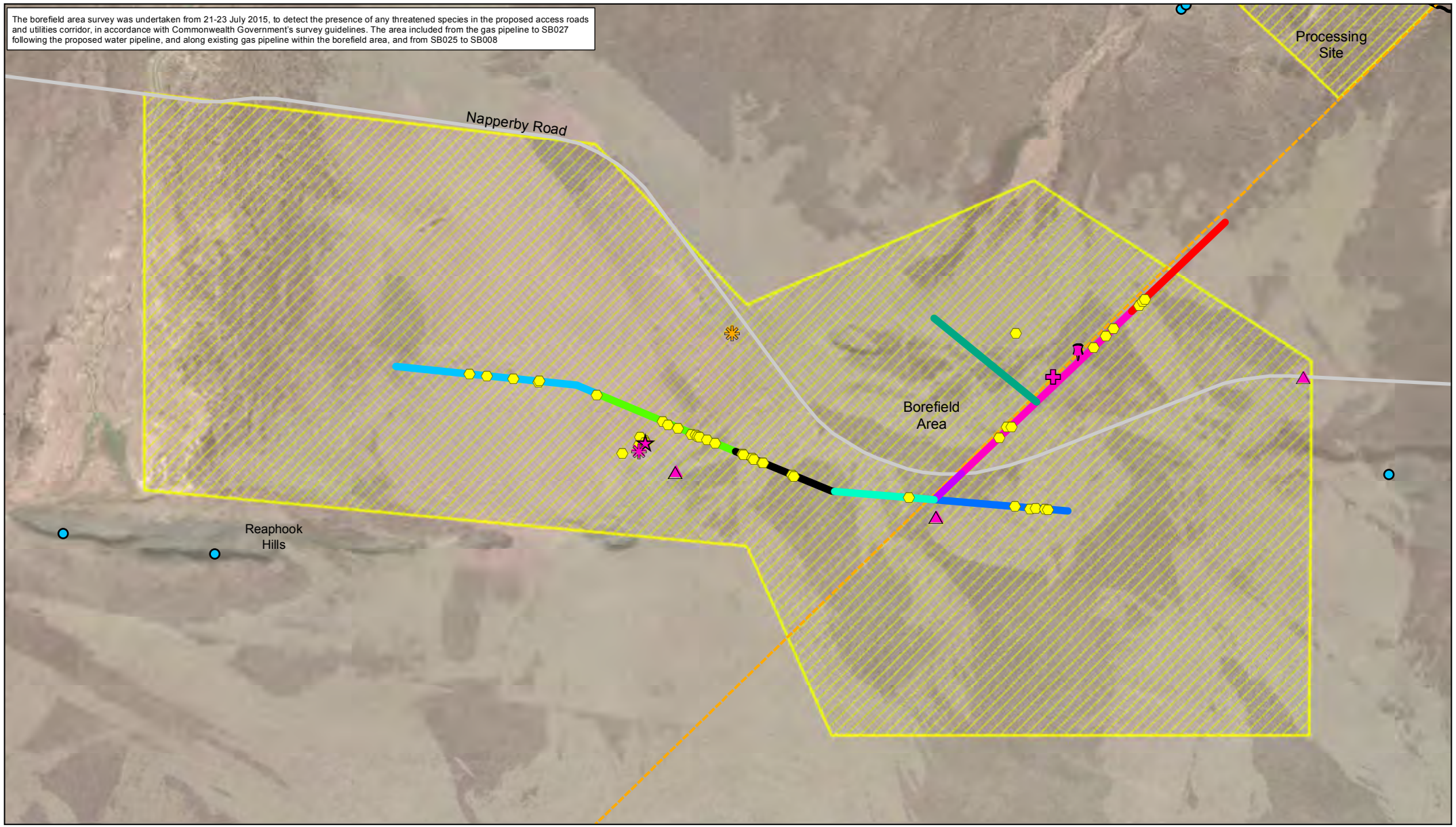
Rocky areas are unlikely to be suitable. Areas with spinifex occurring at the mine site are likely to be too rocky to support this species.

Multiple Brush-tailed Mulgara burrows, scats and diggings were recorded in the borefield area, where the proposed access roads and water pipeline corridor occur. Figure 11 shows locations of these.

Conclusion – Brush-tailed Mulgara

Targeted survey for mulgara in July 2015 in the sandplain areas (i.e. borefield area and southern extent of proposed water supply pipelines) was carried out to determine the size and distribution of the population in areas proposed for impacts. Mulgara burrows, scats and diggings were recorded along the proposed access roads and water pipeline corridor. During targeted surveys a total of 45 active Mulgara burrows (indicated by fresh tracks, digging and/or scat) were recorded along the 37.4 km of proposed alignments, or within 20 m of the centreline (Figure 11). These results suggest that mulgara are present in quite high numbers and widespread in areas of suitable sandplain habitat across the southern borefield area.

Plate 7 Brush-tailed Mulgara photographed using motion-sensing camera at the latrine site west of N13, with images of typical habitat below



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0 1 2 3 4 5

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

N

LEGEND

- Mulgara Burrows
- Black Footed Rock Wallaby Survey
- Great Desert Skink (DLRM)
- Australian Bustard, 2015
- Brush-tailed Mulgara, 2015
- Emu, 2015
- Great Desert Skink, 2015
- Spectacled Hare-wallaby, 2015

Transect: A-B, B-C, C-D, D-E, E-F, E-G, G-H, H-I, I - J

- Roads
- Gas Pipeline
- Access Roads

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Borefield survey effort including records of Brush-tailed Mulgara/Great Desert Skink and other Near Threatened Species Figure 11

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Level 5 66 Smith Street Darwin NT 0800 Australia T 61 8 8982 0100 F 61 8 8981 1075 E drwmail@ghd.com W www.ghd.com

Data source: GA - Roads, Gas Pipeline, Imagery (2015). GHD - Study Area, Black-footed rock-wallaby data (2015). Created by: CM

4.5.4 Black-footed Rock-wallaby MacDonnell Ranges race (*Petrogale lateralis*)

The Black-footed Rock-wallaby (*Petrogale lateralis lateralis*) (Plate 8) is a moderately sized macropod found in rocky arid areas of central Australia. This species is a habitat specialist (rocky ranges and slopes) and is likely to occur in any suitable habitat throughout the region. They feed on grass, but some herbs and some leaves and fruits are eaten. Both spearbush (*Pandorea doratoxylon*) and fig (*Ficus brachypoda*) are important food plants for rock-wallabies (Geelen 1999). A range of grasses and forbs, such as *Cymbopogon ambiguus*, *Digitaria brownii* and *Enneapogon polyphyllus*, are also key components of their diet (Geelen 1999). Though occasionally drinking when water is present they can survive extended periods without water. Water requirements are reduced by wallabies sheltering during the day in caves and under boulders, where relative humidity is higher and air temperatures cooler, usually emerging in the late afternoon or early evening to feed. In cooler months, animals may bask in the sun during the early morning following a cold night (Pavey 2006).

The Black-footed Rock-wallaby is listed as vulnerable under the EPBC Act and near threatened under the TPWC Act. Northern Territory animals belong to a currently undescribed subspecies, centred in the MacDonnell Ranges. The distribution of the MacDonnell Ranges subspecies is centred on the MacDonnell Ranges bioregion of the southern Northern Territory. In the Northern Territory its range extends north to the Davenport and Murchinson Ranges, east to the Jervois Range, west to the Western Australian border and south to the South Australian border (Pavey 2006). Major threats faced by isolated populations in Western Australia and South Australia and parts of the Northern Territory include predation by introduced (Red Fox, Cat) and native (Wedge-tailed Eagle) predators, and habitat degradation caused by changed fire regimes and grazing by introduced herbivores (Pavey 2006; Read and Ward 2011). With their specific habitat requirements, Black-footed Rock-wallabies can be limited in their ability to disperse.

Plate 8 Black-footed Rock-wallaby (Photo taken at Finke Gorge National Park, NT)

4.5.5 Black-footed Rock-wallaby Survey records – 2010 and 2011

Baseline fauna survey of the mine site area conducted by GHD (2010) detected the Black-footed Rock-wallaby (*Petrogale lateralis*) in the rocky sections of the Mine Site area.

A range of macropod scats were collected from the Mine Site area during 2010 and 2011 surveys. scats from a *Petrogale sp.* (probable) were collected during the 2010 survey and confirmed by Barbara Triggs (Dead Finish Pty Ltd, authority and author of *Scats Tracks and Other Traces: A Field Guide to Australian Mammals 2004*).

The only Petrogale species with a distribution that includes the Mine Site is the Black-footed Rock-wallaby (*Petrogale lateralis* MacDonnell Ranges race). Areas containing suitable Black-footed Rock-wallaby habitat were identified in the mine site area during 2010 and 2011 survey.

Sites assessed in detail during targeted survey in 2011 are described below as Outcrops A-D and shown in Figure 12. Plate 9 illustrates the habitat within the Mine Site area that is considered suitable for the Black-footed Rock-wallaby.

Outcrop A

Outcrop A is a tall isolated outcrop located in the west of the Mine site area, with numerous caves, crevices and fissures that could be used for shelter by Black-footed Rock-wallabies (Ward *et al.* 2011). There is a diverse ground layer of vegetation including grasses that may provide foraging opportunities (Woinarksi *et al.* 2006). Scats collected from this area (September 2010) were fresh and formally identified as 'probable' *Petrogale* sp. (Dead Finish Pty Ltd). Black-footed Rock-wallabies are likely to forage and shelter on this outcrop.

Outcrop B

Outcrop B is part of a long granitic ridge that extends for approximately 3 km, mostly outside the mineral lease. More elevated portions of the outcrop (outside Mine Site) support Black-footed Rock-wallaby habitat based on observations through binoculars and from vantage points within the mine site. The lower eastern extension of this outcrop, located within the mine site, appears to support dispersal habitat for Black-footed Rock-wallaby, with low quality grazing habitat. The vegetation is dominated by spinifex (*Triodia* sp.) which would limit grazing opportunities. Scat samples collected (September 2010) was later identified as likely to be *Petrogale* sp.

Outcrop C

There are caves, crevices and fissures in this area that could provide refugia for Rock-wallaby, but there are limited foraging habitats. The location is open, has a relatively low elevation and at the time of assessment (December 2011) was heavily littered with Euro (*Macropus robustus*) scat. The area was dominated by spinifex (*Triodia* sp.) and had recently burnt. Black-footed Rock-wallaby may inhabit this area, but perhaps for daytime resting only or as part of a broader transient population.

Outcrop D

There is abundant refuge and foraging habitat on this tall boulder outcrop. There were also small springs along the base of this outcrop during the September 2010 baseline survey. Scat samples collected were formally identified as 'probable' *Petrogale* sp. Suitable habitat extends to adjoining elevated rocky cliffs. Black-footed Rock-wallaby are likely to inhabit the area.

Outcrop E

Outcrop E contains marginal habitat that adjoins higher rocky ranges which are likely to provide suitable shelter and foraging habitat for rock-wallabies. The lower adjacent rocky foothills may provide occasional dispersal/foraging habitat, but are unlikely to provide core shelter/refuge habitats due to the low elevation.

Other habitats of the Mine Site

Other parts of the Mine Site are considered unsuitable for this species, although individuals may move through these habitats between patches of suitable rocky habitat. The western and southern sides of the Mine Site support no suitably large rocky outcrops. The vegetation in those areas is primarily mulga shrubland or spinifex-dominated sand plain. Rock-wallabies may disperse through these habitats to other nearby rocky outcrops, but this behaviour is likely to be rare given the wallabies vulnerability to predation outside rocky habitats.

Cave at Outcrop A

Cave at Outcrop A

Cave at Outcrop A

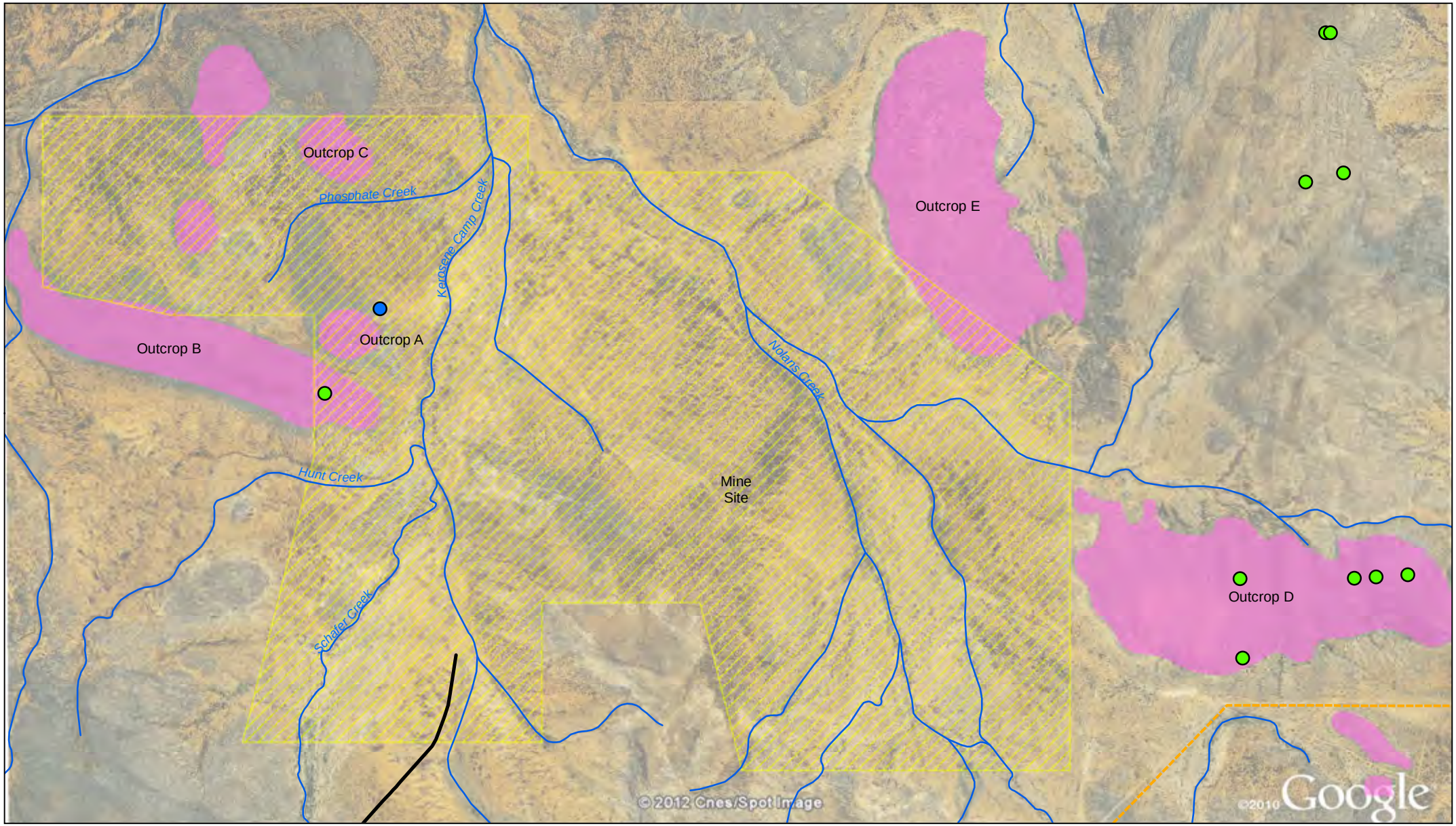
Steep rock outcropping at Outcrop A

Boulders with cracks and fissures at Outcrop C

Suitable habitat at Outcrop D

Marginal habitat at Outcrop E

Plate 9 Suitable Black-footed Rock-wallaby habitat at Outcrops A – D (see also Figure 12)



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Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

N

LEGEND

- Black-footed Rock Wallaby scat locations (2010)
- Black-footed Rock Wallaby scat locations (2015)
- Roads
- Gas Pipeline
- Access Roads
- Study Area
- Likely Black-footed Rock Wallaby Habitat

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Black-footed Rock-wallaby potential habitat and scat locations Figure 12

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Level 5 66 Smith Street Darwin NT 0800 Australia **T** 61 8 8982 0100 **F** 61 8 8981 1075 **E** drwmail@ghd.com **W** www.ghd.com

Data source: Google Earth Pro - Imagery (Date extracted: 01/02/2012). GA - Roads, Gas Pipeline (2015). GHD - Study Area, Black-footed rock-wallaby data (2010). Created by: CM

4.5.6 Black-footed Rock-wallaby Survey records – 2015

Black-footed Rock-wallaby targeted surveys were completed over three days at 65 survey sites. No scat records were made from areas within the proposed mine footprint during this survey (see Figure 24).

Fresh and old signs (scat) of both adult and juvenile rock-wallaby were found at 35 of the 65 survey sites, spread broadly throughout a 650 km^2 survey area, in areas of suitable habitat, in all directions from the mine site (Figure 23).

At the 35 sites where scats were found (Figure 23), scat counts at individual sites ranged from two to 120 scats (Figure 13).

Scat count categories
0 = no scat found
1 = <10 scats counted
2 = 10-20 scats counted
3 = 20-30 scats counted
4 = 30-40 scats counted
5 = 40-100 scats counted
6 = 100+ scats counted.

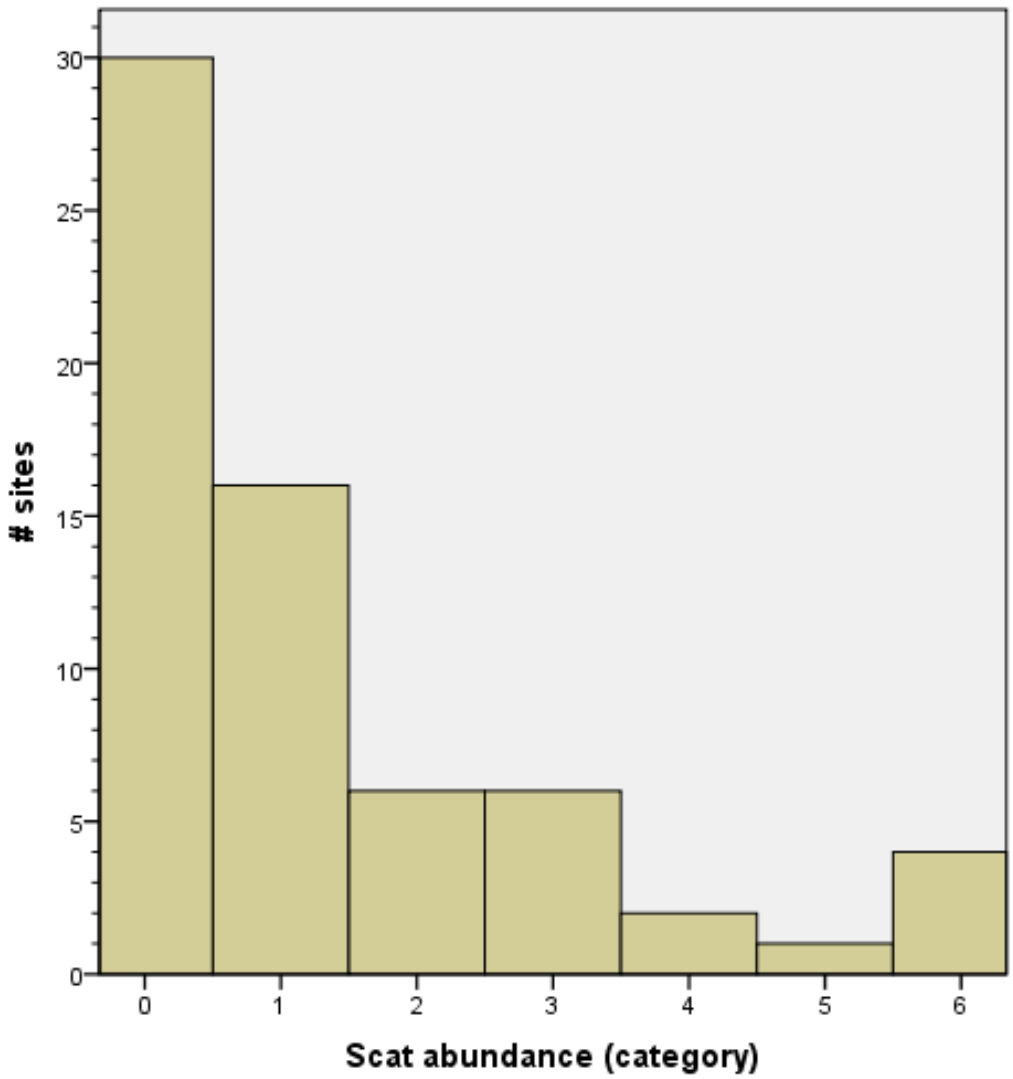


Figure 13 Scat counts at sites, presented in abundance categories

Of the 35 sites where scat was observed:

- Old scat was found at all of the 35 sites
- Fresh scat was found at only twenty-one sites (Figure 24).

Both old and fresh scats were recorded from sites across most of the study area, except for the four sites within the south-eastern part of the area (Hann Range), where fresh scat were not found and also within the central northern part of the study area (Figure 12). This suggests that individuals use that area occasionally or periodically rather than continuously, perhaps while moving across the landscape, dispersing from one more suitable area of habitat to another, or in response to deterioration of other habitat areas (e.g. from fire). In contrast, fresh scat was recorded at both of the sites in the Reaphook Hills in the south-western part of the area (Figure 24), which appears quite isolated but in fact is connected to a series of hills extending for >100 km to the west.

Of the 35 sites where rock-wallaby scat was observed, five sites included scats of juvenile rock-wallabies (Figure 5; Figure 23). This is considered important as it indicates breeding activity by this species in or near that area. Juvenile rock-wallabies are likely to be more susceptible than adults to predation, so may be less likely to survive in marginally suitable habitat.

Juvenile rock-wallabies were only recorded from sites immediately east and north of the mine site - these areas may provide higher quality habitats suitable for breeding and rearing young. Additionally, juvenile scat was observed only at sites where fresh scat was observed (Figure 15). No juvenile scat was observed at sites where only old scat was observed.

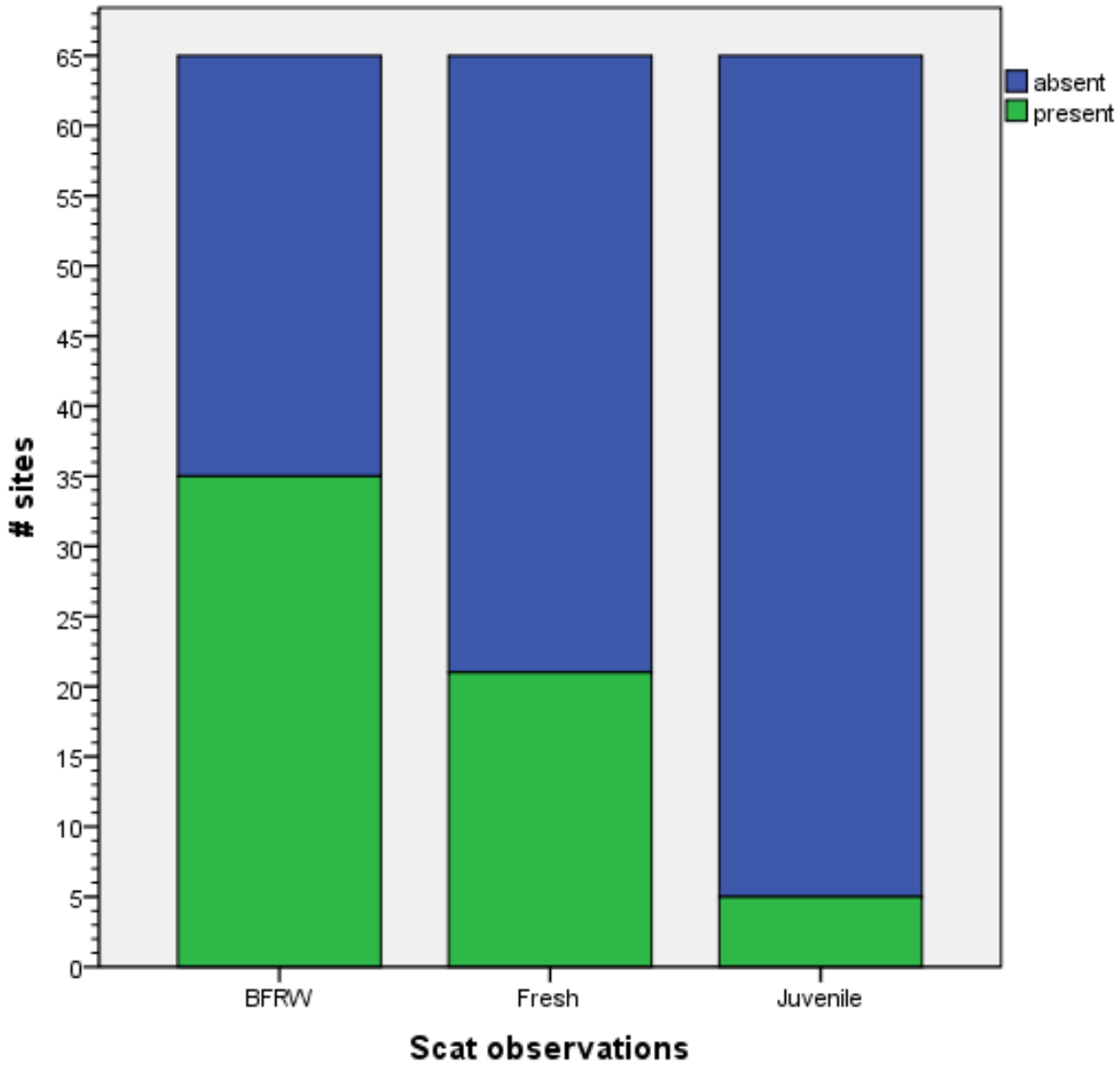


Figure 14 Numbers of sites where different categories of scat were found: i) BFRW scat; ii) Fresh scat; iii) Juvenile scat

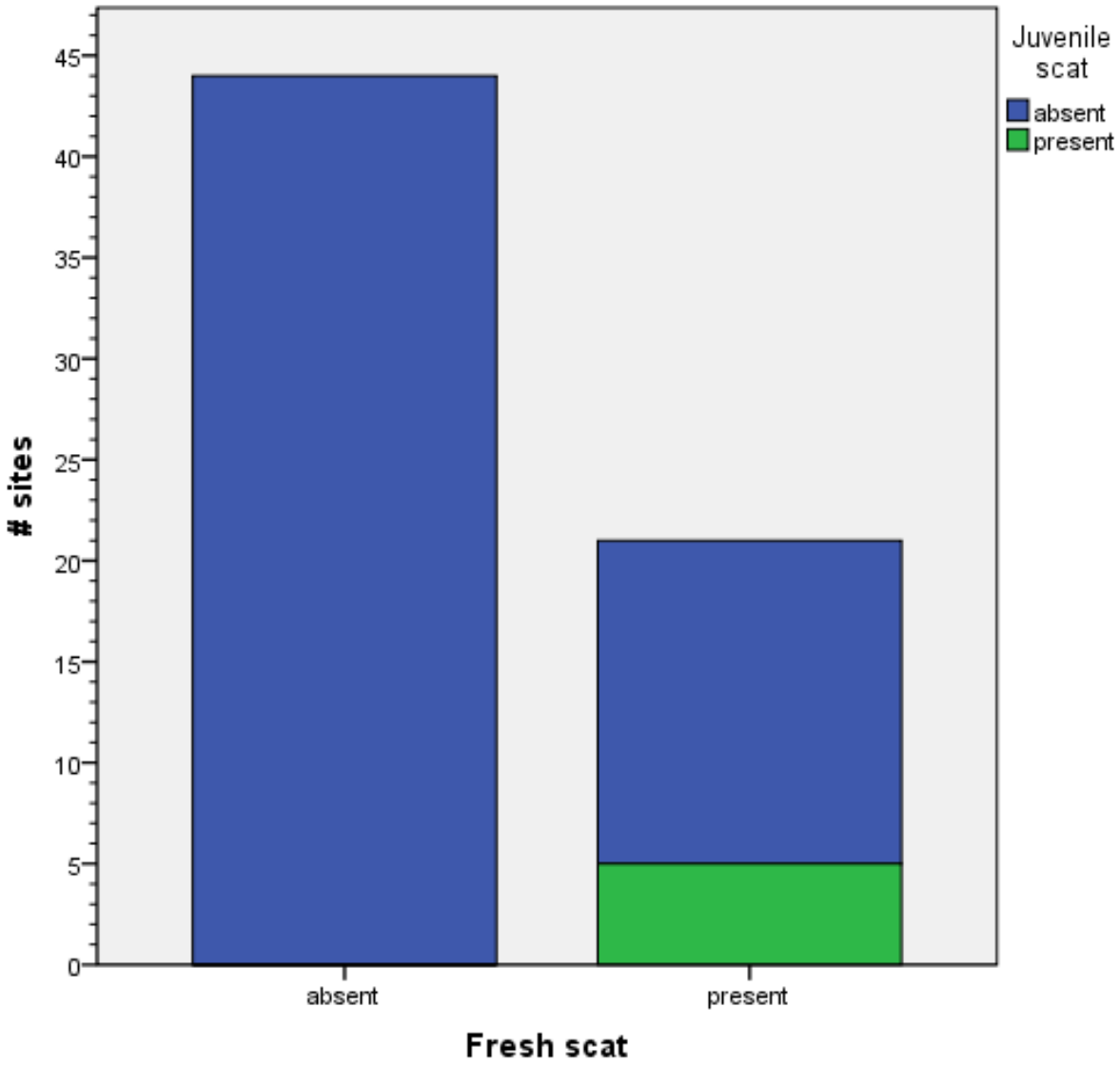


Figure 15 Relationship between presence/absence of fresh scat and of juvenile scat

Most of the 65 assessed sites supported potential forage species such as Spearbush (*Pandorea doratoxylon*) (57 sites) and Fig (*Ficus brachypoda*) (50 sites). The invasive Buffel Grass (*Cenchrus ciliaris*) was observed at only 13 (20%) of the 65 sites (Figure 16). The pattern of presence/absence of these species was similar for sites where rock-wallaby scat was or was not observed (Figure 17). Proportionally, sites where rock-wallaby scat was observed had higher presence of Buffel grass and Fig and lower presence of Spearbush, but the differences are relatively small (Figure 17).

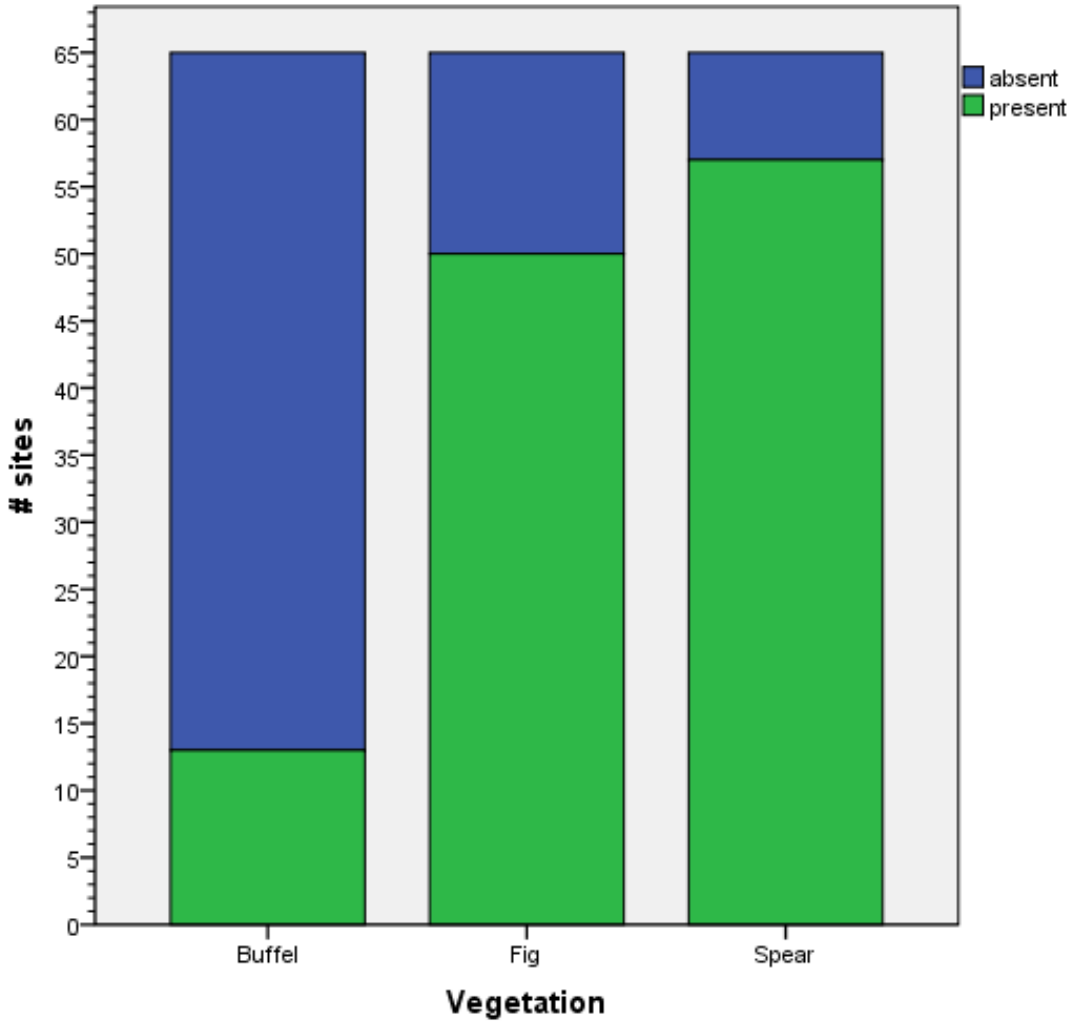
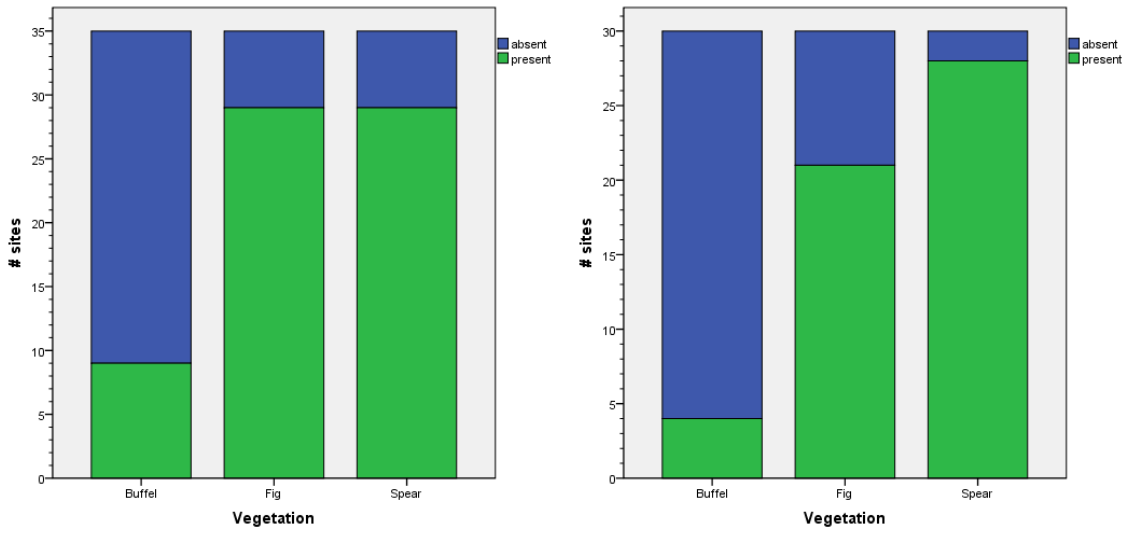


Figure 16 Presence/absence of vegetation at the sites visited



a) BFRW scats observed

b) BFRW scats **not** observed

Figure 17 Presence/absence of vegetation at sites where BFRW scat was or was not observed

Many of the sites had signs of other fauna, which are potential competitors for food resources (Camel, Cattle, Rabbit, Euro) or predators (Dingo, Cat, Fox) (Figure 18). All but one site had Euro scat, and this species was considered common at more than half of the sites (on the basis of scat counts). Cattle and Rabbits were present at less than half of the sites, but tended to be common wherever they occurred. Signs of Camel were found at 12 sites, and were never common.

Signs of predators were also found at 12 sites only (Figure 18). Camel and predator signs observed were mostly footprints in sand; sandy areas are less prevalent in rocky habitats, so predators and camels were probably more widespread than the observations suggest.

No signs of predators were observed at the 5 sites where juvenile wallaby scat was observed.

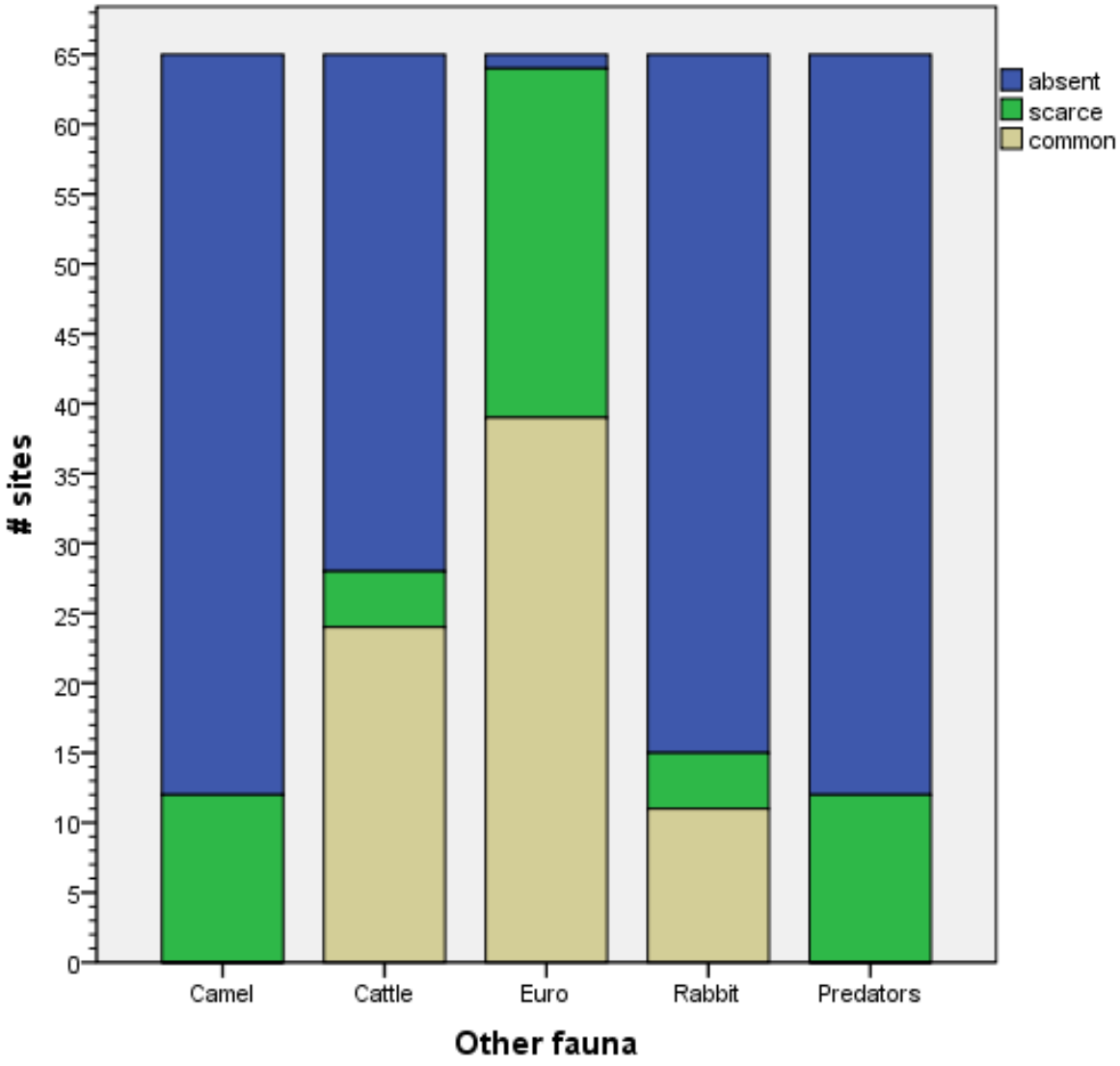
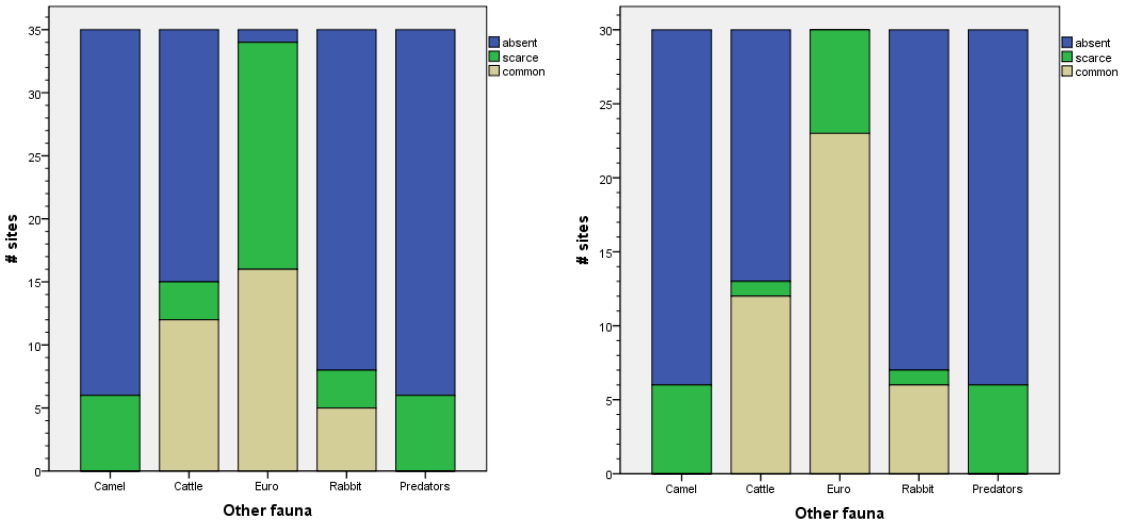


Figure 18 Relative abundance of competitors and predators at the sites visited.

The pattern of presence/abundance of competitors and predators was similar for sites where rock-wallaby scat was or was not observed (Figure 19). The most notable difference was for Euro; Euro scat tended to be less common (but not absent) at sites where rock-wallaby scat was observed.



a) BFRW scats observed

b) BFRW scats **not** observed

Figure 19 Observations of other fauna at sites where BFRW scat was or was not observed

A site's fire history appears to have some relationship with whether or not rock-wallabies occur there. Three field-estimated attributes of fire history (% burnt in the last 2 years; % burnt 2-10 years ago; % burnt more than 10 years ago) were combined to form a burn score (an index of the burn history of a site). Higher burn scores indicate that a greater proportional area of the site was burnt more recently. Rock-wallaby scat was observed at sites that tended to have a lower burn score (Figure 20), where there was less evidence of recent fire. This pattern was consistent for all rock-wallaby scat, and for fresh scat and juvenile scat (Figure 20).

This pattern may be confounded by the fact that fire will burn scats also. At sites that have evidence of recent fire, scats may have burned (and therefore been removed) more recently. At sites that have no evidence of recent fire, there has been more time for scats to accumulate since the last fire.

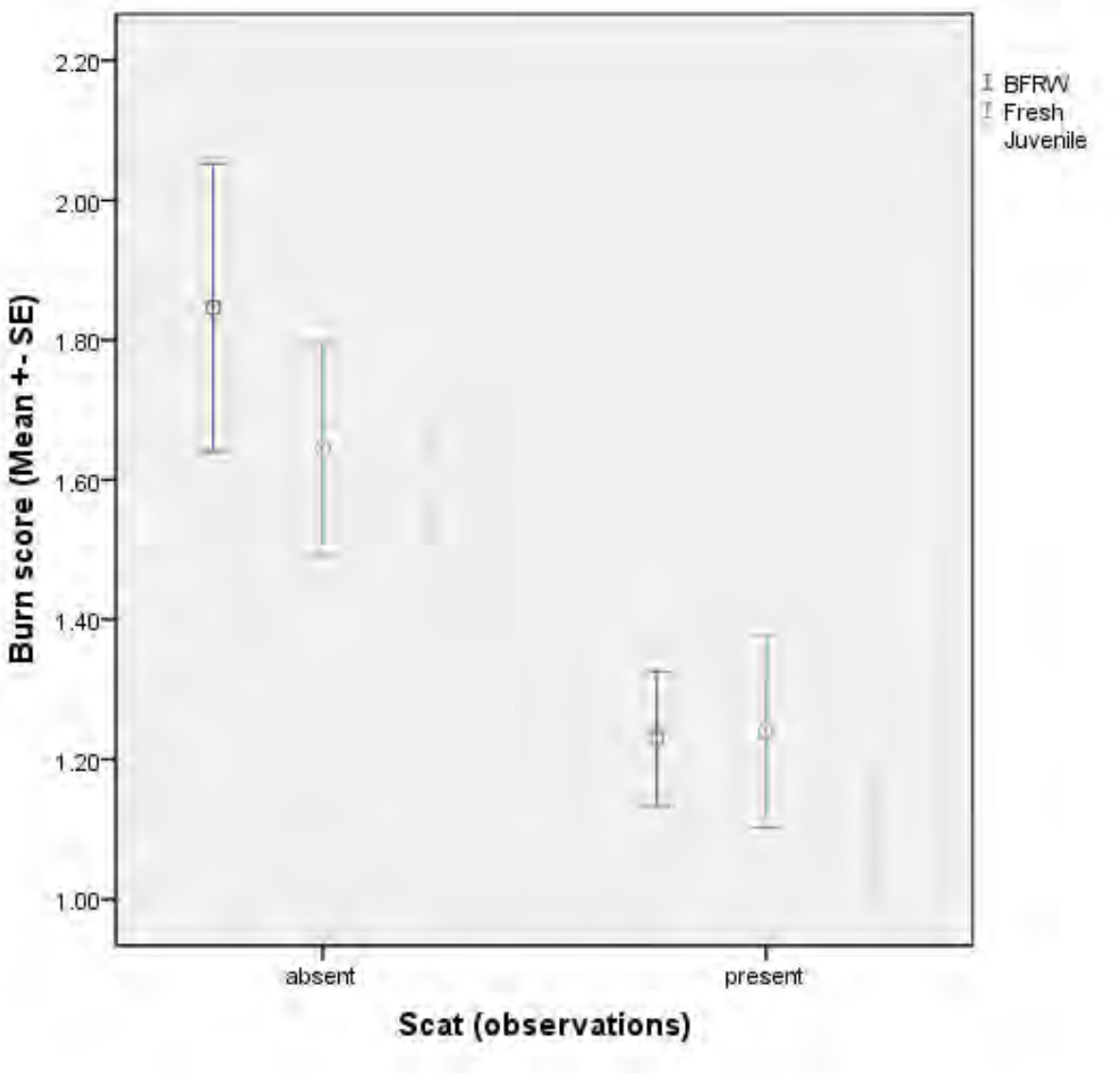


Figure 20 Presence/absence of rock-wallaby scat (all, fresh, juvenile) relative to a site's apparent fire history (higher burn scores indicate greater area burnt more recently)

A site's estimated distance to a (known) reliable water source showed little relationship with rock-wallaby scat abundance (Figure 21). While scat abundance (assessed in categories, mean ± SE) varied, there was no obvious pattern across sites relative to the site's distance to water; sites at the minimum and maximum estimated distances to water (categories 1 and 4 respectively) did not differ notably in their scat abundance (Figure 21). There are at least two obvious reasons why there a stronger pattern was not evident here:

i) rock-wallabies are arid-adapted fauna and survive in seemingly dry landscapes possibly by exploiting alternative water sources or by travelling large distance to get water

ii) there are likely to be alternative sources of water in the study area that were not known for this assessment.

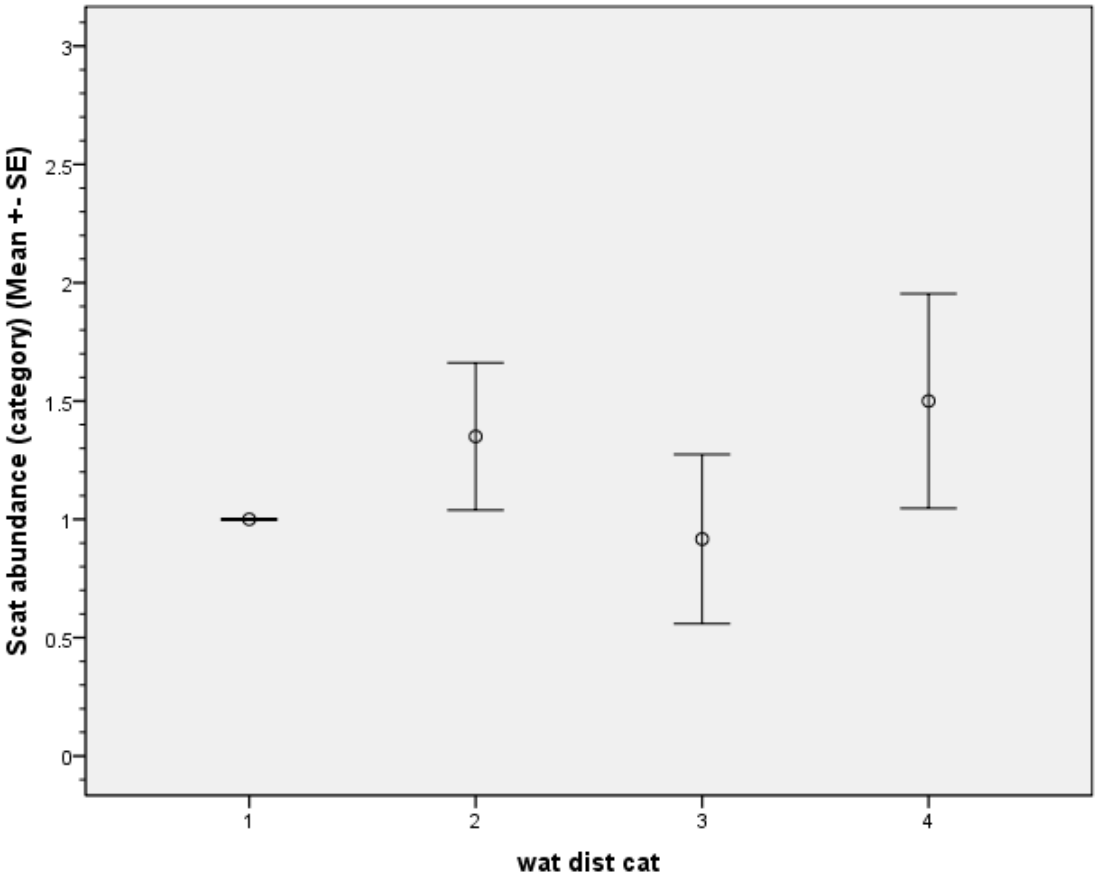


Figure 21 Relationship between rock-wallaby **observations and a site's** proximity to a reliable water source

Distance to water categories:
1 = site is <5 km from water (n=3);
2 = site is approximately 5 km from water (n=40);
3 = site is within 10 km of water (n=12);
4 = site is >10 km from water (n=10).
Scat abundance categories: see Figure 24.

A site's estimated distance to "high quality habitat" showed a potentially interesting pattern with rock-wallaby scat abundance (Figure 22), but is compromised by skewed sample sizes towards smaller categories. Scat abundance (assessed in categories, mean ± SE) at sites was similar across sites that were estimated to be up to approximately 5 km from high quality habitat. The one site that was further than 5 km from high quality habitat had no scat observed. This may indicate a threshold in distance for smaller rocky outcrops, such as those that occur within and near the Mine site area. Wallabies may not venture to more distant outcrops often or at all or if they do may be subject to predation in the process.

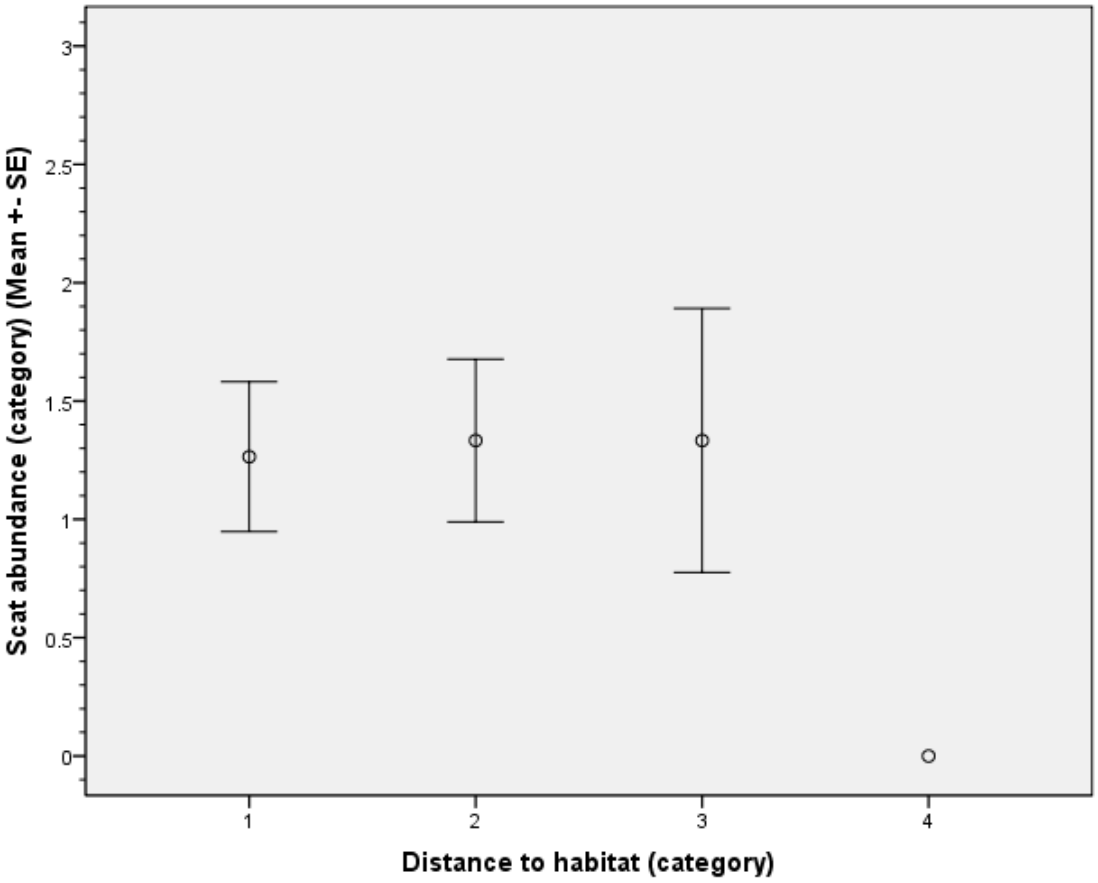


Figure 22 Relationship between rock-**wallaby observations and a site's** proximity to ideal or highly suitable habitat

Distance to habitat categories:
1 = site is within high quality habitat (i.e. distance = 0) (n=34);
2 = high quality habitat is within 1 km (n=24);
3 = high quality habitat is within 5 km (n=6);
4 = high quality habitat is >5 km away (n=1).
Scat abundance categories: see Figure 24

A pairwise correlation matrix of all the data highlighted a range of patterns which may be influencing rock-wallaby distribution in the area including and surrounding the Mine Site. Correlations with a significant p-value are shown in Table 19. These correlations suggest the following patterns:

- Presence of Black-footed Rock-wallaby at a site is strongly and positively associated with scat abundance, presence of fresh scat, and absence of recent fire. It is weakly positively associated with presence of juvenile wallaby scat.
- Presence of Black-footed Rock-wallaby at a site is strongly and negatively associated with presence of Euro, and weakly negatively associated with and evidence of recent fire.
- Scat count (abundance) is strongly and positively associated with absence of recent fire, and weakly positively associated with presence of Fig (*Ficus brachypoda*).
- Scat count (abundance) is weakly negatively associated with presence of Euro.
- Presence of fresh scat at a site is strongly and positively associated with presence of juvenile scat and with scat abundance (count). It is weakly positively associated with absence of recent fire and presence of Fig (*Ficus brachypoda*).
- Presence of juvenile scat at a site is strongly and positively associated with scat abundance (count).

Table 19 Notable pairwise correlations among the rock-wallaby data (one-tailed Spearman rank correlation)

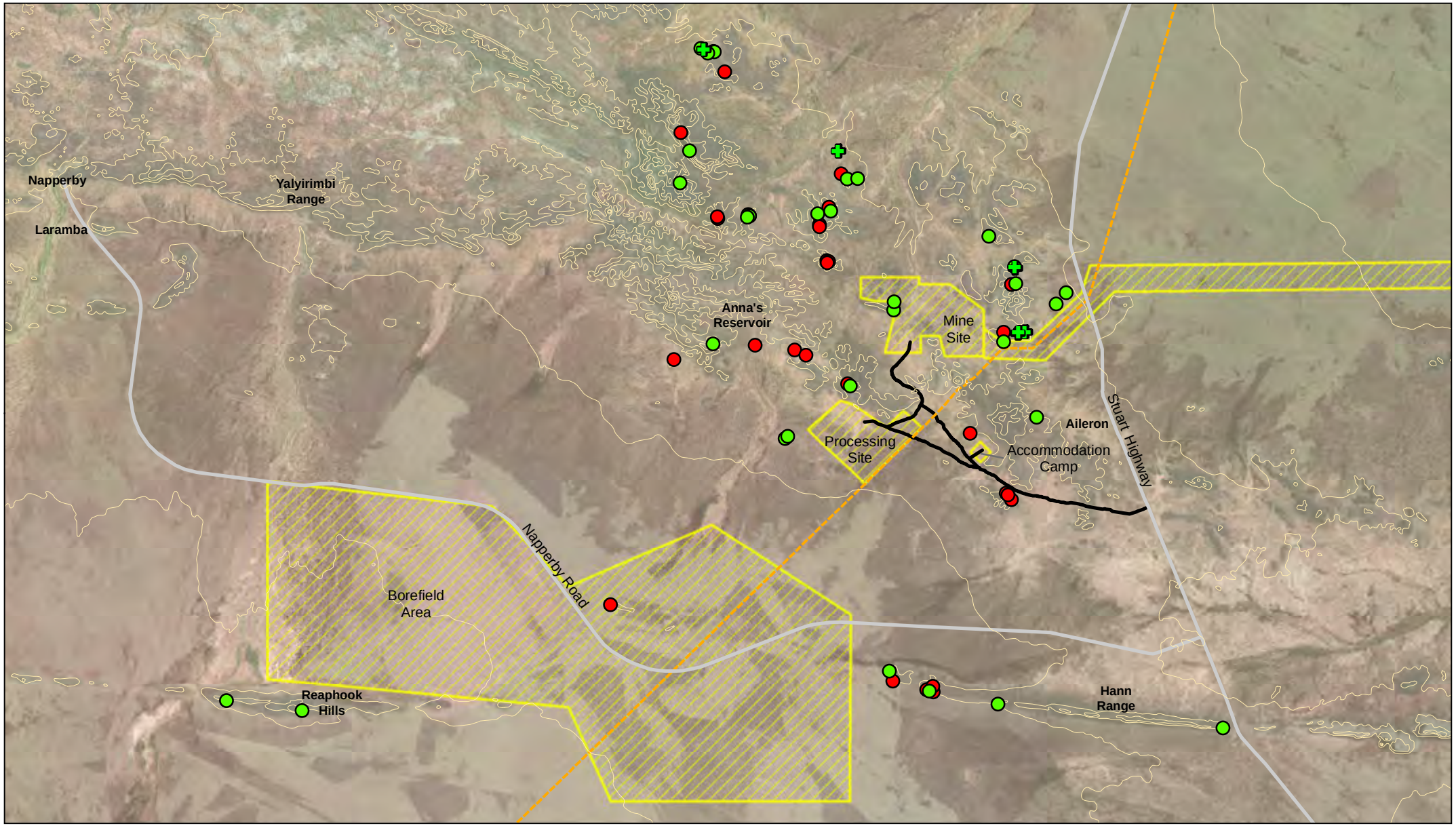
Variable	Positive strong (p<0.01)	Positive weak (p<0.05)	Negative weak (p<0.05)	Negative strong (p<0.01)
BFRW presence	Scat presence (fresh) Scat count Fire (non-recent)	Scat presence (juvenile)	Fire (recent)	Presence of Euro
Scat count	Fire (non-recent)	Presence of Figs	Presence of Euro	
Scat presence (Fresh)	Scat presence (juvenile) Scat count	Presence of Figs Fire (non-recent)		
Scat presence (Juvenile)	Scat count			

Conclusion – Black-footed Rock-wallaby

Signs of Black-footed Rock-wallaby were widespread across the broader study area, which indicates that this species is present, at least in small numbers. Based on observations of scat abundance and freshness, wallabies appear to favour some sites over others, and appear to have used some sites more recently than others. Evidence of juveniles at a small number of sites indicates that rock-wallabies are likely to be breeding in the area, or possibly dispersing through the area, but suggests that breeding/rearing does not occur in all areas, and may be limited to the most favourable habitat (e.g. abundance of food or safety from predators).

When assessed against vegetation, other fauna, fire history, distance to water and distance to higher quality habitat, patterns in rock-wallaby distribution were obscure and difficult to interpret. A larger and more comprehensive study of rock-wallaby ecology would be required to confidently explain the distribution of the species in the rocky hills that surround the mine site area.

That said, most areas where Black-footed Rock-wallaby were recorded are not within the footprint of the mine or associated infrastructure corridors (although fresh scat and juvenile scat was recorded within a distance of approximately 2 km from the mine site). Therefore, direct impacts on this species are expected to be minimal, although indirect impacts on the population may occur throughout the broader area through increases in the prevalence of wildfire and introduced predators, which may be a consequence of the project. Mitigation measures must be put in place to minimise the effects of these.



1:300,000 @ A4

0 2.5 5 7.5 10

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

N

LEGEND

- Adult rock-wallaby present
- Adult and juvenile rock-wallaby present
- Rock-wallaby not present
- Roads
- Gas Pipeline
- Access Roads
- Contours (50m)
- Study Area

Arafura Resources Limited
Nolans Project

Job Number	4322301
Revision	0
Date	18 Mar 2016

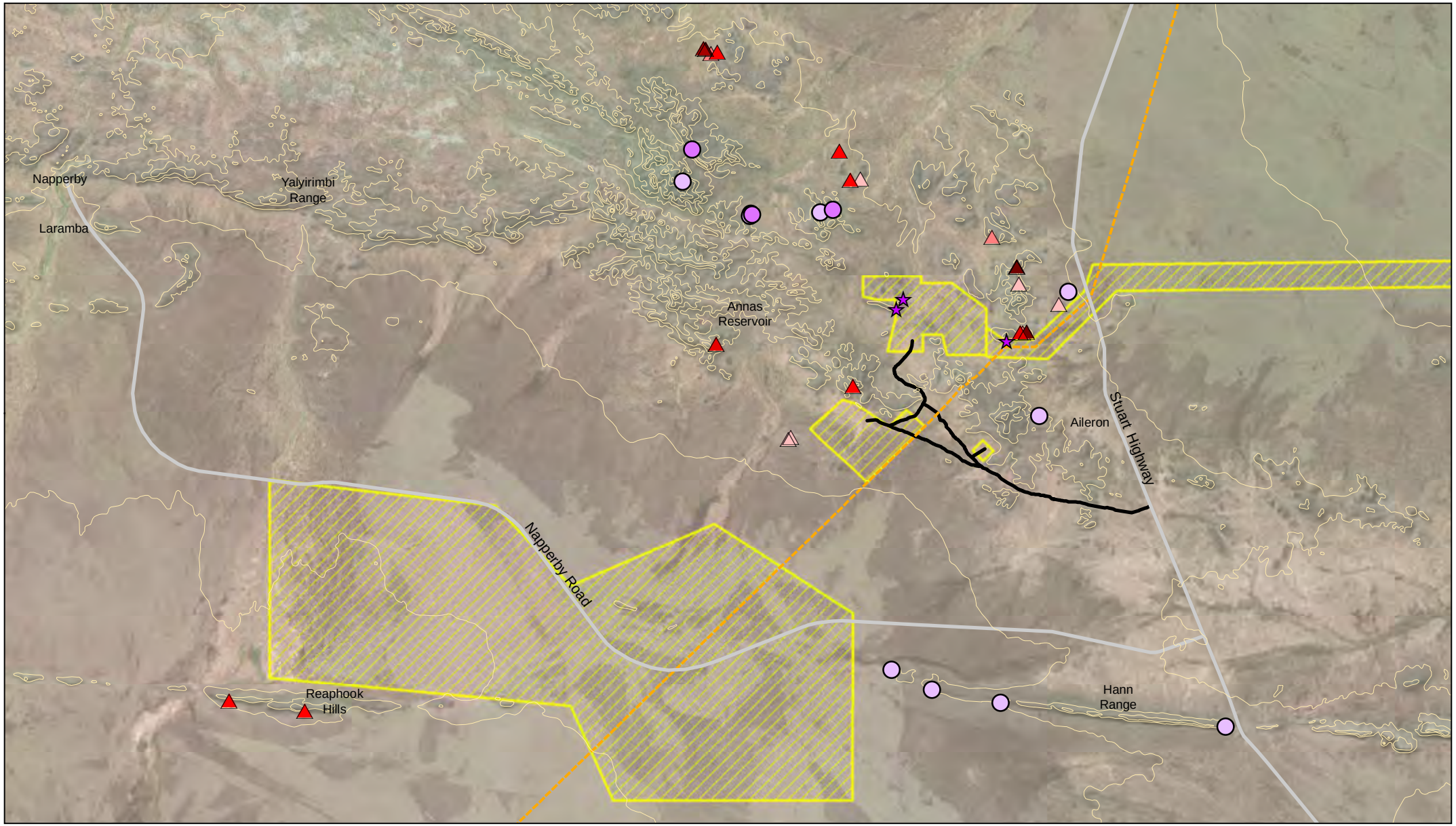
Locations of Black-footed Rock-wallaby scat collected

Figure 23

G:\43\22301\GIS\Maps\4322301_208_RockWallabyFieldWork.mxd

Level 5 66 Smith Street Darwin NT 0800 Australia **T** 61 8 8982 0100 **F** 61 8 8981 1075 **E** drwmail@ghd.com **W** www.ghd.com

Data source: GA - Roads, Gas Pipeline, Imagery (2015). GHD - Study Area, Black-footed rock-wallaby data (2015). Created by: CM



1:300,000 @ A4

0 2.5 5 7.5 10

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

N

LEGEND

- Black-footed Rock-wallaby scat (2010)

Fresh Scat

- 1
- 2
- 3
- 4
- 5
- 6

Old Scat

- 1
- 2

- Contours (50m)
- Roads
- Gas Pipeline
- Access Roads
- Study Area

Arafura Resources Limited
Nolans Project

Job Number	4322301
Revision	0
Date	18 Mar 2016

Black-footed Rock-wallaby scat age and abundance

Figure 24

G:\43\22301\GIS\Maps\4322301_209_RockWallabyScatAge.mxd

Level 5 66 Smith Street Darwin NT 0800 Australia **T** 61 8 8982 0100 **F** 61 8 8981 1075 **E** drwmail@ghd.com **W** www.ghd.com

Data source: GA - Roads, Gas Pipeline, Imagery (2015). GHD - Study Area, Black-footed rock-wallaby data (2015). Created by: CM

4.5.7 Great Desert Skink (*Liopholis kintorei*)

The Great Desert Skink (*Liopholis kintorei*) (Plate 3) is the largest of its genus, growing up to 187 mm (snout-vent length) (Wilson and Swan 2008). This skink creates characteristic communal burrows and latrines and is predominantly nocturnal, particularly in warm and hot weather (McAlpin 2001; McAlpin *et al*. 2011).

The Great Desert Skink occupies a range of vegetation types, with its main habitat being sandplain and adjacent swales. Great Desert Skinks prefer a landscape that supports a mosaic of differently-aged vegetation, and typically inhabit sites that have been burnt in the previous three to fifteen years (McAlpin 2001). Vegetation usually consists of hummock grassland (*Triodia basedowii*, *T. pungens* and *T. schinzii*), with some scattered shrubs and occasional trees (e.g. *Acacia spp*., *Eucalyptus spp*., *Hakea spp*., *Grevillea spp*. and *Allocasuarina decaisneana*) (Cogger et al. 1993; McAlpin 2001).

Great Desert Skinks construct large burrow complexes with multiple entrances spreading over an area up to 13 m diameter (McAlpin *et al*. 2011). They live in family groups and defecate at a nearby communal latrine (Pearson et al. 2001). Great Desert Skinks can move up to 100 m from their burrow to forage, and have been recorded moving 10 km or more to colonise new areas (McAlpin 2000). They mainly eat termites, but also feed on other invertebrates such as beetles, grasshoppers as well as some leaves, flowers and fruits (R. Paltridge *pers. comm*.).

Threats to the species include intense large-scale fires, predation by foxes and cats, and rabbits digging up burrow systems.

Survey records

One Great Desert Skink (*Liopholis kintorei*) burrow system was found during the 2015 fauna survey (Plate 11; Figure 10). It was in habitat that appeared not to have been burnt very recently, but had been burnt recently enough that the spinifex tussocks were large but not very large (perhaps burnt within the past 5-6 yrs.).

The NT Fauna Atlas (DLRM) results (June 2015) indicate that the species has also previously been recorded in the Borefield Area, Napperby Access Road, but the record is undated. All parts of the Study area that are spinifex-dominated sandplain provide potentially suitable habitat for this species, but areas that have larger and more established spinifex (perhaps as a result of less frequent fire) are most likely to support burrow systems.

Surveys for Great Desert Skink burrows were completed during the 37.4 km of walking transects of the proposed alignments, and intensively within 200 m of the known Great Desert Skink burrow identified previously and an historic record 3 km north of the proposed alignment close to Napperby Road (see Figure 11).

No signs of Great Desert Skink were detected along the proposed access roads and water pipeline corridor, or in the area surrounding the historic record. No additional burrow systems were found in the area around the known Great Desert Skink burrow.

Four separate remote fauna cameras were established at the Great Desert Skink warren during the July 2015 survey and left *in situ* until they were collected on the 22 October 2015. Great Desert Skinks first emerged from the burrows on the 17 of September 2015 and remained active up until the cameras were collected. Plate 10 below displays a range of images of various Great Desert Skink individuals including animals of different sizes including large adults and juveniles. Several images of Centralian Blue-tongued Skink (*Tiliqua multifasciata*) and Central Sand Monitor (*Varanus gouldii flavirufus*) are included for size comparison. It is clear that the identified Great Desert Skink warren supports several individuals including juveniles from the previous season (2014/15).


KeepGuard
10-21-2015 17:28:09


KeepGuard
09-26-2015 18:40:46


KeepGuard
09-17-2015 12:27:19


KeepGuard
10-05-2015 17:35:25


KeepGuard
09-29-2015 18:08:47


KeepGuard
10-10-2015 18:44:05


KeepGuard
08-26-2015 13:28:11


KeepGuard
09-14-2015 14:03:25

Plate 10 A range of Great Desert Skink images captured using remote sensor cameras collected on 22 Oct 2015. Images of Sand Monitor and Centralian Blue-tongued Skink for size comparison

Area where Great Desert Skink burrow/latrine was detected

Great Desert Skink latrine

Great Desert Skink burrows beside latrine

Great Desert Skink scat, showing large size

Plate 11 Great Desert Skink habitat, latrine and burrows in the borefield area, just west of site N13

4.5.1 Brush-tailed Mulgara (*Dasycercus blythi*)

Targeted surveys found Brush-tailed Mulgara to be widespread and quite numerous in suitable sandplain habitats across the south of the study area (see Figure 11). It is expected that Brush-tailed Mulgara would be present throughout the broader sandplain areas of the south of the study area, and that the construction of proposed linear infrastructure corridors for roads and borefield pipelines may have direct impacts on a small number of individuals, but little direct impact on the broader Brush-tailed Mulgara population throughout the area. Impacts associated with fragmentation of habitat, and increased prevalence of wildfire and introduced predators have the potential to indirectly impact the Brush-tailed Mulgara population across the study area. Mitigation measures should be put in place to minimise the effects of these.

4.5.2 Greater Bilby (*Macrotis lagotis*)

Extensive and intensive spotlighting searches were undertaken in 2010/11 and in 2015 and walking transects along all linear infrastructure corridors (access roads, pipelines etc.) in 2015 in an effort to detect active individuals of this species. This species was not recorded during the 2010/2011 or 2015 surveys, and no historical records exist for the Study area. However, spinifex-dominated habitats within the Study area provide potential habitat, including rocky areas and areas with a low shrub cover.

Surveys for Bilby burrows were completed during the 37.4 km of walking transects of the proposed alignments, and from the air by helicopter when flying over areas of sandplain during rock-wallaby surveys. No signs of Greater Bilby were detected along the proposed access roads or water pipeline corridor.

This species was not recorded during the targeted surveys, and no historical records exist for the Study area, however spinifex-dominated habitats in the Borefield area provide potential habitat, including rocky areas and areas with a low shrub cover.

The Greater Bilby (*Macrotis lagotis*) is known from the Burt Plain bioregion, and is considered likely to still be present in this part of the Northern Territory, albeit probably in small numbers. In favourable conditions, populations can expand rapidly in abundance and occupied area (Woinarski *et al*. 2007).

The Greater Bilby is listed as vulnerable under the EPBC and TPWC Acts. Wild bilby populations are restricted predominantly to the Tanami Desert, Northern Territory (Johnson and Southgate 1990), the Great Sandy and Gibson Deserts, Western Australia (Friend 1990), and an outlying population between Boulia and Birdsville in south-west Queensland (Gordon et al. 1990).

The species occupies three major vegetation types, open tussock grassland on uplands and hills, mulga woodland/shrubland growing on ridges and rises, and hummock grassland in plains and alluvial areas (Southgate 1990a). In the Tanami Desert the Greater Bilby is less abundant on dune and sand substrate than on laterite/rock features or drainage/calcrete substrates (Southgate et al. 2007).

Bilbies are known to consume a wide range of foods, including root-dwelling larvae, nasute termites, hypogeal fungi, bulbs, fruit and seed (Gibson 2001). Fire and the promotion of key food plants are thought to be important processes affecting bilby distribution. Fire management may present an opportunity to improve habitat suitability and the status of the bilby (Southgate and Carthew 2006). Bilbies burrow and are able to survive in habitats that have little vegetation. Southgate and Carthew (2006) found that a large part of their diet consisted of seeds from fire-promoted plants.

The bilby was once distributed over 70% of mainland Australia (Southgate 1990b). The distribution of the bilby has significantly decreased to about 20% of its former range since European settlement (Southgate 1990b). Fox predation may be the primary factor associated with regional declines of the species (Abbott 2001). Feral cats have been known to take the greater bilby as prey (Southgate 1990b). Clearing of habitat for grazing and as a result of fire are potential threats (Southgate 1990b).

Bilbies are allogenic ecosystem engineers, meaning that their burrows are used by other species (Read *et al.* 2008). Bilby warrens provide shelter for germinating seeds deposited by ants or other dispersers, and are important sites of microbial activity and decomposition (Read et al. 2008).

4.5.3 Princess Parrot (*Polytelis alexandrae*)

This species was not recorded during the 2010 or 2015 surveys, and no records exist for the Study area. Suitable habitat is present within the Study area, but the species is generally rare

and highly mobile, and is considered to be, at most, an occasional visitor to the Study area. Consequently, targeted surveys are not considered necessary for this species. If the species is observed within the Study area at any stage during the project, then that information should be made known to the NT DLRM.

4.5.4 Near-threatened species identified within the study area

In addition to the three threatened species, six fauna species listed as near-threatened (NT) under the TPWC Act were detected also (Table 18). Near-threatened species are those that do not currently qualify for higher categories of threat (CR, EN, VU), but are close to qualifying and may qualify in the near future.

Spectacled hare-wallaby (Lagorchestes conspicillatus)

Tracks (prints) of this species were recorded in the Borefield area during the GHD 2015 baseline survey. No animals were seen. No other records were made during the surveys, nor during previous field surveys at the site (Low Ecological Services 2007). Additional field observations are required to confirm the presence of this species, but it appears that a population persists at the site, most likely in spinifex-dominated areas, particularly areas with a dense mid-level, or sparse tree and shrub cover (Menkhorst and Knight 2004). The Study area is near the southern limit of the potential distribution for this species (Menkhorst and Knight 2004).

Northern Nailtail Wallaby (Onychogalea unguifera)

Northern Nailtail Wallaby tracks (prints) and scats were recorded at a mulga woodland site around the processing site during the 2015 survey. Additional field observations are required to confirm the presence of this species, but it appears that a population persists within the Study area. This species has not been recorded previously in the Study area prior to the 2015 survey. The Northern Nailtail Wallaby (*Onychogalea unguifera*) could occur anywhere in open woodland or shrubland, which includes most of the Study area.

Emu (Dromaius novaehollandiae)

Emu tracks were recorded in sandplain spinifex habitat during the GHD 2015 survey. This species uses a broad range of habitats, and potential habitat occurs throughout the Study area.

Australian Bustard (Ardeotis australis)

The Australian Bustard (*Ardeotis australis*) (Plate 12) was listed as 'vulnerable' under the TPWC Act at the time of the 2010 survey, but has since been downgraded to Near Threatened.

Suitable habitat for this species tends to be open grassland (Woinarski *et al.* 2007). After fire, this species may use a wider range of open habitats, even woodland areas (Woinarski *et al.* 2007).

Three Australian Bustards were detected in open grassland along the haul route in 2010, approximately 10 km west of the eastern extent.

Plate 12 Australian bustard (*Ardeotis australis*), seen east of the mine site area in September 2010

Flock Bronzewing (Phaps histrionica)

This species is listed as 'near threatened' under the TPWC Act. During 2010 survey, two Flock Bronzewings were observed in sand plain habitat at the far eastern end of the haul route. Similar habitats are widespread within the Study area.

Spinifex-dominated grasslands and sparse mulga shrublands are amongst habitats known to be used by the species, but are probably not considered to be amongst the habitats in which the species is most commonly detected (Higgins and Davies 1996).

Bush Stone-curlew (Burhinus grallarius)

The Study area appears to support a persistent population of the Bush-stone Curlew in and around the Study area. The Bush Stone-curlew has been recorded relatively recently in the DLRM database (2006). Low (2007) recorded this species at the Mine Site. During the 2015 survey, the Bush-stone Curlew was observed on numerous occasions whilst spotlighting, as well as being detected by tracks (prints) in sandy habitat. There was also a recently roadkilled bird found during the 2015 survey along the Stuart Highway near Ryan Well.

Suitable habitat for this species occurs across much of the Study area, including the Mine Site area and Processing Site area.

4.6 Threatened species – known and expected occurrence within study area

The threatened species identified as being most likely to occur within the Study area vary in their use of habitats – some are fairly specific to certain habitats, while others can be found in a range of habitat types. Consequently, the species vary in their likelihood of occurrence in different parts of the Study area, which has implications for potential impacts on fauna that may result from the project. Table 20 lists the most likely threatened species in the Study area, with an indication of their likelihood within the main infrastructure/impact areas associated with the project.

Table 20 Threatened, near threatened and data deficient fauna species identified within the Study area during this assessment

Key:

K – known to occur in this section of the Study area;

P – occurrence possible in this section of the Study area.

Blank cells indicate that a species is unlikely to occur in that section on the basis of dominant habitat in that section (but do not mean that species are absent).

Species listed under the EPBC Act are indicated as 'EPBC'.

For the utilities corridor, "north" and "south" refer to north and south of the Processing Site.

Species	Mine site area	Accomm area	Processing site area	Proposed access road (to Stuart Hwy)	Potable water pipeline Utilities corridor (north)	Potable water pipeline Utilities corridor (south)	Borefield area
MAMMALS							
Bilby (EPBC)	P	P	P	P	P	P	P
Black-footed Rock-wallaby (EPBC)	K		K				K
Southern Marsupial Mole						P	P
Brush-tailed Mulgara						P	K
Common Brushtail Possum	P		P				
Pale Field-rat	P		P				
Kultarr						P	P
Spectacled Hare-wallaby	P	P	P	P	P	P	K
Northern Nailtail Wallaby	P	P	K	P	P	P	P
Long-haired Rat	P	P	P	P	P	P	P
BIRDS							
Princess Parrot (EPBC)		P	P	P	P	P	P
Grey Falcon	P	P	P	P	P	P	P
Redthroat	P	P	P	P	P	P	P

Species	Mine site area	Accomm area	Processing site area	Proposed access road (to Stuart Hwy)	Potable water pipeline Utilities corridor (north)	Potable water pipeline Utilities corridor (south)	Borefield area
Emu	P	P	P	P	P	P	K
Australian Bustard	P	P	P	P	P	P	K
Flock Bronzewing	P	P	P	P	P	P	P
Square-tailed Kite	P	P	P	P	P	P	P
Red-tailed Black-cockatoo (central Australia)	P	P	P	P			
Scarlet-chested Parrot	P	P	P	P	P	P	P
Striated Grasswren	P	P	P	P	P	P	P
Bush Stone-curlew	K	P	K	K	P	P	P
Chestnut Quail-thrush	P	P	P	P	P	P	P
Grey Honeyeater	P	P	P	P	P		
REPTILES							
Great Desert Skink (EPBC)			P			P	K
Centralian Blind Snake	P	P	P	P	P	P	P
Mulga Snake	P	P	P	P	P	P	P
Woma Python		P	P	P	P	P	P
Count (EPBC-listed species)	2	2	3	2	2	3	3
Count (All threatened species)	21	20	23	20	19	22	22

4.7 Migratory species

Eight fauna species identified for the Study area are listed as Migratory under the EPBC Act. These are listed in Table 21 with an evaluation of each species' likelihood of occurrence in the Study area.

Two of the Migratory species (Fork-tailed Swift, *Apus pacificus* and Rainbow Bee-eater, *Merops ornatus*) are likely to occur within the Study area, and one of those (Rainbow Bee-eater, *Merops ornatus*) was detected during the 2010 surveys. The other species tend to prefer wetland habitats (except Oriental Plover, *Charadrius veredus* and Oriental Pratincole, *Glareola maldivarum*) which are also found in drier areas. There is one old (1977) DLRM record of the Glossy Ibis within the proposed Mine Site area.

Wetlands areas do not occur within the Study area (other than occasional temporary flooding that may occur after heavy rain), so habitats within the Study area are unlikely to be considered 'important habitat', and the birds that occur there are unlikely to be an 'ecologically significant population' (in accordance with the EPBC Act).

The Project is not expected to impact on any listed migratory species.

Table 21 Fauna species identified for the study area and listed as migratory under the EPBC Act

Species	Likelihood of occurrence within Study area	Comments
Migratory Marine Birds		
Fork-tailed Swift *Apus pacificus*	**Possible** – All areas	Not recorded in any field surveys. Generally an aerial foraging visitor to Australia. May occur occasionally in the airspace above the Study area, but highly unlikely to make use of terrestrial habitats. Thus, habitats within the Study area are not considered 'important habitat', and the birds that visit are unlikely to be an 'ecologically significant population' (in accordance with the EPBC Act).
Migratory Terrestrial Species		
Rainbow Bee-eater *Merops ornatus*	**Present** – all areas	Common across the NT, and recorded within the area in 2010 survey. The NT Fauna Atlas (DLRM) results (6 February 2015) indicate records in the mine site, borefield area and between the mine and processing site. This species is common and widespread, so habitats within the Study area are unlikely to be considered 'important habitat', and the birds that occur there are unlikely to be an 'ecologically significant population' (in accordance with the EPBC Act).
Migratory Wetland Species		
Great Egret (White Egret) *Ardea alba (=modesta)*	**Unlikely –** All areas.	Common in wetlands in the NT. No wetlands are present in the mine site, processing site or Borefield area. Lake Lewis likely to provide suitable habitat occasionally, but is located approximately 30 km west of the Borefield area.
Cattle Egret *Ardea ibis*	**Unlikely –** All areas.	Common in wetlands and flooded grasslands in the NT. These habitats are not present in the mine site, processing site or Borefield area.
Oriental Plover, Oriental Dotterel *Charadrius veredus*	**Unlikely –** All areas.	Unlikely, except as rare or occasional summer visitor. Thus, habitats within the Study area are unlikely to be considered 'important habitat', and the birds that visit are unlikely to be an 'ecologically significant population' (in accordance with the EPBC Act).
Oriental Pratincole *Glareola maldivarum*	**Unlikely –** All areas.	This species generally occurs in the northern parts of the NT. Unlikely to occur within the Study area, except as rare or occasional visitor. Thus, habitats within the Study area are unlikely to be considered 'important habitat', and the birds that visit are unlikely to be an 'ecologically significant population' (in accordance with the EPBC Act).
Australian Painted Snipe *Rostratula benghalensis (australis)*	**Unlikely –** All areas.	Generally found in wetlands and flooded grasslands. These habitats are not present in the mine site, processing site or Borefield area. Not recorded from the mining lease during 2007 surveys.
Glossy Ibis *Plegadis falcinellus*	**Unlikely –** All areas.	There is one DLRM record of the Glossy Ibis within the proposed Mine Site area (1977). This species moves in response to rainfall. Core breeding areas are within NSW, Victoria and southern Queensland. The species often moves north in autumn, then returns south in spring and summer (Birds Australia 2010b). Generally found in wetlands and flooded grasslands. These habitats are generally not present in the mine site, processing site or Borefield area.

4.8 Introduced species

Twelve introduced fauna species are identified for the Study area. Ten of these are mammals, one is a bird and one is a reptile (Table 22). The Rock Dove and Asian House Gecko tend to occur in locations that have human development (houses, buildings, etc.) and so are unlikely to impact on the natural environment in the Study area. All of the mammals are known to be capable of invading natural environments, and are generally considered to be responsible for major impacts on Australia's natural environment. Of the ten mammals identified, five have been recorded previously on the DLRM database (i.e. within 20 km of the Project Area), and six were detected during the baseline survey by GHD in April/May 2015. Cattle are present as an agricultural asset, but all others are present as feral animals.

The introduced fauna that occurs at the site is likely to have had, and to continue to have, an adverse impact on the area's ecology.

An account of each species (except Rock Dove and Asian House Gecko) is provided below.

Table 22 Introduced (non-native) fauna species identified for the study area

Common name	Scientific name	BPB	DLRM	PMST	Low 2007	GHD
Mammals						
Dog	*Canis lupus familiaris*			x		
House Mouse	*Mus musculus*	x	x	x	x	x
Red Fox	*Vulpes vulpes*	x		x		x
Cat	*Felis catus*	x		x	x	x
European Rabbit	*Oryctolagus cuniculus*	x	x			x
Donkey	*Equus asinus*	x				
Horse	*Equus caballus*	x	x			
Camel	*Camelus dromedarius*	x	x	x		x
Cattle	*Bos taurus*	x	x	x	x	x
Goat	*Capra hircus*	x				
Birds						
Rock Dove	*Columba livia*	x		x		
Reptiles						
Asian House Gecko	*Hemidactylus frenatus*	x		x		
Total	***12***	**11**	**5**	**8**	**3**	**6**

BPB – Burt Plain Bioregion; DLRM – Department of Land and Resource Management; PMST – Protected Matters Search Tool; GHD – detected during 2010 or 2015 surveys.

Dog (domestic/feral) (Canis lupus familiaris)

Feral domestic dogs pose a predatory threat to fauna. However, because the Study area already supports the closely-related Dingo (*Canis lupus lupus*), the impact of dogs on native fauna in this area are likely to be low as they are at least adapted to dingo predation.

Careful consideration of the role that the Dingo plays within the ecosystem of the study area will be required (i.e. careful consideration would be required before any control of Dingos is undertaken – exclusion from waste would be a better solution to suppress potential population growth in response to the mine). Ritchie *et al* 2012 notes that dingoes are likely to suppress introduced predators such as cats and foxes, which are well documented as preying on small/medium ground- dwelling mammals/reptiles such as the threatened Black-footed Rock-wallaby, Brush-tailed Mulgara and Great Desert Skink while dingoes themselves are unlikely to target these species if sufficient larger prey is available, leading to decreased predation on these threatened species.

The Dingo was observed during the GHD survey and appears to be common in the Study area, but feral dogs were not knowingly seen. It is acknowledged, however, that identification of some dogs/dingoes is near impossible without genetic analysis.

House Mouse (Mus musculus)

Despite their distribution throughout Australia, often in great abundance, house mice are not currently considered to be a major threat to biodiversity in the Northern Territory. Nevertheless, there have been some concerns about the impacts of house mice seed predation on native vegetation. In some locations, house mice prey on young birds.

This species is likely to be present at varying levels of abundance depending on rainfall, with plagues potentially occurring following good rainfall, followed by relatively low numbers in dry years (Menkhorst and Knight 2011). Impacts from this species are likely to be low generally, except when their numbers are high.

The House Mouse was captured in small numbers during the 2010 and 2015 fauna surveys.

Red Fox (Vulpes vulpes)

The red fox was introduced to mainland Australia in the 1860s. It is now widespread and common south of the Tropic of Capricorn and is found in most habitats from wet forest to desert (Menkhorst and Knight 2011). Foxes are opportunistic omnivores, but are predominantly carnivorous. The red fox is responsible for local extinction of many populations of small to medium-sized mammals (Saunders *et al.* 2010). Historical accounts detail how the arrival of foxes in many areas coincided with the local demise of native fauna. Fox control measures include trapping, shooting, den fumigation and exclusion fencing; baiting using the toxin 1080 is the most commonly employed method.

Tracks of the Red Fox were observed in sandy habitat during the 2015 GHD survey. Additional field observations are required to confirm this sighting. This species is known to occur within the Burt Plain Bioregion, but there are no historical records within 20 km of the Study area (DLRM 2015).

Cat (Felis catus)

Feral cats occupy all Northern Territory habitats, ranging from rainforest to desert. Their occupation of arid regions has apparently been facilitated by their ability to survive without drinking. Available data indicate that populations fluctuate markedly in time and space. Predation by feral cats is considered to have had a major deleterious influence on fauna in arid Australia (particularly small mammal communities) and is appropriately listed as a key threatening process under the EPBC Act.

Cat tracks were recorded at most sites throughout the Study area, and a cat was photographed at night by motion-sensing camera at Site N11 (see Figure 5).

European Rabbit (Oryctolagus cuniculus)

Rabbits compete with domestic stock for food, damage soils contributing to erosion, and cause profound damage to native plants. In the arid areas of Australia, including the southern Northern Territory, rabbits overgraze pasture plants and reduce trees and shrubs by killing mature plants and suppressing the recruitment of seedlings.

Rabbits have a deleterious impact on many native fauna either directly through competition for food or shelter, or indirectly through environmental modification. The result is loss of biodiversity. Rabbits have been linked to the decline of species like the Bilby (*Macrotis lagotis*) in the Northern Territory. Competition and land degradation by rabbits is listed as a key threatening process under the EPBC Act.

Rabbits are patchily distributed in arid areas south of a line extending east-west across the Territory 100 km north of the tropic of Capricorn. A few isolated populations have been recorded further north.

The Rabbit was recorded (tracks/scat) within the Mine Site area during the 2010 fauna survey. There is one record from 1987 within 20 km of the site (DLRM 2015).

Donkey (Equus asinus)

Feral donkeys pose a significant threat to the natural environment, and have been associated with increased erosion of soil and waterways, spread of weeds, trampling of native vegetation, consumption of native seedlings leading to reduced biodiversity, sedimentation of waterways and water bodies, destruction of infrastructure, and competition with native species and domestic cattle for resources (DLRM website http://www.lrm.nt.gov.au/feral/donkey).

No donkeys were seen during the fauna surveys. There are no records of this invasive species within 20 km of the Study area (DLRM Atlas results), however Arafura Resources report seeing donkeys on the Nolans mine site (B. Fowler *pers. comm.*).

Horse (Equus caballus)

Horses can pose a significant threat to the natural environment. They have been associated with increased erosion of soil and waterways, spread of weeds, trampling of native vegetation, consumption of native seedlings leading to reduced biodiversity, sedimentation of waterways and water bodies, destruction of infrastructure, and competition with native species and domestic cattle for resources.

In central Australia, feral horses overgraze large areas because they can travel up to 50 km from water in search of food. This can force native wildlife from its favoured habitats.

No horses were seen during the GHD survey. There are two records within 20 km of the Study area, most recently in 2004 (DLRM 2015).

Camel (Camelus dromedarius)

According to the DLRMhttp://www.lrm.nt.gov.au/feral/camel, feral camels have demonstrable environmental, economic and cultural impacts (DLRM website http://www.lrm.nt.gov.au/feral/camel). In central Australia, camels feed on more than 80% of the available plant species. Serious impacts of camels on vegetation are evident in situations where camels occur at densities greater than two animals per km^2, which is the case throughout much of the Northern Territory. Feral camels severely defoliate and suppress the recruitment of some shrub and tree species, with such impacts being greatly exacerbated in drier years. Feral camels have a noticeable impact on fragile salt lake ecosystems and foul waterholes, which are important sites for Aboriginal people and for native fauna. Feral camels are also likely to destabilise dune crests thereby contributing to erosion.

The Camel was detected across most of the Study area during the 2010 and 2015 surveys, and there are numerous records within 20 km of the Study area (DLRM 2015). Most observations made during the field surveys were of tracks, but animals were also seen and photographed (motion-sensing cameras), and scat was seen. This species is widespread and common across the region.

Cattle (Bos taurus/indicus)

In Australia, cattle negatively affect the natural environment by contributing to land degradation through trampling, soil compaction and erosion, increased nutrient loading, spread of weeds, and sedimentation of waterways. Feral cattle may be present within the Study area, although it is more likely that widely ranging domesticated cattle would be encountered across the Study area depending on conditions and available pasture.

Cattle seen within the Study area are agricultural stock rather than feral animals.

Goat (Capra hircus)

Feral goats are a major environmental pest, and competition and land degradation by feral goats is listed as a key threatening process under the EPBC Act. They cause land degradation through soil damage, overgrazing and strip-browsing. Feral goats are capable of inflicting substantial losses on biodiversity.

According to the DLRMhttp://www.lrm.nt.gov.au/feral/goat, feral goats are considered absent from the mainland in the Northern Territory (DLRM website http://www.lrm.nt.gov.au/feral/goat). In the late 1980s and early 1990s, feral goats north and north-east of Alice Springs were eradicated.

5. Assessment of potential impacts on fauna

5.1 Foci of the impact assessments

The threatened species assessed are the EPBC and NT listed Black-footed Rock-wallaby (MacDonnell Ranges race) (vulnerable EPBC/NT), Greater Bilby (vulnerable EPBC/NT), Great Desert Skink (vulnerable) and Princess Parrot (vulnerable). The Brush-tailed Mulgara (vulnerable NT) is also included in the assessment, despite not being listed as threatened under the EPBC Act – see Section 1.5.1 for rationale.

Potential impacts on the Nolans bore fauna as a whole is also assessed below.

5.2 Criteria for determining significant impacts

Evaluations of the significance of potential impacts are based on the *Commonwealth's Significant Impacts Guidelines: Matters of National Environmental Significance (the guidelines)* as applied to endangered and vulnerable species.

In the absence of a generally recognised set of criteria for assessing potential impacts on a local fauna as a whole, potential impacts on the community of fauna at the Nolans Bore are assessed according to the guidelines on significance of impacts on natural values of National Heritage places.

5.2.1 Definitions for threatened species impacts

Assessment under the guidelines requires use of three definitions. These are for population, important population, and habitat critical to the survival of a species or ecological community:

- A *population* of a species' is defined under the EPBC Act as an occurrence of the species in a particular area. In relation to critically endangered, endangered or vulnerable threatened species, occurrences include but are not limited to:
  - A geographically distinct regional population, or collection of local populations
  - A population, or collection of local populations, that occurs within a particular bioregion.
- An *important population* is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:
  - Key source populations either for breeding or dispersal
  - Populations that are necessary for maintaining genetic diversity
  - Populations that are near the limit of the species range.
- *Habitat critical to the survival of a species or ecological community* refers to areas that are necessary:
  - For activities such as foraging, breeding, roosting, or dispersal
  - For the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators)
  - To maintain genetic diversity and long-term evolutionary development, or for the reintroduction of populations or recovery of the species or ecological community.

Such habitat may be, but is not limited to: habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the Register of Critical Habitat maintained by the minister under the EPBC Act.

5.2.2 Guideline on impact significance – critically endangered and endangered species

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

- Lead to a long-term decrease in the size of a population
- Reduce the area of occupancy of the species
- Fragment an existing population into two or more populations
- Adversely affect habitat critical to the survival of a species
- Disrupt the breeding cycle of a population
- Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline
- Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat
- Introduce disease that may cause the species to decline
- Interfere with the recovery of the species.

5.2.3 Guideline on impact significance – natural heritage values

An action is likely to have a significant impact on natural heritage values of a National Heritage place if there is a real chance or possibility that the action will:

- Modify or inhibit ecological processes in a National Heritage place
- Reduce the diversity or modify the composition of plant and animal species in a National Heritage place
- Fragment or damage habitat important for the conservation of biological diversity in a National Heritage place
- Cause a long-term reduction in rare, endemic or unique plant or animal populations or species in a National Heritage place
- Fragment, isolate or substantially damage habitat for rare, endemic or unique.

5.3 Assessment of the "real chance of probability" of an EPBC significant impact

Risk is expressed and assessed in terms of a combination of the consequence of an event and the associated likelihood of occurrence.

A "real chance or probability" of a significant impact from a particular source is defined as there being an extreme or high risk of a population (or the fauna community) experiencing of a significant consequence as defined in the guidelines e.g. reduce the diversity or modify the composition of plant and animal species in a National Heritage place.

The initial levels of risk and determination of residual risk (after avoidance, mitigation and management actions have been applied) have been undertaken using standard qualitative risk assessment procedures consistent with AS/NZS ISO 31000:2009 'Risk Management –

Principles and guidelines', with the exception of economic risk which is not addressed in the guidelines (Table 23).

Assessment of risk has been conducted through consideration of the circumstances around risks, identifying necessary controls to address potential impacts and assuming effective implementation of planned and committed mitigation of potential impacts.

Avoidance, mitigation and management actions are proposed in an attempt to reduce residual risk (risk after actions) where possible to below "Extreme" or "High" risk outcomes to the extent reasonably practicable as part of reducing the overall project.

The depth of focus on risk controls is linked to the level of risk and opportunity for reduction to meet organisational commitments and goals linked to an environmentally and socially responsible operation, and those requirements are part of the regulatory obligations and impact assessment guidelines.

Table 23 provides a summary of the qualitative risk matrix adopted and the levels of risk for the various consequence and likelihood combinations and a brief description of each risk classification and the likely responses for the threatened species assessed is provided in Table 24.

Table 23 Qualitative risk analysis matrix

Likelihood	Consequence Level				
	Insignificant (1)	Minor (2)	Moderate (3)	Major (4)	Catastrophic (5)
Almost Certain (5)	Medium	High	High	Extreme	Extreme
Likely (4)	Medium	Medium	High	High	Extreme
Possible (3)	Low	Medium	Medium	High	High
Unlikely (2)	Low	Low	Medium	Medium	High
Rare (1)	Low	Low	Low	Medium	Medium

Table 24 Definition of level of likelihood

Level of Likelihood	Definitions
Almost certain	The event is expected to occur in most circumstances This event could occur at least once during a project of this nature 91-100% chance of occurring during the project
Likely	The event will probably occur in most circumstances This event could occur up to once during a project of this nature 51-90% chance of occurring during the project
Possible	The event could occur but not expected This event could occur up to once every 10 projects of this nature 11-50% chance of occurring during the project
Unlikely	The event could occur but is improbable This event could occur up to once every 10-100 projects of this nature 1-10% chance of occurring during the project
Rare	The event may occur only in exceptional circumstances This event is not expected to occur except under exceptional circumstances (up to once every 100 projects of this nature)

Level of Likelihood	Definitions
	Less than 1% chance of occurring during the project

Table 25 Definitions of levels of consequence

Levels of Consequence	Definitions
Catastrophic	Moderate or substantial regional decrease in size of population(s) of listed fauna species
Major	Substantial local decrease in size of population(s) of listed fauna species
Moderate	Moderate local decrease in size of population(s) of listed fauna species
Minor	Minor local decrease in size of population(s) of listed fauna species
Insignificant	No loss of individuals of listed fauna species

5.4 The fauna and populations of threatened species

Each of the species to be assessed can be regarded as having a “population” in the Nolans Bore area. The assessment is risk averse in that two of the species were not recorded during the study.

The populations of each of the threatened species occupy specific areas in and around the study area as defined by the species’ preferred habitats and biologies. Areas occupied/possibly occupied by the fauna and population of each species are unlikely to be related to boundaries imposed by mine site/borefield boundaries or mineral leases.

The areas occupied by the populations/the entire fauna are:

- Black-footed Rock-wallaby is known (from July 2015 survey) to occur throughout the rocky habitats of the eastern parts of the Reynolds Range which incorporates the study area. Transient populations only appear to occur within the actual Mine Site footprint (old scat recorded, see Figure 23), however a viable population was found to occur in the immediate vicinity of the Mine Site with 20 sites found to contain fresh rock-wallaby scat and 25% of those sites containing juvenile scat (of 65 sites visited, 35 contained rock wallaby scat, 20 sites had fresh scat and 5 of the 20 had juvenile scat)
- The Brush-tailed Mulgara was found to be well represented within the sandplain habitats of the borefield (see Figure 11) with 45 records of active burrows for this species made during the May and July 2015 surveys (37.4 km walked looking for active burrows covering a width of at least 30 m giving an area of 112.2 ha resulting in a frequency of 2.5 active Brush-tailed Mulgara burrows per ha). It is assumed that this species would be present within sandplain habitats throughout the study area and surrounds at similar density given that the same habitat exists in a local area (Napperby and Aileron Station of approx. 41,568 ha for the borefield assessment area our team was provided with, see Figure 11).
- The Great Desert Skink was only recorded on one occasion in the far south-west of the proposed borefield (see Figure 11). Although only one active Great Desert Skink warren was recorded despite extensive searches of the proposed borefield (37.4 km walked along proposed bore pipeline network using a minimum of three ecologists) it is possible that this species could occur within any of the sandplain habitats of the study area (one other historic record for this species exists in the borefield).

- The Greater Bilby was not recorded during the previous surveys (despite a distance of 37.4 km covered by 3 ecologists in addition to aerial surveys looking for burrows, see Figure 11) and there are no historic records within the proposed project footprint, however it is possible that this species could occur within any of the sandplain habitats of the study area.
- The Princess Parrot was not recorded during the previous surveys and there are no historic records within the proposed project footprint, however it is possible that this species could occur within any of the habitats within the proposed project footprint apart from the rocky habitats.
- The entire fauna is assumed to be broadly present within the Burt Plain Bioregion within their preferred habitats as described above.

In reality the fauna and its threatened species extend much further than considered in the assessments.

5.5 Potential sources of impact

Potential sources of impact arising from the proposed project include:

- Clearing of breeding and/foraging habitat (includes harming or killing of animals directly)
- Dust generated by construction, mining and processing activities
- Noise generated by construction, mining and processing activities
- Wildfire that may result unintentionally from construction, mining and processing activities
- Introduction and/or spread of exotic plants and animals
- Poisoning of fauna from drinking tailings dam water and residue storage facility
- Lowering or contamination of the water table
- Artificial light generated by mining and processing activities
- Injury and death of fauna from collisions with vehicles.

Each of these potential sources of impact are addressed below.

5.5.1 Clearing of breeding and/or foraging habitat

Potential impacts caused by clearing of breeding and/foraging habitat include the harming and/or killing of individual animals during that process.

In all parts of the Study area, clearing of areas of habitat, or high impact disturbance to habitat, could result in:

- Killing/injuring fauna
- Displacement of fauna
- Disruption to nesting/roosting/foraging habitats and/or behaviour
- Reduction of area of fauna habitat locally and/or regionally
- Habitat fragmentation
- Erosion and sedimentation resulting from vegetation clearing
- Degradation of surface water quality due to erosion of soils and landforms
- Increasing likelihood of weed establishment in cleared areas.

Whilst not necessarily a direct habitat clearing activity, the diversion of Kerosene Camp Creek in the Mine Site area may result in landform disturbance and an altered hydrological regime in the old creek bed and in the new creek alignment. This may cause indirect impacts on fauna, including:

- Changes in surface and sub-surface flow resulting in impacts on riparian and ephemeral ecosystems and vegetation (habitat) dependent on overland flows, leading to loss of fauna habitat
- Loss of riparian habitat associated with old creek channel and loss of terrestrial habitat along new creek alignment.

Construction of linear infrastructure (e.g. access roads and water supply pipelines) through otherwise natural habitat can result in:

- Habitat fragmentation, particularly for small ground-dwelling fauna
- Introduction and/or spread of exotic plants (weeds)
- Increase in the area of habitat used by non-native predators, by creation of tracks.

Clearing of the vegetation of the study area is reported as cumulative clearing (i.e. total clearing of all vegetation types) using the vegetation mapping from 'Appendix M'.

The vegetation types that will be affected by the proposal comprise 14 distinct vegetation communities (GHD 2015) (and sub-communities) which are presented in Table 26. The vegetation communities have been mapped at a scale of 1:10,000.

Table 26 Nolans project vegetation communities and proposed clearing areas for each community

Nolans Mine 2010 and 2015 mapping		% of total area proposed to be cleared	Total (ha)
V*	**Description**		
1	Riparian woodland along water courses and drainage channels	5.77%	239.96
2a	Mulga shrubland on sandy red earths over spinifex	0.14%	5.90
2b	Mulga shrubland on sandy red earths over tussock grasses	33.92%	1411.45
2c	Mulga shrubland on sandy read earths over chenopods	0.84%	34.82
3a	Mixed woodland over tussock grasses	15.79%	657.18
3b	Mixed woodland over spinifex	0.26%	10.97
3c	Mixed woodland over a highly disturbed understorey dominated by **Cenchrus ciliaris*	0.16%	6.46
4	*Triodia schinzii* hummock grassland on red clayey sands	0.00%	0.00
5	Hakea/Senna shrubland on calcareous alluvial plains and low rises	5.59%	232.49
6	Eucalyptus (mallee)/Acacia kempeana/Triodia shrubland on rocky slopes	1.44%	59.86
7	Acacia/Triodia shrubland on rocky outcrops	4.95%	205.99
8	Rocky gneiss or schist outcrops with no spinifex	0.01%	0.37
9	Acacia kempeana and/or Mulga shrubland on gravel	1.07%	44.44
10	Claypans with chenopods and herbs	0.00%	0.12
11	Cottonbush chenopod shrubland on highly erodible duplex soils	0.09%	3.55
12	Triodia basedowii hummock grassland on sand plains	2.53%	105.39

Nolans Mine 2010 and 2015 mapping		% of total area proposed to be cleared	Total (ha)
13	Senna shrubland on quartz	0.14%	5.96
14	Coolabah woodland on claypans	0.00%	0.00
2a/2b	Mulga shrubland on sand red earths over tussock grasses / Mulga shrubland on sandy red earths over spinifex	26.73%	1112.43
2b/3a	Mulga shrubland on sandy red earths over tussock grasses / Mixed woodland over tussock grasses on alluvial plains	0.13%	5.23
3a/12	Mixed woodland over tussock grasses on alluvial plains / Cottenbush chenopod shrubland on highly erodible duplex soils	0.12%	5.05
3b/2b	Mixed woodland over spinifex on alluvial plains / Mulga shrubland on sandy red earths over tussock grasses.	0.32%	13.35
	Disturbed	0.01%	0.59
Total		**100.00%**	**4161.56**

The proposed operation of the Nolans Rare Earths Project is likely to result in the following loss of habitat – note that these figures are highly conservative in that the total areas of clearing presented below indicate broad areas of habitat that may not completely represent preferred habitat (e.g. for rock-wallaby, the 266.23 ha of rocky habitat proposed for clearing is likely to be primarily comprised of lower quality dispersal habitat).

- Black-footed Rock-wallaby (MacDonnell Ranges race) in the study area to lose:
  - A total cumulative loss of (all vegetation communities) of 266.23 ha (conservatively veg communities 6, 7 and 8) of known foraging and dispersal habitat. This equates to broadly 0.41% of the 65,000 ha of potential habitat within the 150,000 ha search area from the July 2015 survey (see Figure 25).
  - The habitat to be lost within the project footprint appears to be foraging/dispersal habitat only (old scats present) compared to the foraging/breeding/dispersal habitat within the surrounding Reynolds Range in the vicinity of the proposed mine (see Figure 24).
- The Brush-tailed Mulgara in the study area to lose:
  - A total cumulative loss (all vegetation communities) of 122.25 ha (conservatively veg communities 2a, 3b and 12) of known foraging/breeding/dispersal habitat. This equates to broadly 0.29% of the approximately 41,568 ha of potential habitat within the sandplain habitats of Napperby and Aileron Stations that encompass the Nolans Project (borefield area assessed for the project, see Figure 26). There is certainly far more extensive potential habitat in the Burt Plain Bioregion in addition to this area. A total of 45 active burrows/scats (a frequency of approx. 2.5 active burrows/ha) were recorded from the July 2015 survey in addition to records of a Brush-tailed Mulgara from a remote camera (numerous photographs of possibly the same individual) from the May 2015 surveys. It appears that the Brush-tailed Mulgara is well represented in the study area and quite likely in the broader region.
- The Great Desert Skink in the study area to lose:
  - A total cumulative loss (all vegetation communities) of 122.25 ha (conservatively veg communities 2a, 3b and 12) of known foraging/breeding/dispersal habitat. This equates to broadly 0.29% of the approximately 41,568 ha of potential habitat within the sandplain habitats of Napperby and Aileron Stations that encompass the Nolans Project (see Figure 27). There is certainly much more extensive potential habitat in the Burt Plain Bioregion in addition to this area. A single Great Desert Skink active

warren was recorded in the far south-west of the study area that is currently situated outside of the proposed development area for the borefield. It will be important to avoid this location during the construction and operation of the project.

- The Greater Bilby in the study area to lose:
  - A total cumulative loss (all vegetation communities) of 122.25 ha (conservatively veg communities 2a, 3b and 12) of possible foraging/breeding/dispersal habitat. This equates to broadly 0.29% of the approximately 41,568 ha of potential habitat within the sandplain habitats of Napperby and Aileron Stations that encompass the Nolans Project (see Figure 28). There is certainly much more extensive potential habitat in the Burt Plain Bioregion in addition to this area;
  - This species was not recorded during any of the previous surveys conducted within the study area (including aerial flyover of habitat looking for burrows). Despite not being detected, this species is mobile and could still occur in very low abundance (thus difficult to detect). Impacts would likely be low with the primary impacts being vehicle strike at night (low likelihood) and increased predation due to greater presence of people and their waste (i.e. increase in predator abundance).
- The Princess Parrot in the study area to lose:
  - A total cumulative loss (all vegetation communities) of 362.21 ha (conservatively veg communities 1, 2a, 3b and 12) of possible foraging/dispersal habitat. This equates to broadly 0.87% of the approximately 41,568 ha (borefield) (see Figure 29). There is certainly much more extensive potential habitat in the Burt Plain Bioregion in addition to this area. This species is highly nomadic and would be an occasional visitor to the study area at most;
  - This species was not recorded during any recent or previous surveys in the study area. As mentioned, this species is highly nomadic and irruptive in response to rainfall and improved conditions. This species arrived at Newhaven Station in 2012 (approx. 180 km from the Nolans study area) following good rainfall in central Australia. It is possible that this species could visit the study area under similar conditions in the future.
- The entire fauna of the study area to lose:
  - A total cumulative loss of (all vegetation communities) 4,161.56 ha, which over the broader area that was assessed by both vehicle and air during all surveys (approx. 150,000 ha) equates to around 2.77% of the habitats of this broad area.

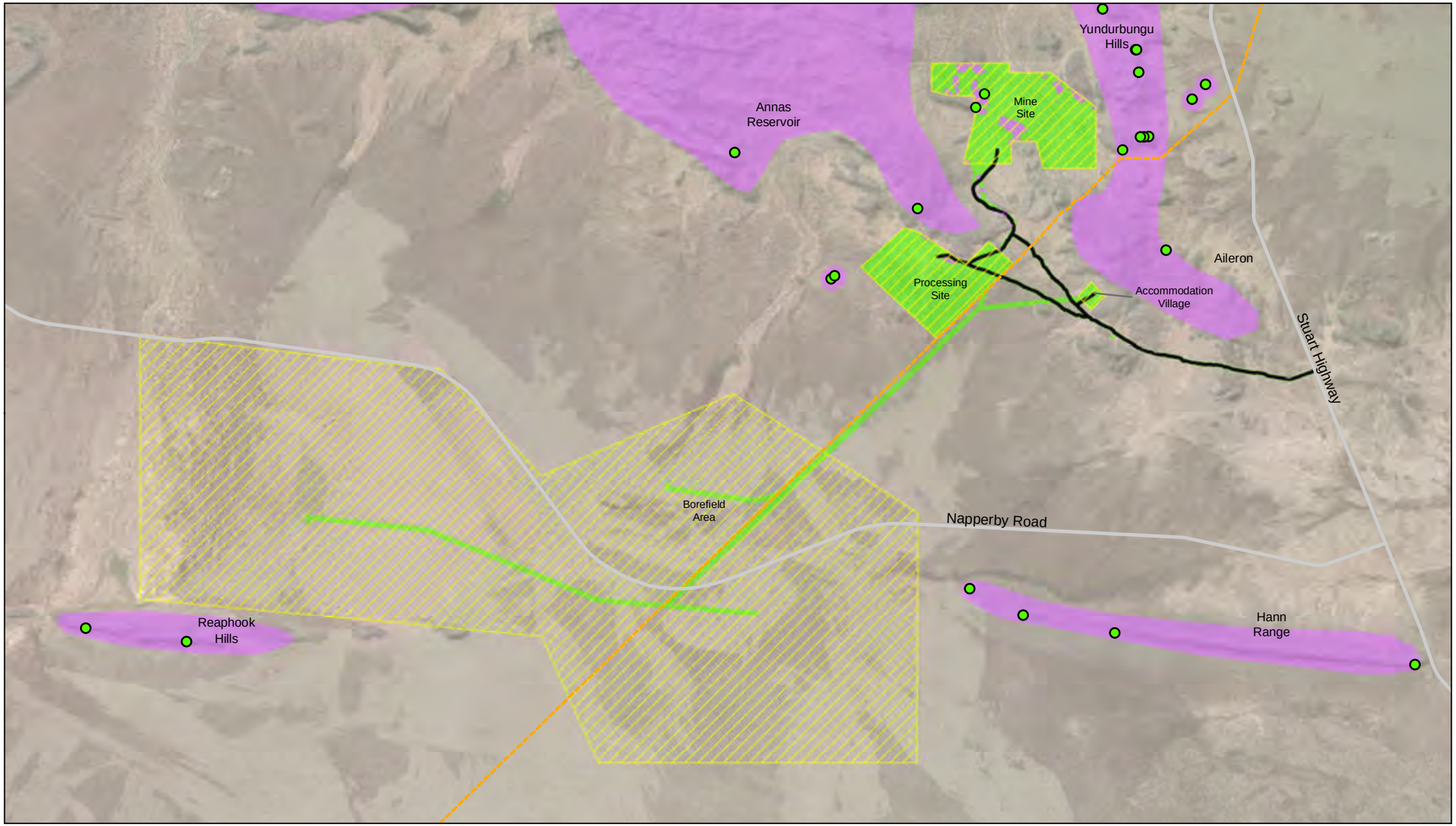
The areas to be cleared will form small islands of cleared habitat in a near continuous area of native vegetation. The area is bounded to the south by the Reaphook Hills and Hann Range and Stuart Highway to the east. The proposed mining will not cause any fragmentation of the habitat.

The proposed loss of habitat for these threatened species and the entire fauna are relatively small compared to the actual Study area over which the faunal populations are distributed and potentially occur within the area assessed (approx. 150,000 ha by both vehicle and helicopter) and broader region which includes the eastern end of the Reynolds Range, Napperby and Aileron Stations.

Clearing seems unlikely to have any significant direct impact on any of the threatened species and populations.

The fauna as a whole is similarly likely to experience no significant effects from the clearing itself with other impacts discussed below such as vehicle strike and the introduction of exotic predators likely to be more important for future management. Impacts from the clearing would likely be minimal, and not amenable to detection at the population level.

Specific mitigation measures (Section 6) would need to be implemented for species with very small known populations such as the Great Desert Skink active warren in the south-west of the study area. The active warren is not currently part of the proposed development and this would need to remain with protection of this location occurring.



1:225,000 @ A4

0 2 4 6 8

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

N

LEGEND

- Black Footed Rock Wallaby Survey
- Roads
- Access Roads
- Gas Pipeline
- Clearing Area
- Known Rock Wallaby Habitat
- Site Boundaries

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Nolans Project

Black-footed Rock-wallaby (MacDonnell Ranges race) known and potential habitat

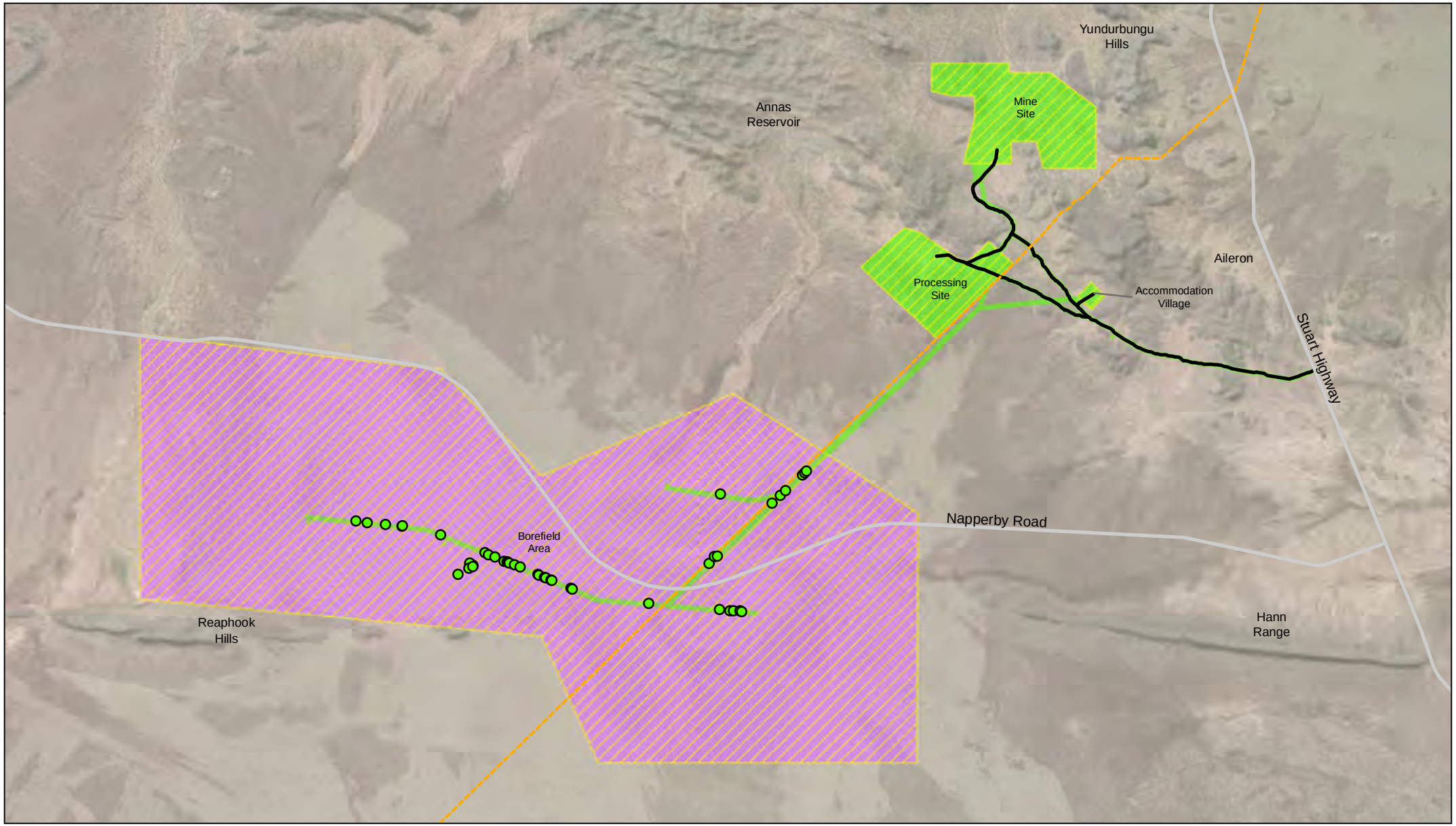
Job Number 4322301
Revision 0
Date 18 Mar 2016

Figure 25

G:\43\22301\GIS\Maps\4322301_215_RockWallabyHabitat.mxd

Level 5 66 Smith Street Darwin NT 0800 Australia **T** 61 8 8982 0100 **F** 61 8 8981 1075 **E** drwmail@ghd.com **W** www.ghd.com

Data source: GA - Imagery (2009), Roads, Gas Pipeline (2015). GHD - Clearing Area, Site Boundaries, Rock Wallaby Habitat (2015). Created by: CM



1:225,000 @ A4

0 2 4 6 8

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

N

LEGEND

- Brush-tailed Mulgara records
- Roads
- Access Roads
- Gas Pipeline
- Clearing Area
- Known Mulgara Habitat
- Site Boundaries

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Nolans Project

Job Number 4322301
Revision 0
Date 18 Mar 2016

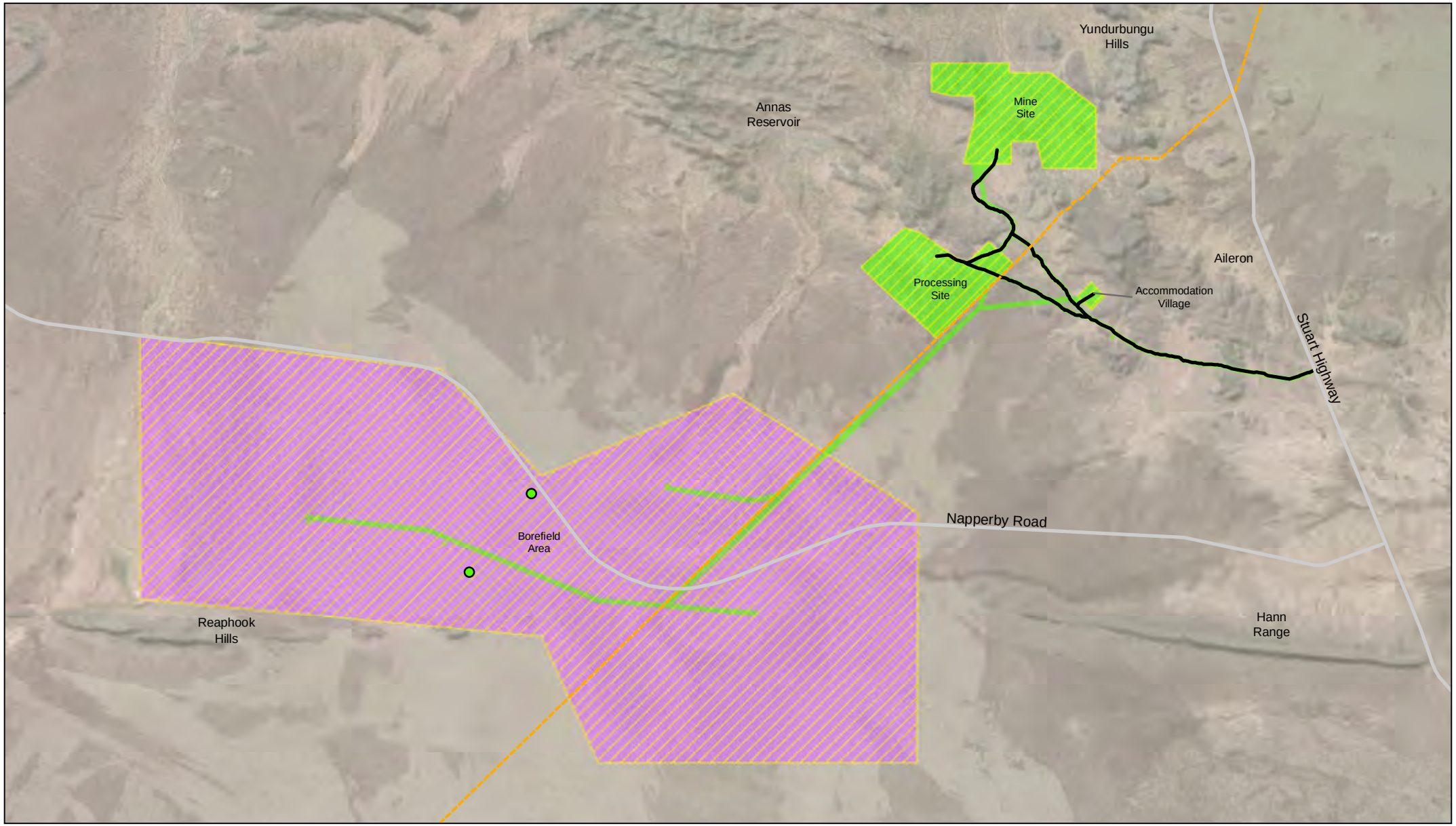
Mulgara known and potential habitat

Figure 26

G:\43\22301\GIS\Maps\4322301_211_MulgaraHabitat.mxd

Level 5 66 Smith Street Darwin NT 0800 Australia **T** 61 8 8982 0100 **F** 61 8 8981 1075 **E** drwmail@ghd.com **W** www.ghd.com

Data source: GA - Imagery (2009), Roads, Gas Pipeline (2015). GHD - Clearing Area, Site Boundaries, Mulgara Habitat (2015). Created by: CM



1:225,000 @ A4

0 2 4 6 8

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

N

LEGEND

- Great Desert Skink
- Roads
- Access Roads
- Gas Pipeline
- Clearing Area
- Known Desert Skink Habitat
- Site Boundaries

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Nolans Project

Job Number	4322301
Revision	0
Date	18 Mar 2016

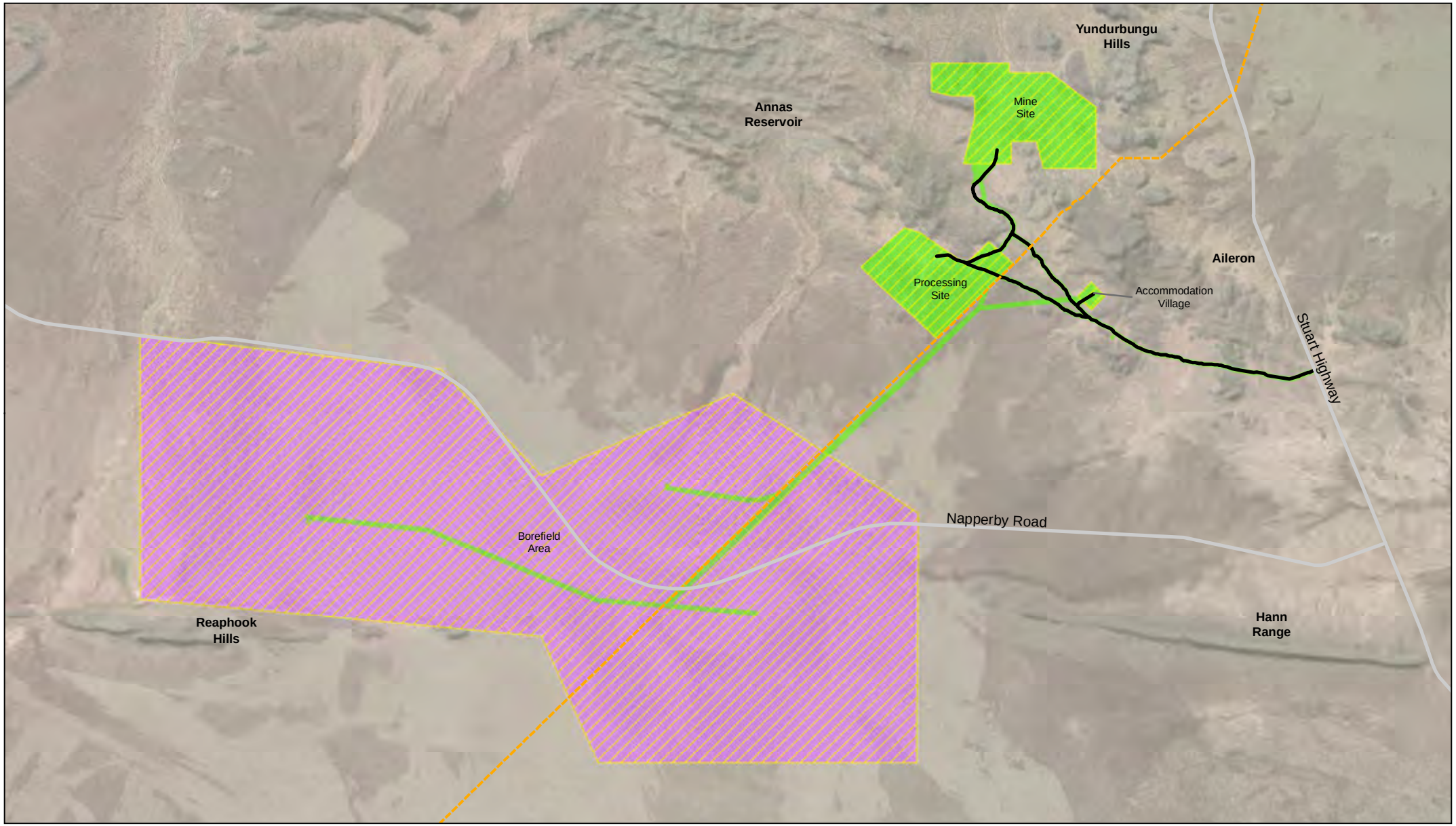
Great Desert Skink known and potential habitats

Figure 27

G:\43\22301\GIS\Maps\4322301_214_DesertSkinkHabitat.mxd

Level 5 66 Smith Street Darwin NT 0800 Australia **T** 61 8 8982 0100 **F** 61 8 8981 1075 **E** drwmail@ghd.com **W** www.ghd.com

Data source: GA - Imagery (2009), Roads, Gas Pipeline (2015). GHD - Clearing Area, Site Boundaries, Skink Habitat (2015). Created by: CM



1:225,000 @ A4

0 2 4 6 8

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

N

LEGEND

- Roads
- Access Roads
- Gas Pipeline
- Clearing Area
- Possible Bilby Habitat
- Site Boundaries
- Anna's Reservoir Reserve

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Nolans Project

Job Number	4322301
Revision	0
Date	18 Mar 2016

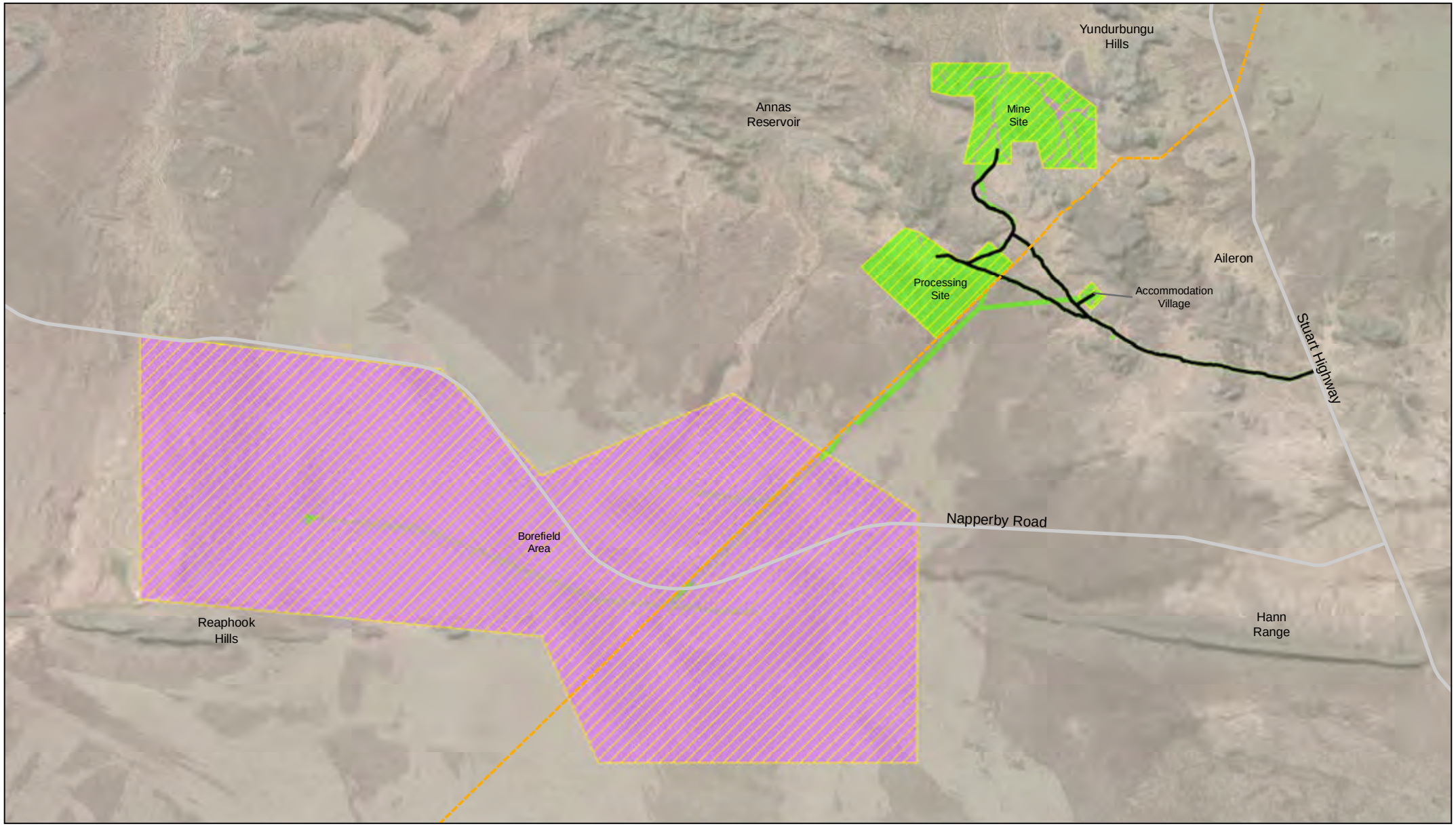
Greater Bilby potential habitat

Figure 28

G:\43\22301\GIS\Maps\4322301_212_BilbyHabitat.mxd

Level 5 66 Smith Street Darwin NT 0800 Australia **T** 61 8 8982 0100 **F** 61 8 8981 1075 **E** drwmail@ghd.com **W** www.ghd.com

Data source: GA - Imagery (2009), Roads, Gas Pipeline (2015). GHD - Clearing Area, Site Boundaries, Bilby Habitat (2015). Created by: CM



1:225,000 @ A4

0 2 4 6 8

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

N

LEGEND

- Roads
- Access Roads
- Gas Pipeline
- Clearing Area
- Possible Princess Parrot Habitat
- Site Boundaries

Arafura Resources Limited
Nolans Project

Job Number	4322301
Revision	0
Date	18 Mar 2016

Princess Parrot potential habitat

Figure **29**

G:\43\22301\GIS\Maps\4322301_210_PrincessParrotHabitat.mxd

Level 5 66 Smith Street Darwin NT 0800 Australia **T** 61 8 8982 0100 **F** 61 8 8981 1075 **E** drwmail@ghd.com **W** www.ghd.com

Data source: GA - Imagery (2009), Roads, Gas Pipeline (2015). GHD - Clearing Area, Site Boundaries, Princess Parrot Habitat (2015). Created by: CM

5.5.2 Dust generated by mining and processing activities

The New South Wales Department of Environment and Conservation (DEC 2005) sets a dust criterion of 50 ugm^{-3} TSP for human exposure. There is no applicable criterion for fauna. It would be anticipated that small birds/mammals would require a lower dust criterion (Newman and Schreiber 1988) i.e. they have higher rates of inhalation per unit body mass than do humans.

Research and knowledge with respect to airborne pollutants, and in particular dust effects on wildlife, are mostly restricted to effects of concentrated population of domestic animals such as chickens in restricted environments; or more general studies on the effects of infrastructure such as roads and mines on adjacent fauna populations (Collins and Algers 1986; Spellerberg 1998).

The toxic effects of air pollution on wildlife can range from significantly decreased fitness of individuals (Brown *et al.* 1997) to increased incidence of infectious diseases as a result of exposure to gaseous or particulate emissions, leading to injury and death (Newman and Schreiber 1988). The understanding of the toxicological effects of air pollution on wildlife is limited mainly to symptoms observed in the field and extrapolated from studies on livestock and laboratory animals (Newman and Schreiber 1988).

Current air quality standards cannot be assumed to protect wildlife from the effects of air pollution due the lack of direct evidence or research for most taxa (Newman and Schreiber 1988).

Dust is a potential problem for projects in regions that experience extended dry periods. Central Australia exhibits an arid and unpredictable climate could go extended periods of months without rain.

Drilling, blasting, excavation, movement of vehicles and handling of materials results in dispersion of particulates and dust, particularly from the Mine Site, and consequent soil, surface/groundwater contamination.

Potential impacts of dust on fauna can include:

- Degradation/loss of fauna habitat from detrimental impacts of dust deposition on flora species and vegetation communities
- Degradation/loss of water source for fauna resulting from degradation of surface water quality due to dust deposition/sedimentation.

The following activities are identified as potentially the main generators of dust:

- Uncontrolled dispersion of particulates and dust from the Concentrator (comminution and beneficiation circuits) at the Mine Site, resulting in dispersion of particulate, gas or dust
- Operation of RE processing units, sulfuric acid plant and gas fired generators at the Processing Site results in dispersion of particulate, gas or dust
- Haulage and transport of material within the Mine Site, along haul roads and tracks resulting in dispersion of particulate, gas or dust
- General site movements over unsealed surfaces resulting in dispersion of particulate, gas or dust
- Wind erosion mobilising dust from exposed surfaces, such as pits, waste dumps, tailings and residue storage facilities, laydown areas, stockpiles, roads and sites of vegetation clearing.

It is likely that a range of non-threatened taxa that exist within the vicinity of the proposed Mine Site could be adversely impacted by dust generated by mine operations. This would include birds, small ground-dwelling mammals and possibly small reptiles (although a lack of data on the effects of dust on reptiles does not allow any solid conclusions to be drawn). However, the majority of the threatened species either do not or would not regularly occur in the vicinity of the Mine Site (Brush-tailed Mulgara, Great Desert Skink, Greater Bilby, Princess Parrot) and hence would only ever be subjected to very low dust levels mainly from vehicles driving along gravel/dirt tracks. Populations of Black-footed Rock-wallaby do occur within <2 km of the Mine Site and could be subjected to low levels of dust. Mitigation measures will need to be implemented to keep dust levels to a minimum.

5.5.3 Noise generated by mining and processing activities

Disturbance to fauna associated with generation of unexpected and/or excessive noise from mining and processing activities during construction can result in:

- Displacement of fauna
- Disruption to nesting/roosting/foraging behaviour.

Displacement of fauna into sub-optimal habitats could increase their susceptibility to predation and competition.

FHA (2004) and Kaseloo (2005) reviewed literature on bird responses to intense noise levels and found that responses varied greatly (FHA 2004). Approximately 60% of 43 species studied exhibited population declines adjacent to roads, with the declines directly related to levels of traffic (Kaseloo 2005). Kaseloo (2005) and FHA (2004) reported that susceptible species exhibited declining populations in areas with greater than 50 dB(A). Declines were however subject to variation among years with interaction with and between habitat quality and population density playing significant roles in determining the nature if any of a decline.

Many bird (and other faunal classes) species remain unaffected by or persist with high population densities in areas with high noise levels e.g. near roads, mines or military testing/training grounds, airports (FHA 2004; Kaseloo 2005).

It is likely that faunal communities in the immediate vicinity of the Mine Site and mine operations would be most acutely affected by the proposal and could experience periodic periods of high noise levels that may encourage them to move to other nearby habitats.

It is envisaged that the majority of the threatened species that are known or whom have the potential to occur within the study area (Brush-tailed Mulgara, Great Desert Skink, Greater Bilby, Princess Parrot) occur some distance from the Mine Site >10 km and would be unlikely to be effected by Mine Site noise.

Increased vehicle noise in the borefield could have some localised and isolated low-level impacts however most of these species are nocturnal and their activity patterns would unlikely be adversely impacted by activity in the borefield at night. Vehicle passage in this area would be infrequent for maintenance purposes and may occur on a weekly basis only.

The Black-footed Rock-wallaby does occur within <2 km of the Mine Site and appears to occasionally pass through the actual Mine Site footprint (old scat recorded adjacent to Nolans Bore, see Figure 24). It is quite likely that noise generated by the mine could preclude rock-wallaby movements through the Mine Site as has occurred previously, however particularly noisy activities would likely occur during diurnal periods when rock-wallabies are sheltering and noise would be somewhat buffered by their rocky, elevated habitat.

It is possible that particularly 'high noise' activities (e.g. blasting) should be prevented from occurring during the rock-wallabies' nocturnal activity period when they could potentially be most disturbed.

5.5.4 Artificial light generated by mining and processing activities

Light plays a critical role in ecology. It determines activity levels of diurnal and nocturnal fauna, it assists predators in their hunting success, and some light sources attract invertebrate fauna that attract and are then preyed on by other fauna. Localised disturbance to nocturnal fauna associated with generation of light in mining and processing areas can cause the following impacts on fauna:

- Local displacement of fauna (i.e. nocturnal fauna moves away from brightly lit areas)
- Increased susceptibility of fauna to predation (e.g. prey species find it harder to remain concealed in brightly lit areas)
- Disruption to nesting/roosting behaviour (e.g. bright lights may awaken diurnal species).
- Disorientation of migrating birds (e.g. Longcore *et al*. 2008)
- Attraction and disorientation of amphibians (Buchanan 2006)
- Disorientation of bats (e.g. Stone et al., 2009; Polak 12011)
- Attraction of and enhanced mortality of insects (e.g. Yoon et al., 2010; Ferreira and Scheffrahn 2011; Fox 2012)
- Alteration of bird calling behaviour (e.g. Kepempenaers et al., 2010; Longcore 2010)
- Breeding behaviour of amphibians (e.g. Baker and Richardson 2005)
- Small mammal activity rhythms (e.g. Rotics et al., 2011).

The study of the effects of artificial light on fauna is in its infancy and viewed as a new focus for research in ecology, and a pressing conservation challenge (Longcore and Rish 2004). Recorded responses from fauna subjected to artificial light are many and vary widely among species. There is a possibility that the Nolans Mine could be operated 24 hours a day, seven days a week which has potential to negatively impact on the fauna, and specific species of fauna. The lack of specific information as to what the precise impacts may be makes it problematic to define the likely impacts. The valid approach under this circumstance may be to not assess the potential impacts, but to implement measures to mitigate the types of impacts that have been recorded for other faunas and species of relevance. Impacts would depend on hours of operation and scale of nocturnal lighting.

It is likely that faunal communities in the immediate vicinity of the Mine Site and mine operations would be most acutely affected by the proposal and could experience periodic periods of prolonged lighting that could impact on 'normal' nocturnal behaviours (e.g. bats, migratory birds).

It is envisaged that the majority of the threatened species that are known or whom have the potential to occur within the study area (Brush-tailed Mulgara, Great Desert Skink, Greater Bilby, Princess Parrot) occur some distance from the Mine Site >10 km and would be unlikely to be affected by Mine Site light. Increased vehicle and infrastructure lighting in the borefield could have some localised and isolated low-level impacts however, is unknown whether artificial lighting has any adverse impacts on these species. It is entirely possible that the mulgara could be attracted to lighting in an attempt to prey on insects, although it is unknown what the long-term effects of this would be on individuals or the population.

The Black-footed Rock-wallaby does occur within <2 km of the Mine Site and appears to occasionally pass through the actual Mine Site footprint (old scat recorded adjacent to Nolans Bore, see Figure 24). It is possible that light emitted from the Mine Site could impact on the nocturnal movement of rock-wallabies in the immediate vicinity of the Mine Site (i.e. previous rock-wallaby activity in the Mine Site appears to have been transitory only. Nocturnal lighting could reduce these dispersal activities in the immediate mine site vicinity). Rock-wallabies occurring at distances greater than or equal to 2 km from the Mine Site are unlikely to be adversely impacted by artificial lighting, provided that lights are not directed at their habitat. The distance and buffering by the elevation and rocky habitat would diminish the penetration of the 'brightness' of the majority of lights that would be used for illumination purposes.

5.5.5 Unplanned wildfire

Wildfire has an influential role in arid zone ecology, and is a necessary ecological process in some habitats. Fire can benefit some disturbance-tolerant species, but can have detrimental impacts on other types of fauna and fauna habitat, if it occurs at the wrong time of year, or in habitats that don't respond well to fire, or with excessive heat.

This project introduces a range of potential sources of fire. Vehicles, machinery, hot works, switchgear, transformers, HV power and personnel provide potential ignition sources that could lead to fire. Impacts of fire on fauna include:

- Killing/injuring fauna
- Displacement of fauna
- Disruption to nesting/roosting/foraging habitats and/or behaviour
- Reduction of area of fauna habitat locally and/or regionally
- Habitat fragmentation
- Subsequent erosion and sedimentation resulting from loss of vegetation
- Degradation of surface water quality due to erosion of soils and landforms.

The impacts of too frequent, hot and extensive fires are well documented in the arid zone of central Australia (Woinarski *et al.* 2007). A number of the threatened species recorded within the study area are adversely affected by too frequent and extensive fires. Large-scale, intense wildfires from a lack of patch burning can devastate or fragment local populations of Great Desert Skink (Woinarski *et. al.* 2007). Wildfire within Black-footed Rock-wallaby habitat is also a major impact on populations as it burns food plants such as Spearbush and fig rendering habitats unsuitable for periods of time (Dr J. Read *pers. comm.*).

There is great potential for the proposal to lead to increased wildfire in the study area in the event that appropriate mitigation measures are not implemented. It is expected that all of the threatened species either known or potentially occurring within the study area would be affected by fire (both positive and negative impacts).

Controlled and strategic cool patch burns of spinifex sandplain habitat could have positive outcomes for species such as Greater Bilby (promotes food plants). Extensive burns (not patchy) of Great Desert Skink and Black-footed Rock-wallaby habitat could be detrimental as the fire would remove important shelter and food resources.

Burning of rocky habitat is unlikely to be beneficial for many species and should be avoided as there are some excellent examples of long-unburnt rocky habitats supporting species such as pine and mulga that should continue to be protected. Continued persistence of the Black-footed Rock-wallaby in the area will depend on prevention of wildfire in the surrounding rocky habitats of the study area and surrounds.

There is limited information regarding the response to fire for mulgaras. Woinarski 2007 does mention that changes fire regimes may have been a factor in their historic decline. Removal of ground layer vegetation is thought to leave mulgaras more vulnerable to predation (Kortner et al. 2007). As mentioned above, too frequent, hot and extensive wildfire is unlikely to benefit any of the threatened species in the study area and surrounds, whereas localised cool patch burns are likely to be beneficial.

5.5.6 Introduction and/or spread of exotic plants and animals

Exotic plants (Weeds)

The establishment or spread of weeds can alter the ecological balance of arid zone ecology. Weed dominated habitats are generally less favourable for fauna than weed-free habitats. In particular, Buffel Grass (*Cenchrus ciliaris*) is a serious ecological pest in central Australia and its spread into rocky habitats of the study area should be prevented.

Transport of materials, vehicle movements and inappropriate waste management allows for introduction of new weeds and spread of existing weeds during construction and operations. These can cause:

- Local decline in habitat quality
- Displacement of fauna from habitats as habitat quality deteriorates
- Invasion of fauna species that are attracted to the weed species (e.g. cattle with buffel grass)
- Impacts on conservation significant fauna (i.e. threatened species)
- Changes in fuel load, resulting in changes to fire frequency and intensity.

Non-native animals

Creation of new roads and tracks and inappropriate management of waste (garbage) allows for introduction or spread of pest animal species (and potentially in some cases native predators including the dingo). This can cause:

- Increased predation pressure (particularly on threatened species) by opening up of new areas to feral predators (e.g. Cat, Red Fox) and potentially native predators such as the dingo
- Increased competition (particularly on threatened species) by natural areas becoming invaded by aggressive and dominating pest species (e.g. House Mouse, Black Rat)
- Large-scale decline in habitat quality as natural areas are trampled and grazed increasingly by non-native species that have the potential to alter ecological processes (e.g. Cattle, Camel, Goat).

Feral (and native – e.g. dingo) predators appear to be common within the study area, with all transects walked in the borefield (approx. 36 km walked by a minimum of three people situated at least 5 m apart) recording a least one of fox, cat or dingo. Each of these species was also recorded on the Mine Site. It will be important that with an increase in people on-site waste products are contained within a predator-proof fence to prevent access (access to easily obtain food resources could allow predators to increase in abundance).

5.5.7 Radioactivity exposed by mining and processing activities

The project involves mining and processing of rare earths with which radioactive isotopes are closely associated. Arafura has conducted a radiological risk assessment for fauna in the region

and found the level of risk of impact to fauna to be negligible. Refer to Chapter 11 (Radiation) for more detail.

5.5.8 Poisoning of fauna from drinking contaminated water

The links between use of tailings dams and poisoning in waterfowl and other species of avifauna is well documented in the Australian literature (Ryan and Shanks 1996). Effects can be immediate or cumulative. Consumption of contaminated water can cause:

- Killing/harming fauna
- Disruption to breeding success
- Knock-on effects, by attracting predators/scavengers to ill/dead fauna.

It is assumed that the tailings facilities for the Nolans project will be quite small (approx. 244.03 ha) and will contain free-standing supernatant water. It is unlikely that the majority of the threatened species that are known or whom have the potential to occur with the study area (Black-footed Rock-wallaby, Great Desert Skink, Brush-tailed Mulgara, Greater Bilby, and to a lesser extent, Princess Parrot) would access liquid contained within a tailings dam.

There would be an extremely low chance that passing Princess Parrots would stop for a drink at a tailings dam. It is possible that other non-threatened fauna could access the water however. The dams will be designed to prevent access by domestic stock and larger macropods.

5.5.9 Lowering or contamination of the water table

Changes to the water table can lead to changes in surface vegetation and habitat characteristics, particularly those communities reliant on surface water runoff and groundwater (e.g. riparian vegetation). Lowering or contamination of the water table has the potential to cause the following impacts on fauna:

- Decline in availability of water to ecosystems including riparian vegetation (e.g. River Red Gum communities along watercourses, particularly adjacent to the mine site) resulting in loss of habitat for species relying on riparian habitat
- Shorter inundation period in waterbodies that may provide water for fauna.

After decommissioning, the mine void may act as a sink concentrating salts/contaminants which can seep to groundwater. This in turn can lead to:

- Impacts on vegetation that rely on groundwater or surface water flows, in turn leading to reduction in available habitat for fauna
- Contamination of ephemeral waterways and subsequently groundwater in the broader area from uncontrolled release resulting in impacts on ecosystem health and/or public water supply
- Unnatural inundation of fauna habitats.

In this project, the water table (and therefore fauna habitat) could be impacted in the following areas and in the following ways:

- Progressive water table drawdown from unsustainable groundwater extraction rates from the Southern Basins Borefield
- Mine void results in a long-term source of contaminated water with the potential to contaminate groundwater and surface water
- Embankment failure or overtopping of Tailings Storage Facility (TSF) at Mine Site and RSF at Processing Site, due to slope instability or extreme wet weather event (all of which could damage fauna habitat)

- Inappropriate storage and handling of hazardous substances on Mine Site or Processing Site resulting in uncontrolled release, spills or passive discharge.

Lowering of the water table due to groundwater drawdown could occur within the mine site, processing facility and borefield, however only the mine site appears to support Groundwater Dependent Ecosystems (GDEs) such as riparian River Red Gum communities.

None of the threatened species known or predicted to occur within the study area (Black-footed Rock-wallaby, Great Desert Skink, Brush-tailed Mulgara, Greater Bilby and Princess Parrot) are likely to be directly impacted by water table impacts.

5.5.10 Injury and death from collisions with vehicles

There is substantial literature and reviews on the effect of roads and vehicle traffic on adjacent biota (Forman and Alexander 1998; Forman and Deblinger 2000; Johnston and Johnston 2004; Lugo and Gucinski 2000; Pagotto et al. 2001; Trombulak and Frissell 2000; Walker and Everett 1987) and more recently the topic of road ecology has been considered a research discipline in itself (Coffin 2007). The history of the development of road ecology (Forman 1998) is well described in this publication. Creation and use of new roads and tracks through fauna habitats can lead to increased collisions with fauna, particularly at night, when nocturnal fauna can become dazed by a vehicle's bright lights. There can be both biotic and abiotic effects of roads on ecosystems (Coffin 2007) and these include:

- Injuring/killing fauna
- Breeding failure caused by loss of naïve young fauna, or adult fauna that have dependent offspring
- Changes to hydrology and water quality, both increases and decreases (Forman and Alexander 1998)
- Erosion and sediment transport (Jones *et al.* 2000)
- The introduction of chemical pollutants, including toxic contaminants (Forman *et al.* 2003)
- Noise effects (Bayne *et al.* 2008)
- Direct mortality (Erritzoe *et al*. 2003)
- Barriers to movement (Shepard et al. 2008)
- The creation of new habitat types, especially in agricultural landscapes (Bellamy et al. 2000)
- The creation of corridors and conduits of species movement or invasion (von der Lippe and Kowarik 2008)
- Fragmentation and edge effects (Hawbaker *et al*. 2006).

It is possible that several of the species that occur within the borefield could occasionally be struck and killed by vehicles moving in the area (e.g. Brush-tailed Mulgara, Great Desert Skink). The majority of the threatened species that are known or have the potential to occur in the study area are nocturnal and would only be affected by vehicles travelling at night. Mitigation discussed below would likely involve the implementation of speed limits and possibly the reduction in vehicle travel at night.

6. Mitigation measures and monitoring

Mitigation measures will be required to control, reduce or eliminate impacts of mining and processing activities on fauna (particularly threatened species) and their habitat. Monitoring will be required for some aspects, to evaluate level of impact and effectiveness of mitigation.

This section provides guidance on the types of mitigation and monitoring that will need to be considered for the construction and operations phases of the project. All mitigation and monitoring efforts will need to be described in detail in a Biodiversity Management Plan, prior to impact activities taking place.

6.1 Clearing of breeding and/or foraging habitat

As outlined above, 4,529.69 ha of vegetation/habitats is proposed to be cleared for the Nolans Rare Earths Project. It has been calculated that this equates to:

- Black-footed Rock-wallaby (MacDonnell Ranges race) in the study area to lose 266.23 ha of known foraging and dispersal habitat
- The Brush-tailed Mulgara in the study area to lose 122.25 ha of known foraging/breeding/dispersal habitat
- The Great Desert Skink in the study area to lose 122.25 ha of known foraging/breeding/dispersal habitat
- The Greater Bilby in the study area to lose 122.25 ha of possible foraging/breeding/dispersal habitat
- The Princess Parrot in the study area to lose 362.21 ha of possible foraging/dispersal habitat
- The entire fauna of the study area to lose a total cumulative loss of 4,161.56 ha.

6.1.1 Avoidance actions

The primary avoidance actions that can be taken with respect to the threatened species considered in this report includes:

- Complete avoidance of the Great Desert Skink warren recorded in the far south-western corner of the study area (see Figure 11)
- Notwithstanding the fact that the entire mine cannot be relocated, particular attention has been paid to the location of all infrastructure so that it is situated to largely avoid threatened species breeding and foraging habitats.

6.1.2 Minimising and mitigating actions

To minimise and mitigate clearing effects on threatened species populations, breeding habitat and foraging habitat the following actions have been considered:

- Subtle realignment and preliminary design and -siting of all infrastructure to minimise loss of key breeding and feeding habitat (particularly in the borefield to avoid the Great Desert Skink warren)
- Clearly marking areas of land to be cleared and areas to be retained (No-Go areas), so that impacts do not extend any further than necessary into important habitat

- Construction and clearing during non-breeding period (e.g. clearing to occur preferably in autumn when young animals are mobile and less dependent on parents and when reptiles are still active and have a chance to escape)
- Consider a cool, well managed fuel reduction burn of all habitats to be cleared to allow fauna to have the chance to escape prior to chaining of vegetation and bulldozing up into windrows. Details on this approach would be contained within a Biodiversity Management Plan
- Pre-clearing fauna surveys prior to construction of the mine with qualified ecologists on site to capture and translocate animals that are found during the clearing process
- Strict vehicle hygiene protocols to prevent new weed incursion and spread, including a vehicle wash down facility on site
- Strict fire prevention management protocols to prevent wildfire during clearing activities
- Possibly offsetting habitat at a higher quantum and condition, the habitat to be cleared, including actions to manage offset areas to decrease threatening processes, and increase threatened species populations. Details on this approach would be contained within a Biodiversity Management Plan
- Rehabilitation of edges (of clearing) abutting threatened species habitat to remove weed species, and maximise the presence of native plant regeneration
- Monitoring of habitat clearing to ensure compliance with areas marked as No-Go areas
- Use of already-disturbed areas (rather than undisturbed areas) wherever possible (e.g. set down areas for construction)
- Progressive and incremental clearing of land as needed, rather than large-scale clearing in advance
- Progressive rehabilitation/stabilisation of cleared land as activities are completed (which forms part of the Closure and Rehabilitation Plan)
- Ongoing pest animal control (e.g. control of cats and foxes in particular).

6.2 Dust generated by mining and processing activities

6.2.1 Avoidance actions

The main avoidance actions for dust suppression could potentially be avoiding mine operations during particularly dry and windy weather however this may not be a viable option on all occasions that these conditions occur.

6.2.2 Minimising and mitigating actions

To minimise and mitigate the effects of dust on threatened species populations, breeding habitat and foraging habitat the following actions are recommended:

- The minimisation of dust emission controls as defined in a Dust Management Plan that includes, but is not limited to:
  - Crusher dust controls to industry standards, via watering, emission screens, road sealing, chemical applications, covering of exposed loads where practicable
  - Minimising mining, hauling and vehicle travel when prevailing winds and strength of winds reach a particular trigger level that would results in spatially extensive and heavy dust deposition in surrounding habitats where practicable.

- Dust monitoring to assess dust effects with distance from the mine or dust-generating activity as per GHD Air Quality report
- Reduced vehicle speeds for high-use areas/roads
- Progressive rehabilitation/stabilisation of cleared land as activities are completed (which forms part of the Closure and Rehabilitation Plan).

6.3 Noise generated by mining and processing activities

6.3.1 Avoidance actions

The primary noise avoidance activities would be to avoid activities that produce excessively loud noise at night when the majority of threatened species would be active. This may not always be practical.

6.3.2 Minimising and mitigating actions

Minimising impacts on fauna from noise will involve:

- Minimising noise wherever possible
- Limiting high-impact noise (e.g. blasting) to daylight hours only (this will reduce the impact on nocturnal fauna, which includes most of the threatened species).

6.4 Artificial light generated by mining and processing activities

6.4.1 Avoidance actions

Avoidance actions would predominately involve turning off lights at night when nocturnal fauna are active, however this may not always be practical.

6.4.2 Minimising and mitigating actions

The potentially negative impacts of artificial light can be mitigated by:

- Limiting artificial light to areas where it is essential
- Turning off lights when not required
- Limiting the escape of light into surrounding areas of fauna habitat (i.e. using shields/deflectors)
- Ensuring that artificial lighting is not directed upwards or laterally (i.e. should be directed towards the ground)
- Using lower rather than higher lighting installations
- Using lower wavelengths of light wherever possible, i.e. red/yellow lights
- Using light intensities that are as low as possible without reducing safety or efficiency
- Avoiding painting large structures bright or reflective colours and minimise use of bright or reflective construction materials and finishes for large structures.

6.5 Unplanned wildfire

6.5.1 Avoidance actions

The avoidance of unplanned wildfire should be a high priority for the mine as this could have serious implications for the biodiversity of the area given that recent fires have already occurring in both rock and sandplain habitats of the study area (it appears that most of the spinifex

sandplain habitat is younger than 5-10 years, additional burns could be harmful to species such as the Great Desert Skink).

6.5.2 Minimising and mitigating actions

Minimising impacts on fauna from unplanned wildfire will involve:

- Careful planning of where high-risk activities can take place
- Maintenance of fire breaks around high-risk areas/activities
- Active fire management, and the use of cool-season control burns
- Development of a Fire Management Plan
- Erosion control in waterways, if fire should occur and kill vegetation that otherwise stabilises soil/sediments.

6.6 Introduction and/or spread of exotic plants and animals

6.6.1 Avoidance actions

Complete avoidance of exacerbating the incidence of exotic flora and fauna would be the aim for the mine site, however in practise this may be difficult to achieve completely.

6.6.2 Minimising and mitigating actions

6.6.3 Exotic plants (Weeds)

Minimising impacts on fauna from the introduction or spread of weeds will involve:

- Development of a Weed Management Plan (likely to be part of broader Biodiversity Management Plan) to document mitigation measures to control existing exotic plants, and to stem the spread of others
- Cleaning vehicles (washdown) that are new to the site, to prevent the introduction of new weeds
- Washdown when moving from areas of high weed density to areas that are currently weed free
- Keeping vehicles to established tracks and roads, and limiting the use of vehicles off-road
- Annual weed monitoring and mapping
- Weed control activities in consultation/partnership with Aileron/Napperby Station owners as necessary (assuming existing landholders will continue to run these stations).

6.6.4 Non-native animals

Minimising impacts on native fauna from the introduction or spread of non-native fauna (and in some cases native predators such as dingoes) will involve:

- Sound waste management (garbage) to limit invasion/colonisation by Black Rat (*Rattus rattus*). This will also be particularly important for the Black-footed Rock-wallaby population near the Mine Site as any on-site garbage waste will need to be held in a securely fenced (i.e. the fence will need to prevent the entry of cats, foxes and dingoes) compound to prevent the scavenging of waste material and potential population increases in both feral and native predators.
- A pest animal management plan will need to be produced (as part of a broader Biodiversity Management Plan).

- Investigate innovative new passive baiting and trapping methods such as the newly developed 'Feral Cat Grooming Trap' (see http://www.ecologicalhorizons.com/initiatives for more information). The trap incorporates four rangefinder sensors, a programmable audiolure, a camera that photographs all activations, solar-charged battery and an electric motor-tensioned spring that fires sealed doses of toxic gel at 60 m/s. The sensors ensure that animals smaller or larger than a cat or fox do not activate the trap which holds 20 measured doses and can operate without intervention for several months. Field tests confirm that cats walking past at a distance of within 4 m will be sprayed, meaning the Grooming Traps will provide a long-term tool to control trap- or bait-shy cats in areas of high conservation value (e.g. could be used at Nolans in areas of known Black-footed Rock-wallaby habitat).
- Pest eradication/control program, targeting foxes, cats and rabbits across the Study area, and non-native rats and mice in Mine Site and Accommodation areas.
- Monitoring of feral fauna species.

6.7 Poisoning of fauna from drinking tailings dam water

Although it is indicated that the tailings dams for the Nolans Rare Earths Project will be relatively small (244.03 ha), their presence in a dry, arid climate may still render certain water dependent species susceptible to drinking from these facilities. This could be particularly apparent during 'resource bottlenecks' when smaller ephemeral water sources have dried out. The susceptibility and limits of tolerance of birds to drinking at these water sources is unknown, though there is clear evidence that birds do use these types of facilities and there is a risk of mortality from use of the tailings water.

6.7.1 Avoidance actions

To avoid the increased effect of the consumption or absorption of toxic waste water on local species this would require either:

- Surface areas of tailings dams to be kept to a practicable minimum, and 'up not out' principal applied to the design of additional facilities (i.e. increase the depth of water sources in enhance capacity rather than increasing surface area)
- The maintenance of toxins within the surface water at a consistently low level below that considered poisonous to wildlife.

6.7.2 Minimising and mitigating actions

- The reduction of impacts of tailings storage facilities on wildlife by following best practice guidelines currently recommended for the Northern Territory where practicable:
- The reduction of the attractiveness of the dam landscape for wildlife via design that includes, but is not limited to, the reduction of the dam surface area, removing dam bank vegetation, creating steep dam walls, providing alternative adjacent 'fauna friendly' water sources, and avoiding the creation of islands in the dam
- Fencing off the TSF and RSF to prevent ground-based fauna from accessing the water.

6.8 Lowering or contamination of the water table

6.8.1 Avoidance actions

The main avoidance actions for this impact would be to avoid, where practicable, drawing down the water table in areas where Groundwater Dependent Ecosystems (GDEs) exist, such as

along waterways where River Red Gums occupy the riparian zone. Also complete avoidance of any spills of leaks of contaminated water.

6.8.2 Minimising and mitigating actions

Impacts on native fauna through changes to the water table can be reduced by:

- Constructing adequate bunds around the tailings dam and other sources of potential contamination, to contain contaminated water in the event of heavy rainfall
- Monitor hydrogeological changes
- Undertake predictive groundwater flow modelling
- Development and implementation of groundwater and surface water management strategies
- Establish a Surface Water Plan for contaminated sites that serves to minimise the chance of contamination escaping into waterways.

6.9 Injury and death from collisions with vehicles

As outlined previously, the effects of roads and vehicle traffic on wildlife has been well documented, and have the potential to impact on threatened species and other fauna at the project site. The most significant consequences are likely to be the direct effect of mortality through vehicle strike, noise effects on breeding behaviour, and the dispersal of chemical pollutants in road dust. There may also be some indirect effects of habitat degradation via vehicle spread of exotic plant species into relatively undisturbed habitat which might change the quality and extent of habitat in the area.

While there will also be some perverse benefits in the construction of new roads, such as granivorous birds/herbivorous mammals feeding in road verges, as seeding grasses may be encouraged in these microhabitats due to changes in hydrology and accumulation of water in verges encouraging graminoid growth. However, this might be counteracted by the increased probability for vehicle strike of birds, mammals, reptiles, especially if feeding/basking (reptiles) animals are flushed by passing traffic.

Though these threats might have some effect, vehicle traffic is not often considered in the Recovery Plans or recent reviews of the conservation status of the threatened species considered here and this is possibly a diversion from more significant actions such as feral predators (cats/foxes) and wildfire.

The only caveat to this is the increase in fire-promoting exotic grass species by vehicles (e.g. Buffel Grass) which, if unmanaged, could also pose significant risks to a range of threatened species within the study area.

6.9.1 Avoidance actions

To avoid any negative effect of increased road traffic on the threatened species populations of the area, there should be no further increase in the current road network or the vehicle traffic at the mine site. It is inevitable that vehicle traffic will increase, but speed restrictions and the limit of vehicle travel at night should be a priority.

6.9.2 Minimising and mitigating actions

To minimise and mitigate the effects of increased road traffic or increased road network on the threatened species populations the following actions are recommended:

- Keep the proposed road network to a minimum and upgrade and utilise existing vehicle tracks
- Reduce speed limits and install speed reduction infrastructure such as whoa-boys and speed humps
- Provide road safety and awareness training to all staff and contractors with respect to safe driving in areas where native wildlife occurs
- Implementing and enforcing speed restrictions in high-use areas
- Limiting the movement of vehicles at night (between the period of one hour before dusk to one hour after dawn)
- Monitoring roadkill for threatened species
- Documenting location and time of day of roadkill within the Study area, to determine high-risk periods or locations (additional mitigation may be required)
- Fatigue management for vehicle operators
- Development and implementation of a Traffic Management Plan.

6.10 Assessment of the impacts on threatened species

Details of the risk assessments of individual sources of risk to the threatened species of the Nolans site are provided in Table 27 and Table 28 below.

A risk assessment was conducted separately for the Black-footed Rock-wallaby (MacDonnell Ranges race) due to the habitat requirements of the species. The other threatened species mainly occupy the borefield and sandplain habitats rather than the rocky outcrops in the vicinity of the mine site.

Table 27, which presents the risk assessment for Black-footed Rock-wallaby indicates that the most serious risk to this species is likely to come from unplanned wildfire and exotic flora/fauna. Both have the potential if unmitigated to exert a **High** risk on population size, critical habitat, breeding cycles and lead to population decline and inhibit species recovery. However, the implementation of mitigation and management measures presented in Section 6 would reduce these impacts to a point where the residual risk would remain **Low** to **Medium**.

Table 28 which presents the risk assessment for threatened species present within the borefield (in particular species that were recorded including the Great Desert Skink and Brush-tailed Mulgara) indicates that the most serious risk to these species is likely to come from unplanned wildfire and exotic flora/fauna. Both have the potential if unmitigated to exert a **High** risk on population size, critical habitat, breeding cycles and lead to population decline and inhibit species recovery. There is also a **Medium** risk posed by vehicle strike for vehicles travelling around the borefield at night. However, the implementation of mitigation and management measures presented in Section 6 would reduce these impacts to a point where the residual risk would remain **Low** to **Medium**.

In summary, the implementation of mitigation/management measures would allow impacts to be managed to a point where a significant impact on the threatened species that are known or have the potential to occur on the Nolans site would be unlikely.

Table 27 Project Risk – Black-footed rock-wallaby (*Petrogale lateralis* MacDonnell Ranges Race), species present within the mine site and within the vicinity

Source of Impact	Likelihood	Consequence	Severity	Comments	Minimising, mitigation and management actions	Residual Risk	Reference
Long term decrease in size of population							
Clearing – dispersal and foraging habitat	2	2	**Low**	A loss of 234.64 ha of known (low quality) foraging and dispersal habitat. This equates to broadly 0.36% of the 65,000 ha of potential habitat within the 150,000 ha search area from the July 2015 survey. This suggests that it is **unlikely** that the planned removal of 'transitory' habitat for black-footed rock-wallaby may result in a **minor** impact to the long-term size of the local population.	• Minimise impact via actions in Section 6.1**.** • Produce and apply dedicated Biodiversity Management Plan (BMP) and ensure appropriate construction, weed, weed hygiene, fire and rehabilitation management aspects are covered in an attempt to minimize and mitigate clearing effects on the Black-footed Rock-wallaby population of the area. • As part of BMP incorporate a monitoring program for Black-footed Rock-wallaby using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor the impact that clearing has on the local population.	**Low**	Section 5.5.1 Section 6.1
Dust	2	2	Low	Dust emitted from the proposed mine could have a small effect on any transitory rock-wallabies moving through the mine site footprint. The GHD 2016 Air Quality report indicates that PM10 concentrations well below 50 ug/m^3 only are likely to still be in excess of 1 km from known Rock Wallaby habitat. It is **unlikely** that dust emitted from the proposed mine would have **minor** impacts only to rock-wallaby populations =/> 2 km from the proposed mine site such that populations suffer a long-term decrease in size.	• Refer to Section 6.2**.** • The minimisation of dust emission controls as defined in a Dust Management Plan. • Produce and apply dedicated BMP and ensure appropriate dust controls are in place in an attempt to minimize and mitigate dust effects on the Black-footed Rock-wallaby population of the area. • As part of BMP incorporate a monitoring program for Black-footed Rock-wallaby using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor the impact that dust has on the local population.	Low	Section 5.5.2 Section 6.2
Noise	2	2	Low	Noise emitted from the proposed mine could have a small effect on any transitory rock-wallabies moving through the mine site footprint. The GHD 2016 Noise and Vibration report indicates that at a distance of 2 km (closest known rock-wallaby populations to mine site) most noise will be in the order of 27-43 dB(A), which seems approximately in-line with noise levels of 30-35 dB(A) at nearby residential receivers. It is **unlikely** that noise emitted from the proposed mine would have **minor** impacts only to rock-wallaby populations =/> 2 km from the proposed mine site such that populations suffer a long-term decrease in size. It should be noted that blasting results in noise levels of approx. 115 dB(A), which could potentially negatively impact on rock-wallaby behavior. It is recommended that blasting occur during the day only when rock-wallabies are inactive.	• Refer to Section 6.3**.** • The implementation of noise controls as defined in a Noise Management Plan – likely to include the avoidance of loud noise (e.g. blasting) at night when rock-wallabies are active. • Produce and apply dedicated BMP and ensure appropriate noise controls are in place in an attempt to minimize and mitigate noise effects on the Black-footed Rock-wallaby population of the area. • As part of BMP incorporate a monitoring program for Black-footed Rock-wallaby using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor the impact that noise has on the local population.	Low	Section 5.5.3 Section 6.2
Light	2	2	**Low**	Light emitted from the proposed mine could have a small effect on any transitory rock-wallabies moving through the mine site footprint. It is **unlikely** that light emitted from the proposed mine would have **minor** impacts only to rock-wallaby populations =/> 2 km from the proposed mine site such that populations suffer a long-term decrease in size.	• Refer to Section 6.4**.** • As mentioned in the mitigation measures section of the report, avoiding unnecessary lighting at night when rock-wallabies are active and keeping lighting low and directed at operations rather than surrounding habitat will assist greatly in mitigating impacts. • Produce and apply dedicated BMP and ensure appropriate lighting controls are in place in an attempt to minimize and mitigate artificial light effects on the Black-footed Rock-wallaby population of the area.	**Low**	Section 5.5.4 Section 6.4

Unplanned Wildfire	3	4	**High**	It is **possible** that extensive unplanned wildfire as a result of mine activities may have a **major** impact on the long-term size of the Black-footed Rock-wallaby population. The July 2015 baseline surveys did not record any fresh rock-wallaby scat where recent fires had occurred.	• Refer to Section 6.5**.** • A separate Bushfire Management Plan will be required to manage this risk; • Produce and apply dedicated BMP and ensure appropriate wildfire controls are in place in an attempt to minimize and mitigate the potential 'High' impacts on the Black-footed Rock-wallaby population of the area. • As part of BMP incorporate a monitoring program for Black-footed Rock-wallaby using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor possible impacts of fire (would include naturally occurring fire in addition).	**Medium**	Section 5.5.5 Section 6.5
Exotic plants and animals	3	4	**High**	It is **possible** that the introduction of exotic plants and animals as a result of mine activities may have a **major** impact on the long-term size of the Black-footed Rock-wallaby population. An increase in the incidence of cats, foxes and potentially dingoes could result in increased rock-wallaby predation, particularly of more vulnerable juveniles. An increase in the incidence of Buffel Grass could have serious implications for rock-wallaby habitat.	• Refer to Section 6.6**.** • Various design aspects will need to be considered for the mine such as a predator-proof compound to contain food waste. • Produce and apply dedicated BMP and ensure appropriate controls are in place to minimize and mitigate the potential 'High' impacts of exotic plants and animals on the Black-footed Rock-wallaby population of the area. • As part of BMP incorporate a monitoring program for Black-footed Rock-wallaby using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor possible impacts of exotic plants and animals on the population. Part of this monitoring would include an assessment of the abundance of exotic/native predators.	**Low**	Section 5.5.6 Section 6.6
Waste water	1	1	**Low**	It is predicted that it is **rare** that the Weak Acid Dissociable (WAD) cyanide in onsite water storage facilities may be at levels sufficient to cause wildlife mortality and that there may be **insignificant** impacts from ingestion by Black-footed Rock-wallaby. There is an extremely low likelihood that rock-wallabies would descend from their rocky habitats to drink from tailings facilities.	• Refer to Section 6.7. • Avoid the possibility by maintaining WADCN levels below levels poisonous to wildlife, and prevent wildlife access to new tailings dams. • Produce and apply a Water Quality Monitoring and Management Plan. A Tailings Dam Wildlife Monitoring Program would be incorporated into a BMP and would be more broadly directed at fauna in general rather than rock-wallabies.	**Low**	Section 5.5.8 Section 6.7
Lowering or contamination of water table	1	1	**Low**	It is predicted that it is **rare** that the lowering of the water table or contamination would have **insignificant** impacts on the Black-footed Rock-wallaby population such that it would decrease over time. There is an extremely low likelihood that the rock-wallaby population would be adversely impacted by water table draw-downs or water table contamination as they are not dependent on GDEs or standing water.	• Refer to Section 6.8.	**Low**	Section 5.5.9 Section 6.8
Traffic mortality	1	1	**Low**	It is predicted that it is **rare** that there will be some mortality from collisions with vehicles due to increased traffic that may have a **minor** impact on the Black-footed Rock-wallaby populations.	• Refer to Section 6.9 • Produce and apply a Traffic and Road Safety Management Plan, a Weed Hygiene Procedure and provision of on-site wash down facilities. Aspects of these will be incorporated into a BMP.	**Low**	Section 5.5.10 Section 6.9
Reduce the area of occupancy of an important population							

Clearing – dispersal and foraging habitat	1	2	**Low**	A loss of 234.64 ha of known (low quality) foraging and dispersal habitat. This equates to broadly 0.36% of the 65,000 ha of potential habitat within the 150,000 ha search area from the July 2015 survey. This suggests that it is **rare** that the planned removal of 'transitory' habitat for black-footed rock-wallaby may result in a **minor** impact to the area of occupancy of the local population.	• Minimise impact via actions in Section 6.1. • Produce and apply dedicated Biodiversity Management Plan (BMP) and ensure appropriate construction, weed, weed hygiene, fire and rehabilitation management aspects are covered in an attempt to minimize and mitigate clearing effects on the Black-footed Rock-wallaby population of the area. • As part of BMP incorporate a monitoring program for Black-footed Rock-wallaby using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor the impact that clearing has on the local population.	**Low**	Section 5.5.1 Section 6.1
Dust	2	2	Low	Dust emitted from the proposed mine could have a small effect on any transitory rock-wallabies moving through the mine site footprint. The GHD 2016 Air Quality report indicates that PM10 concentrations well below 50 ug/m^3 only are likely to still be in excess of 1 km from known Rock Wallaby habitat. It is **unlikely** that dust emitted from the proposed mine would have **minor** impacts only to rock-wallaby populations =/> 2 km from the proposed mine site such that populations suffer a long-term decrease in size.	• Refer to Section 6.2. • The minimisation of dust emission controls as defined in a Dust Management Plan. • Produce and apply dedicated BMP and ensure appropriate dust controls are in place in an attempt to minimize and mitigate dust effects on the Black-footed Rock-wallaby population of the area. • As part of BMP incorporate a monitoring program for Black-footed Rock-wallaby using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor the impact that dust has on the local population.	Low	Section 5.5.2 Section 6.2
Noise	2	2	Low	Noise emitted from the proposed mine could have a small effect on any transitory rock-wallabies moving through the mine site footprint. The GHD 2016 Noise and Vibration report indicates that at a distance of 2 km (closest known rock-wallaby populations to mine site) most noise will be in the order of 27-43 dB(A), which seems approximately in-line with noise levels of 30-35 dB(A) at nearby residential receivers. It is **unlikely** that noise emitted from the proposed mine would have **minor** impacts only to rock-wallaby populations =/> 2 km from the proposed mine site such that populations suffer a long-term decrease in size. It should be noted that blasting results in noise levels of approx. 115 dB(A), which could potentially negatively impact on rock-wallaby behavior. It is recommended that blasting occur during the day only when rock-wallabies are inactive.	• Refer to Section 6.3. • The implementation of noise controls as defined in a Noise Management Plan – likely to include the avoidance of loud noise (e.g. blasting) at night when rock-wallabies are active. • Produce and apply dedicated BMP and ensure appropriate noise controls are in place in an attempt to minimize and mitigate noise effects on the Black-footed Rock-wallaby population of the area. • As part of BMP incorporate a monitoring program for Black-footed Rock-wallaby using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor the impact that noise has on the local population.	Low	Section 5.5.3 Section 6.2
Light	2	2	**Low**	Light emitted from the proposed mine could have a small effect on any transitory rock-wallabies moving through the mine site footprint. It is **unlikely** that light emitted from the proposed mine would have **minor** impacts only to rock-wallaby populations =/> 2 km from the proposed mine site such that the area of occupancy is affected.	• Refer to Section 6.4. • As mentioned in the mitigation measures section of the report, avoiding unnecessary lighting at night when rock-wallabies are active and keeping lighting low and directed at operations rather than surrounding habitat will assist greatly in mitigating impacts. • Produce and apply dedicated BMP and ensure appropriate lighting controls are in place in an attempt to minimize and mitigate artificial light effects on the Black-footed Rock-wallaby population of the area.	**Low**	Section 5.5.4 Section 6.4
Unplanned Wildfire	3	4	**High**	It is **possible** that extensive unplanned wildfire as a result of mine activities may have a **major** impact on the area of occupancy of Black-footed Rock-wallaby population. The July 2015 baseline surveys did not record any fresh rock-wallaby scat where recent fires had occurred.	• Refer to Section 6.5. • A separate Bushfire Management Plan will be required to manage this risk; • Produce and apply dedicated BMP and ensure appropriate wildfire controls are in place in an attempt to minimize and mitigate the potential 'High' impacts on the Black-footed Rock-wallaby population of the area. • As part of BMP incorporate a monitoring program for Black-footed Rock-wallaby using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor possible impacts of fire (would include naturally occurring fire in addition).	**Medium**	Section 5.5.5 Section 6.5

Exotic plants and animals	3	4	**High**	It is **possible** that the introduction of exotic plants and animals as a result of mine activities may have a **major** impact on the area of occupancy of the Black-footed Rock-wallaby population. An increase in the incidence of cats, foxes and potentially dingoes could result in increased rock-wallaby predation, particularly of more vulnerable juveniles. An increase in the incidence of Buffel Grass could have serious implications for rock-wallaby habitat.	• Refer to Section 6.6. • Various design aspects will need to be considered for the mine such as a predator-proof compound to contain food waste. • Produce and apply dedicated BMP and ensure appropriate controls are in place to minimize and mitigate the potential 'High' impacts of exotic plants and animals on the Black-footed Rock-wallaby population of the area. • As part of BMP incorporate a monitoring program for Black-footed Rock-wallaby using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor possible impacts of exotic plants and animals on the population. Part of this monitoring would include an assessment of the abundance of exotic/native predators.	**Low**	Section 5.5.6 Section 6.6
Waste water	1	1	**Low**	It is predicted that it is **rare** that the Weak Acid Dissociable (WAD) cyanide in onsite water storage facilities may be at levels sufficient to cause wildlife mortality and that there may be **insignificant** impacts from ingestion by Black-footed Rock-wallaby. There is an extremely low likelihood that rock-wallabies would descend from their rocky habitats to drink from tailings facilities.	• Refer to Section 6.7. • Avoid the possibility by maintaining WADCN levels below levels poisonous to wildlife, and prevent wildlife access to new tailings dams. • Produce and apply a Water Quality Monitoring and Management Plan. A Tailings Dam Wildlife Monitoring Program would be incorporated into a BMP and would be more broadly directed at fauna in general rather than rock-wallabies.	**Low**	Section 5.5.8 Section 6.7
Lowering or contamination of water table	1	1	**Low**	It is predicted that it is **rare** that the lowering of the water table or contamination would have **insignificant** impacts on the Black-footed Rock-wallaby area of occupancy such that it would decrease over time. There is an extremely low likelihood that the rock-wallaby population would be adversely impacted by water table draw-downs or water table contamination as they are not dependent on GDEs or standing water.	• Refer to Section 6.8.	**Low**	Section 5.5.9 Section 6.8
Traffic mortality	1	1	**Low**	It is predicted that it is **rare** that there will be some mortality from collisions with vehicles due to increased traffic that may have a **minor** impact on the Black-footed Rock-wallaby area of occupancy.	• Refer to Section 6.9. • Produce and apply a Traffic and Road Safety Management Plan, a Weed Hygiene Procedure and provision of on-site wash down facilities. Aspects of these will be incorporated into a BMP.	**Low**	Section 5.5.10 Section 6.9

Fragment an existing important population into two or more populations							
Clearing – dispersal and foraging habitat	2	2	**Low**	A loss of 234.64 ha of known (low quality) foraging and dispersal habitat. This equates to broadly 0.36% of the 65,000 ha of potential habitat within the 150,000 ha search area from the July 2015 survey. This suggests that it is **unlikely** that the planned removal of 'transitory' habitat for black-footed rock-wallaby may result in a **minor** impact to habitat connectivity between two or more populations.	• Minimise impact via actions in Section 6.1. • Produce and apply dedicated Biodiversity Management Plan (BMP) and ensure appropriate construction, weed, weed hygiene, fire and rehabilitation management aspects are covered in an attempt to minimize and mitigate clearing effects on the Black-footed Rock-wallaby population of the area. • As part of BMP incorporate a monitoring program for Black-footed Rock-wallaby using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor the impact that clearing has on the local population.	**Low**	Section 5.5.1 Section 6.1
Dust	2	2	Low	Dust emitted from the proposed mine could have a small effect on any transitory rock-wallabies moving through the mine site footprint. The GHD 2016 Air Quality report indicates that PM10 concentrations well below 50 ug/m^3 only are likely to still be in excess of 1 km from known Rock Wallaby habitat. It is **unlikely** that dust emitted from the proposed mine would have **minor** impacts only to rock-wallaby populations =/> 2 km from the proposed mine site such that populations suffer a long-term decrease in size.	• Refer to Section 6.2. • The minimisation of dust emission controls as defined in a Dust Management Plan. • Produce and apply dedicated BMP and ensure appropriate dust controls are in place in an attempt to minimize and mitigate dust effects on the Black-footed Rock-wallaby population of the area. • As part of BMP incorporate a monitoring program for Black-footed Rock-wallaby using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor the impact that dust has on the local population.	Low	Section 5.5.2 Section 6.2
Noise	2	2	Low	Noise emitted from the proposed mine could have a small effect on any transitory rock-wallabies moving through the mine site footprint. The GHD 2016 Noise and Vibration report indicates that at a distance of 2 km (closest known rock-wallaby populations to mine site) most noise will be in the order of 27-43 dB(A), which seems approximately in-line with noise levels of 30-35 dB(A) at nearby residential receivers. It is **unlikely** that noise emitted from the proposed mine would have **minor** impacts only to rock-wallaby populations =/> 2 km from the proposed mine site such that populations suffer a long-term decrease in size. It should be noted that blasting results in noise levels of approx. 115 dB(A), which could potentially negatively impact on rock-wallaby behavior. It is recommended that blasting occur during the day only when rock-wallabies are inactive.	• Refer to Section 6.3. • The implementation of noise controls as defined in a Noise Management Plan – likely to include the avoidance of loud noise (e.g. blasting) at night when rock-wallabies are active. • Produce and apply dedicated BMP and ensure appropriate noise controls are in place in an attempt to minimize and mitigate noise effects on the Black-footed Rock-wallaby population of the area. • As part of BMP incorporate a monitoring program for Black-footed Rock-wallaby using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor the impact that noise has on the local population.	Low	Section 5.5.3 Section 6.2
Light	2	2	**Low**	Light emitted from the proposed mine could have a small effect on any transitory rock-wallabies moving through the mine site footprint. It is **unlikely** that light emitted from the proposed mine would have **minor** impacts only to rock-wallaby populations =/> 2 km from the proposed mine site such that populations become fragmented.	• Refer to Section 6.4. • As mentioned in the mitigation measures section of the report, avoiding unnecessary lighting at night when rock-wallabies are active and keeping lighting low and directed at operations rather than surrounding habitat will assist greatly in mitigating impacts. • Produce and apply dedicated BMP and ensure appropriate lighting controls are in place in an attempt to minimize and mitigate artificial light effects on the Black-footed Rock-wallaby population of the area.	**Low**	Section 5.5.4 Section 6.4

Unplanned Wildfire	3	4	**High**	It is **possible** that extensive unplanned wildfire as a result of mine activities may have a **major** impact on the long-term size of the Black-footed Rock-wallaby population such that the population could be fragmented. The July 2015 baseline surveys did not record any fresh rock-wallaby scat where recent fires had occurred.	• Refer to Section 6.5. • A separate Bushfire Management Plan will be required to manage this risk. • Produce and apply dedicated BMP and ensure appropriate wildfire controls are in place in an attempt to minimize and mitigate the potential 'High' impacts on the Black-footed Rock-wallaby population of the area. • As part of BMP incorporate a monitoring program for Black-footed Rock-wallaby using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor possible impacts of fire (would include naturally occurring fire in addition).	**Medium**	Section 5.5.5 Section 6.5
Exotic plants and animals	3	4	**High**	It is **possible** that the introduction of exotic plants and animals as a result of mine activities may have a **major** impact on the Black-footed Rock-wallaby population such that fragmentation could occur. An increase in the incidence of cats, foxes and potentially dingoes could result in increased rock-wallaby predation, particularly of more vulnerable juveniles. An increase in the incidence of Buffel Grass could have serious implications for rock-wallaby habitat.	• Refer to Section 6.6. • Various design aspects will need to be considered for the mine such as a predator-proof compound to contain food waste. • Produce and apply dedicated BMP and ensure appropriate controls are in place to minimize and mitigate the potential 'High' impacts of exotic plants and animals on the Black-footed Rock-wallaby population of the area. • As part of BMP incorporate a monitoring program for Black-footed Rock-wallaby using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor possible impacts of exotic plants and animals on the population. Part of this monitoring would include an assessment of the abundance of exotic/native predators.	**Low**	Section 5.5.6 Section 6.6
Waste water	1	1	**Low**	It is predicted that it is **rare** that the Weak Acid Dissociable (WAD) cyanide in onsite water storage facilities may be at levels sufficient to cause wildlife mortality and that there may be **insignificant** impacts from ingestion by Black-footed Rock-wallaby. There is an extremely low likelihood that rock-wallabies would descend from their rocky habitats to drink from tailings facilities. It is highly unlikely that this would lead to fragmentation of a population.	• Refer to Section 6.7. • Avoid the possibility by maintaining WADCN levels below levels poisonous to wildlife, and prevent wildlife access to new tailings dams. • Produce and apply a Water Quality Monitoring and Management Plan. A Tailings Dam Wildlife Monitoring Program would be incorporated into a BMP and would be more broadly directed at fauna in general rather than rock-wallabies.	**Low**	Section 5.5.8 Section 6.7
Lowering or contamination of water table	1	1	**Low**	It is predicted that it is **rare** that the lowering of the water table or contamination would have **insignificant** impacts on the Black-footed Rock-wallaby population such that it would become fragmented. There is an extremely low likelihood that the rock-wallaby population would be adversely impacted by water table draw-downs or water table contamination as they are not dependent on GDEs or standing water.	• Refer to Section 6.8.	**Low**	Section 5.5.9 Section 6.8
Traffic mortality	1	1	**Low**	It is predicted that it is **rare** that there will be some mortality from collisions with vehicles due to increased traffic that may have a **minor** impact on the Black-footed Rock-wallaby populations such that they become fragmented.	• Refer to Section 6.9 • Produce and apply a Traffic and Road Safety Management Plan, a Weed Hygiene Procedure and provision of on-site wash down facilities. Aspects of these will be incorporated into a BMP.	**Low**	Section 5.5.10 Section 6.9

Adversely affect habitat critical to the survival of a species							
Clearing – dispersal and foraging habitat	2	1	**Low**	A loss of 234.64 ha of known (low quality) foraging and dispersal habitat. This equates to broadly 0.36% of the 65,000 ha of potential habitat within the 150,000 ha search area from the July 2015 survey. This suggests that it is **unlikely** that the planned removal of 'transitory' habitat for Black-footed Rock-wallaby may result in **insignificant** impact to habitat critical to the survival of the Black-footed Rock-wallaby.	• Minimise impact via actions in Section 6.1. • Produce and apply dedicated Biodiversity Management Plan (BMP) and ensure appropriate construction, weed, weed hygiene, fire and rehabilitation management aspects are covered in an attempt to minimize and mitigate clearing effects on the Black-footed Rock-wallaby population of the area. • As part of BMP incorporate a monitoring program for Black-footed Rock-wallaby using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor the impact that clearing has on the local population.	**Low**	Section 5.5.1 Section 6.1
Dust	2	2	Low	Dust emitted from the proposed mine could have a small effect on any transitory rock-wallabies moving through the mine site footprint. The GHD 2016 Air Quality report indicates that PM10 concentrations well below 50 ug/m^3 only are likely to still be in excess of 1 km from known Rock Wallaby habitat. It is **unlikely** that dust emitted from the proposed mine would have **minor** impacts only to critical habitat for rock-wallaby populations =/> 2 km from the proposed mine site such that populations suffer a long-term decrease in size.	• Refer to Section 6.2. • The minimisation of dust emission controls as defined in a Dust Management Plan. • Produce and apply dedicated BMP and ensure appropriate dust controls are in place in an attempt to minimize and mitigate dust effects on the Black-footed Rock-wallaby population of the area. • As part of BMP incorporate a monitoring program for Black-footed Rock-wallaby using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor the impact that dust has on the local population.	Low	Section 5.5.2 Section 6.2
Noise	2	2	Low	Noise emitted from the proposed mine could have a small effect on any transitory rock-wallabies moving through the mine site footprint. The GHD 2016 Noise and Vibration report indicates that at a distance of 2 km (closest known rock-wallaby populations to mine site) most noise will be in the order of 27-43 dB(A), which seems approximately in-line with noise levels of 30-35 dB(A) at nearby residential receivers. It is **unlikely** that noise emitted from the proposed mine would have **minor** impacts only to critical habitat for rock-wallaby populations =/> 2 km from the proposed mine site such that populations suffer a long-term decrease in size. It should be noted that blasting results in noise levels of approx. 115 dB(A), which could potentially negatively impact on rock-wallaby behavior. It is recommended that blasting occur during the day only when rock-wallabies are inactive.	• Refer to Section 6.3. • The implementation of noise controls as defined in a Noise Management Plan – likely to include the avoidance of loud noise (e.g. blasting) at night when rock-wallabies are active. • Produce and apply dedicated BMP and ensure appropriate noise controls are in place in an attempt to minimize and mitigate noise effects on the Black-footed Rock-wallaby population of the area. • As part of BMP incorporate a monitoring program for Black-footed Rock-wallaby using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor the impact that noise has on the local population.	Low	Section 5.5.3 Section 6.2
Light	2	1	**Low**	Light emitted from the proposed mine could have a small effect on any transitory rock-wallabies moving through the mine site footprint. It is **unlikely** that light emitted from the proposed mine would have **insignificant** impacts only to habitat critical to the survival of rock-wallaby populations =/> 2 km from the proposed mine site such that habitat critical to the survival of this species is adversely impacted.	• Refer to Section 6.4. • As mentioned in the mitigation measures section of the report, avoiding unnecessary lighting at night when rock-wallabies are active and keeping lighting low and directed at operations rather than surrounding habitat will assist greatly in mitigating impacts. • Produce and apply dedicated BMP and ensure appropriate lighting controls are in place in an attempt to minimize and mitigate artificial light effects on the Black-footed Rock-wallaby population of the area.	**Low**	Section 5.5.4 Section 6.4
Unplanned Wildfire	3	4	**High**	It is **possible** that extensive unplanned wildfire as a result of mine activities may have a **major** impact on habitat critical to the Black-footed Rock-wallaby population (i.e. foraging and breeding habitat =/> 2 km from the mine site). The July 2015 baseline surveys did not record any fresh rock-wallaby scat where recent fires had occurred.	• Refer to Section 6.5. • A separate Bushfire Management Plan will be required to manage this risk. • Produce and apply dedicated BMP and ensure appropriate wildfire controls are in place in an attempt to minimize and mitigate the potential 'High' impacts on the Black-footed Rock-wallaby population of the area. • As part of BMP incorporate a monitoring program for Black-footed Rock-wallaby using the recent July 2015 survey as baseline data (see Section XX) to monitor possible impacts of fire (would include naturally occurring fire in addition).	**Medium**	Section 5.5.5 Section 6.5

Exotic plants and animals	3	4	**High**	It is **possible** that the introduction of exotic plants and animals as a result of mine activities may have a **major** impact on habitat critical to the survival of the Black-footed Rock-wallaby population (i.e. foraging and breeding habitat =/> 2 km from the mine site). An increase in the incidence of cats, foxes and potentially dingoes could result in increased rock-wallaby predation, particularly of more vulnerable juveniles. An increase in the incidence of Buffel Grass could have serious implications for rock-wallaby habitat.	• Refer to Section 6.6. • Various design aspects will need to be considered for the mine such as a predator-proof compound to contain food waste. • Produce and apply dedicated BMP and ensure appropriate controls are in place to minimize and mitigate the potential 'High' impacts of exotic plants and animals on the Black-footed Rock-wallaby population of the area. • As part of BMP incorporate a monitoring program for Black-footed Rock-wallaby using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor possible impacts of exotic plants and animals on the population. Part of this monitoring would include an assessment of the abundance of exotic/native predators.	**Low**	Section 5.5.6 Section 6.6
Waste water				No effect is predicted	• Not applicable.		
Lowering or contamination of water table				No effect is predicted	• Not applicable.		
Traffic mortality				No effect is predicted	• Not applicable.		
Disrupt the breeding cycle of a population							
Clearing – dispersal and foraging habitat	2	1	**Low**	A loss of 234.64 ha of known (low quality) foraging and dispersal habitat. This equates to broadly 0.36% of the 65,000 ha of potential habitat within the 150,000 ha search area from the July 2015 survey. This suggests that it is **unlikely** that the planned removal of 'transitory' habitat for Black-footed Rock-wallaby may result in a **minor** impact to the breeding cycle of the Black-footed Rock-wallaby.	• Minimise impact via actions in Section 6.1. • Produce and apply dedicated Biodiversity Management Plan (BMP) and ensure appropriate construction, weed, weed hygiene, fire and rehabilitation management aspects are covered in an attempt to minimize and mitigate clearing effects on the Black-footed Rock-wallaby breeding cycle. • As part of BMP incorporate a monitoring program for Black-footed Rock-wallaby using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor the impact that clearing has on the breeding cycle of the population.	**Low**	Section 5.5.1 Section 6.1
Dust	2	2	Low	Dust emitted from the proposed mine could have a small effect on any transitory rock-wallabies moving through the mine site footprint. The GHD 2016 Air Quality report indicates that PM10 concentrations well below 50 ug/m^3 only are likely to still be in excess of 1 km from known Rock Wallaby habitat. It is **unlikely** that dust emitted from the proposed mine would have **minor** impacts only to rock-wallaby populations =/> 2 km from the proposed mine site such that populations suffer a long-term decrease in size.	• Refer to Section 6.2. • The minimisation of dust emission controls as defined in a Dust Management Plan. • Produce and apply dedicated BMP and ensure appropriate dust controls are in place in an attempt to minimize and mitigate dust effects on the Black-footed Rock-wallaby population of the area. • As part of BMP incorporate a monitoring program for Black-footed Rock-wallaby using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor the impact that dust has on the local population.	Low	Section 5.5.2 Section 6.2

Noise	2	2	Low	Noise emitted from the proposed mine could have a small effect on any transitory rock-wallabies moving through the mine site footprint. The GHD 2016 Noise and Vibration report indicates that at a distance of 2 km (closest known rock-wallaby populations to mine site) most noise will be in the order of 27-43 dB(A), which seems approximately in-line with noise levels of 30-35 dB(A) at nearby residential receivers. It is **unlikely** that noise emitted from the proposed mine would have **minor** impacts only to the rock-wallaby breeding cycle for populations =/> 2 km from the proposed mine site. It should be noted that blasting results in noise levels of approx. 115 dB(A), which could potentially negatively impact on rock-wallaby behavior. It is recommended that blasting occur during the day only when rock-wallabies are inactive.	• Refer to Section 6.3. • The implementation of noise controls as defined in a Noise Management Plan – likely to include the avoidance of loud noise (e.g. blasting) at night when rock-wallabies are active. • Produce and apply dedicated BMP and ensure appropriate noise controls are in place in an attempt to minimize and mitigate noise effects on the Black-footed Rock-wallaby population of the area. • As part of BMP incorporate a monitoring program for Black-footed Rock-wallaby using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor the impact that noise has on the local population.	Low	Section 5.5.3 Section 6.2
Light	2	2	**Low**	Light emitted from the proposed mine could have a small effect on any transitory rock-wallabies moving through the mine site footprint. It is **unlikely** that light emitted from the proposed mine would have **minor** impacts only to the breeding cycle of rock-wallaby populations =/> 2 km from the proposed mine site such that the breeding cycle of this species is adversely impacted.	• Refer to Section 6.4. • As mentioned in the mitigation measures section of the report, avoiding unnecessary lighting at night when rock-wallabies are active and keeping lighting low and directed at operations rather than surrounding habitat will assist greatly in mitigating impacts. • Produce and apply dedicated BMP and ensure appropriate lighting controls are in place in an attempt to minimize and mitigate artificial light effects on the Black-footed Rock-wallaby population of the area.	**Low**	Section 5.5.4 Section 6.4
Unplanned Wildfire	3	4	**High**	It is **possible** that extensive unplanned wildfire as a result of mine activities may have a **major** impact on the breeding cycle the Black-footed Rock-wallaby population (i.e. foraging and breeding habitat =/> 2 km from the mine site). The July 2015 baseline surveys did not record any juvenile rock-wallaby scat where recent fires had occurred.	• Refer to Section 6.5 • A separate Bushfire Management Plan will be required to manage this risk. • Produce and apply dedicated BMP and ensure appropriate wildfire controls are in place in an attempt to minimize and mitigate the potential 'High' impacts on the Black-footed Rock-wallaby population of the area. • As part of BMP incorporate a monitoring program for Black-footed Rock-wallaby using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor possible impacts of fire (would include naturally occurring fire in addition).	**Medium**	Section 5.5.5 Section 6.5
Exotic plants and animals	3	4	**High**	It is **possible** that the introduction of exotic plants and animals as a result of mine activities may have a **major** impact on the breeding cycle of the Black-footed Rock-wallaby population (i.e. foraging and breeding habitat =/> 2 km from the mine site). An increase in the incidence of cats, foxes and potentially dingoes could result in increased rock-wallaby predation, particularly of more vulnerable juveniles. An increase in the incidence of Buffel Grass could have serious implications for rock-wallaby habitat.	• Refer to Section 6.6. • Various design aspects will need to be considered for the mine such as a predator-proof compound to contain food waste. • Produce and apply dedicated BMP and ensure appropriate controls are in place to minimize and mitigate the potential 'High' impacts of exotic plants and animals on the Black-footed Rock-wallaby population of the area. • As part of BMP incorporate a monitoring program for Black-footed Rock-wallaby using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor possible impacts of exotic plants and animals on the population. Part of this monitoring would include an assessment of the abundance of exotic/native predators.	**Low**	Section 5.5.6 Section 6.6
Waste water				No effect is predicted	• Not applicable.		
Lowering or contamination of water table				No effect is predicted	• Not applicable.		
Traffic mortality				No effect is predicted	• Not applicable.		

Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline								
Clearing – dispersal and foraging habitat	2	2	**Low**	A loss of 234.64 ha of known (low quality) foraging and dispersal habitat. This equates to broadly 0.36% of the 65,000 ha of potential habitat within the 150,000 ha search area from the July 2015 survey. This suggests that it is **unlikely** that the planned removal of 'transitory' habitat for Black-footed Rock-wallaby may result in a **minor** impact such that the species is likely to decline.	• Minimise impact via actions in Section 6.1. • Produce and apply dedicated Biodiversity Management Plan (BMP) and ensure appropriate construction, weed, weed hygiene, fire and rehabilitation management aspects are covered in an attempt to minimize and mitigate clearing effects on the Black-footed Rock-wallaby population. • As part of BMP incorporate a monitoring program for Black-footed Rock-wallaby using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor the impact that clearing has on the population.	**Low**	Section 5.5.1 Section 6.1
Dust	2	2	Low	Dust emitted from the proposed mine could have a small effect on any transitory rock-wallabies moving through the mine site footprint. The GHD 2016 Air Quality report indicates that PM10 concentrations well below 50 ug/m^3 only are likely to still be in excess of 1 km from known Rock Wallaby habitat. It is **unlikely** that dust emitted from the proposed mine would have **minor** impacts only to for rock-wallaby populations =/> 2 km from the proposed mine site such the species is likely to decline.	• Refer to Section 6.2. • The minimisation of dust emission controls as defined in a Dust Management Plan. • Produce and apply dedicated BMP and ensure appropriate dust controls are in place in an attempt to minimize and mitigate dust effects on the Black-footed Rock-wallaby population of the area. • As part of BMP incorporate a monitoring program for Black-footed Rock-wallaby using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor the impact that dust has on the local population.	Low	Section 5.5.2 Section 6.2
Noise	2	2	Low	Noise emitted from the proposed mine could have a small effect on any transitory rock-wallabies moving through the mine site footprint. The GHD 2016 Noise and Vibration report indicates that at a distance of 2 km (closest known rock-wallaby populations to mine site) most noise will be in the order of 27-43 dB(A), which seems approximately in-line with noise levels of 30-35 dB(A) at nearby residential receivers. It is **unlikely** that noise emitted from the proposed mine would have **minor** impacts to rock-wallaby populations =/> 2 km from the proposed mine site such that populations decline. It should be noted that blasting results in noise levels of approx. 115 dB(A), which could potentially negatively impact on rock-wallaby behavior. It is recommended that blasting occur during the day only when rock-wallabies are inactive.	• Refer to Section 6.3. • The implementation of noise controls as defined in a Noise Management Plan – likely to include the avoidance of loud noise (e.g. blasting) at night when rock-wallabies are active. • Produce and apply dedicated BMP and ensure appropriate noise controls are in place in an attempt to minimize and mitigate noise effects on the Black-footed Rock-wallaby population of the area. • As part of BMP incorporate a monitoring program for Black-footed Rock-wallaby using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor the impact that noise has on the local population.	Low	Section 5.5.3 Section 6.2
Light	2	1	**Low**	Light emitted from the proposed mine could have a small effect on any transitory rock-wallabies moving through the mine site footprint. It is **unlikely** that light emitted from the proposed mine would have **insignificant** impacts only to the rock-wallaby populations =/> 2 km from the proposed mine site such that the species is likely to decline.	• Refer to Section 6.4. • As mentioned in the mitigation measures section of the report, avoiding unnecessary lighting at night when rock-wallabies are active and keeping lighting low and directed at operations rather than surrounding habitat will assist greatly in mitigating impacts. • Produce and apply dedicated BMP and ensure appropriate lighting controls are in place in an attempt to minimize and mitigate artificial light effects on the Black-footed Rock-wallaby population of the area.	**Low**	Section 5.5.4 Section 6.4

Unplanned Wildfire	3	4	**High**	It is **possible** that extensive unplanned wildlfire as a result of mine activities may have a **major** impact on the Black-footed Rock-wallaby population (i.e. foraging and breeding habitat =/> 2 km from the mine site). The July 2015 baseline surveys did not record any fresh and juvenile rock-wallaby scat where recent fires had occurred. As such, there is potential for the species to decline due to wildfire due to impacts to habitat.	• Refer to Section 6.5. • A separate Bushfire Management Plan will be required to manage this risk. • Produce and apply dedicated BMP and ensure appropriate wildfire controls are in place in an attempt to minimize and mitigate the potential 'High' impacts on the Black-footed Rock-wallaby population of the area. • As part of BMP incorporate a monitoring program for Black-footed Rock-wallaby using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor possible impacts of fire (would include naturally occurring fire in addition).	**Medium**	Section 5.5.5 Section 6.5
Exotic plants and animals	3	4	**High**	It is **possible** that the introduction of exotic plants and animals as a result of mine activities may have a **major** impact on the Black-footed Rock-wallaby population (i.e. foraging and breeding habitat =/> 2 km from the mine site). An increase in the incidence of cats, foxes and potentially dingoes could result in increased rock-wallaby predation, particularly of more vulnerable juveniles. An increase in the incidence of Buffel Grass could have serious implications for rock-wallaby habitat. The impacts described may result in a reduction in habitat quality and availability such that the population declines.	• Refer to Section 6.6. • Various design aspects will need to be considered for the mine such as a predator-proof compound to contain food waste. • Produce and apply dedicated BMP and ensure appropriate controls are in place to minimize and mitigate the potential 'High' impacts of exotic plants and animals on the Black-footed Rock-wallaby population of the area. • As part of BMP incorporate a monitoring program for Black-footed Rock-wallaby using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor possible impacts of exotic plants and animals on the population. Part of this monitoring would include an assessment of the abundance of exotic/native predators.	**Low**	Section 5.5.6 Section 6.6
Waste water				No effect is predicted	• Not applicable.		
Lowering or contamination of water table				No effect is predicted	• Not applicable.		
Traffic mortality				No effect is predicted	• Not applicable.		
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat							
Clearing – dispersal and foraging habitat	2	2	**Low**	A loss of 234.64 ha of known (low quality) foraging and dispersal habitat. This equates to broadly 0.36% of the 65,000 ha of potential habitat within the 150,000 ha search area from the July 2015 survey. This suggests that it is **unlikely** that the planned removal of 'transitory' habitat for black-footed rock-wallaby may result in a **minor** impact which includes the introduction of invasive species.	• Minimise impact via actions in Section 6.1. • Produce and apply dedicated Biodiversity Management Plan (BMP) and ensure appropriate construction, weed, weed hygiene, fire and rehabilitation management aspects are covered in an attempt to minimize and mitigate clearing effects on the Black-footed Rock-wallaby population of the area. • As part of BMP incorporate a monitoring program for Black-footed Rock-wallaby using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor the impact that clearing has on the local population.	**Low**	Section 5.5.1 Section 6.1
Dust				No effect is predicted	• Not applicable.		
Noise				No effect is predicted	• Not applicable.		
Light				No effect is predicted	• Not applicable. .		

Unplanned Wildfire	2	3	**Medium**	It is **unlikely** that extensive unplanned wildfire as a result of mine activities may have a **moderate** impact on the Black-footed Rock-wallaby population such that invasive species are introduced. It is possible that fire could open up habitats for invasion by feral cats/foxes however.	• Refer to Section 6.5. • A separate Bushfire Management Plan will be required to manage this risk. • Produce and apply dedicated BMP and ensure appropriate wildfire controls are in place in an attempt to minimize and mitigate the potential 'High' impacts on the Black-footed Rock-wallaby population of the area. • As part of BMP incorporate a monitoring program for Black-footed Rock-wallaby using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor possible impacts of fire (would include naturally occurring fire in addition).	**Low**	Section 5.5.5 Section 6.5
Exotic plants and animals	3	4	**High**	It is **possible** that the introduction of exotic plants and animals as a result of mine activities may have a **major** impact on the long-term size of the Black-footed Rock-wallaby population. An increase in the incidence of cats, foxes and potentially dingoes could result in increased rock-wallaby predation, particularly of more vulnerable juveniles. An increase in the incidence of Buffel Grass could have serious implications for rock-wallaby habitat.	• Refer to Section 6.6 • Various design aspects will need to be considered for the mine such as a predator-proof compound to contain food waste. • Produce and apply dedicated BMP and ensure appropriate controls are in place to minimize and mitigate the potential 'High' impacts of exotic plants and animals on the Black-footed Rock-wallaby population of the area. • As part of BMP incorporate a monitoring program for Black-footed Rock-wallaby using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor possible impacts of exotic plants and animals on the population. Part of this monitoring would include an assessment of the abundance of exotic/native predators.	**Low**	Section 5.5.6 Section 6.6
Waste water				No effect is predicted	• Not applicable.		
Lowering or contamination of water table				No effect is predicted	• Not applicable.		
Traffic mortality				No effect is predicted	• Not applicable.		
Introduce disease that may cause the species to decline							
Clearing – dispersal and foraging habitat	1	1	**Low**	A loss of 234.64 ha of known (low quality) foraging and dispersal habitat. This equates to broadly 0.36% of the 65,000 ha of potential habitat within the 150,000 ha search area from the July 2015 survey. This suggests that it is **rare** that the planned removal of 'transitory' habitat for black-footed rock-wallaby may result in an **insignificant** impact to the population via the introduction of disease.	• Minimise impact via actions in Section 6.1. • Produce and apply dedicated Biodiversity Management Plan (BMP) and ensure appropriate construction, weed, weed hygiene, fire and rehabilitation management aspects are covered in an attempt to minimize and mitigate clearing effects on the Black-footed Rock-wallaby population of the area. • As part of BMP incorporate a monitoring program for Black-footed Rock-wallaby using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor the impact that clearing has on the local population.	**Low**	Section 5.5.1 Section 6.1
Dust				No effect is predicted	• Not applicable.		
Noise				No effect is predicted	• Not applicable.		
Light				No effect is predicted	• Not applicable.		

Unplanned Wildfire	1	1	**Low**	It is **rare** that extensive unplanned wildfire as a result of mine activities may have an **insignificant** impact on the Black-footed Rock-wallaby population such that the population is exposed to disease.	• Refer to Section 6.5. • A separate Bushfire Management Plan will be required to manage this risk. • Produce and apply dedicated BMP and ensure appropriate wildfire controls are in place in an attempt to minimize and mitigate the potential 'High' impacts on the Black-footed Rock-wallaby population of the area. • As part of BMP incorporate a monitoring program for Black-footed Rock-wallaby using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor possible impacts of fire (would include naturally occurring fire in addition).	**Low**	Section 5.5.5 Section 6.5
Exotic plants and animals	1	1	**Low**	It is **rare** that the introduction of exotic plants and animals as a result of mine activities may have an **insignificant** impact on the Black-footed Rock-wallaby population. It is highly unlikely that disease would be introduced to the population even by exotic predators.	• Refer to Section 6.6. • Various design aspects will need to be considered for the mine such as a predator-proof compound to contain food waste. • Produce and apply dedicated BMP and ensure appropriate controls are in place to minimize and mitigate the potential 'High' impacts of exotic plants and animals on the Black-footed Rock-wallaby population of the area. • As part of BMP incorporate a monitoring program for Black-footed Rock-wallaby using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor possible impacts of exotic plants and animals on the population. Part of this monitoring would include an assessment of the abundance of exotic/native predators.	**Low**	Section 5.5.6 Section 6.6
Waste water				No effect is predicted	• Not applicable.		
Lowering or contamination of water table				No effect is predicted	• Not applicable.		
Traffic mortality				No effect is predicted	• Not applicable.		
Interfere substantially with the recovery of the species							
Clearing – dispersal and foraging habitat	2	2	**Low**	A loss of 234.64 ha of known (low quality) foraging and dispersal habitat. This equates to broadly 0.36% of the 65,000 ha of potential habitat within the 150,000 ha search area from the July 2015 survey. This suggests that it is **rare** that the planned removal of 'transitory' habitat for Black-footed Rock-wallaby may result in a **minor** impact to the extent that it interferes with the recovery of the species.	• Minimise impact via actions in Section 6.1. • Produce and apply dedicated Biodiversity Management Plan (BMP) and ensure appropriate construction, weed, weed hygiene, fire and rehabilitation management aspects are covered in an attempt to minimize and mitigate clearing effects on the Black-footed Rock-wallaby population. • As part of BMP incorporate a monitoring program for Black-footed Rock-wallaby using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor the impact that clearing has on the population.	**Low**	Section 5.5.1 Section 6.1

Dust	2	2	Low	Dust emitted from the proposed mine could have a small effect on any transitory rock-wallabies moving through the mine site footprint. The GHD 2016 Air Quality report indicates that PM10 concentrations well below 50 ug/m^3 only are likely to still be in excess of 1 km from known Rock Wallaby habitat. It is **unlikely** that dust emitted from the proposed mine would have **minor** impacts only to rock-wallaby species recovery.	• Refer to Section 6.2. • The minimisation of dust emission controls as defined in a Dust Management Plan. • Produce and apply dedicated BMP and ensure appropriate dust controls are in place in an attempt to minimize and mitigate dust effects on the Black-footed Rock-wallaby population of the area. • As part of BMP incorporate a monitoring program for Black-footed Rock-wallaby using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor the impact that dust has on the local population.	Low	Section 5.5.2 Section 6.2
Noise	2	2	Low	Noise emitted from the proposed mine could have a small effect on any transitory rock-wallabies moving through the mine site footprint. The GHD 2016 Noise and Vibration report indicates that at a distance of 2 km (closest known rock-wallaby populations to mine site) most noise will be in the order of 27-43 dB(A), which seems approximately in-line with noise levels of 30-35 dB(A) at nearby residential receivers. It is **unlikely** that noise emitted from the proposed mine would have **minor** impacts to rock-wallaby species recovery. It should be noted that blasting results in noise levels of approx. 115 dB(A), which could potentially negatively impact on rock-wallaby behavior. It is recommended that blasting occur during the day only when rock-wallabies are inactive.	• Refer to Section 6.3. • The implementation of noise controls as defined in a Noise Management Plan – likely to include the avoidance of loud noise (e.g. blasting) at night when rock-wallabies are active. • Produce and apply dedicated BMP and ensure appropriate noise controls are in place in an attempt to minimize and mitigate noise effects on the Black-footed Rock-wallaby population of the area. • As part of BMP incorporate a monitoring program for Black-footed Rock-wallaby using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor the impact that noise has on the local population.	Low	Section 5.5.3 Section 6.2
Light	2	1	**Low**	Light emitted from the proposed mine could have a small effect on any transitory rock-wallabies moving through the mine site footprint. It is **rare** that light emitted from the proposed mine would have **insignificant** impacts only to the rock-wallaby populations =/> 2 km from the proposed mine site such that this would impact on the species ability to recover.	• Refer to Section 6.4. • As mentioned in the mitigation measures section of the report, avoiding unnecessary lighting at night when rock-wallabies are active and keeping lighting low and directed at operations rather than surrounding habitat will assist greatly in mitigating impacts. • Produce and apply dedicated BMP and ensure appropriate lighting controls are in place in an attempt to minimize and mitigate artificial light effects on the Black-footed Rock-wallaby population of the area.	**Low**	Section 5.5.4 Section 6.4
Unplanned Wildfire	3	4	**High**	It is **possible** that extensive unplanned wildfire as a result of mine activities may have a **major** impact on the Black-footed Rock-wallaby population (i.e. foraging and breeding habitat =/> 2 km from the mine site) and hence recovery. The July 2015 baseline surveys did not record any fresh and juvenile rock-wallaby scat where recent fires had occurred.	• Refer to Section 6.5. • A separate Bushfire Management Plan will be required to manage this risk. • Produce and apply dedicated BMP and ensure appropriate wildfire controls are in place in an attempt to minimize and mitigate the potential 'High' impacts on the Black-footed Rock-wallaby population of the area. • As part of BMP incorporate a monitoring program for Black-footed Rock-wallaby using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor possible impacts of fire (would include naturally occurring fire in addition).	**Medium**	Section 5.5.5 Section 6.5

Exotic plants and animals	3	4	**High**	It is **possible** that the introduction of exotic plants and animals as a result of mine activities may have a **major** impact on the Black-footed Rock-wallaby population (i.e. foraging and breeding habitat =/> 2 km from the mine site) and hence recovery. An increase in the incidence of cats, foxes and potentially dingoes could result in increased rock-wallaby predation, particularly of more vulnerable juveniles. An increase in the incidence of Buffel Grass could have serious implications for rock-wallaby habitat. The impacts described may result in a reduction in habitat quality and availability such that the population declines.	• Refer to Section 6.6. • Various design aspects will need to be considered for the mine such as a predator-proof compound to contain food waste. • Produce and apply dedicated BMP and ensure appropriate controls are in place to minimize and mitigate the potential 'High' impacts of exotic plants and animals on the Black-footed Rock-wallaby population of the area. • As part of BMP incorporate a monitoring program for Black-footed Rock-wallaby using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor possible impacts of exotic plants and animals on the population. Part of this monitoring would include an assessment of the abundance of exotic/native predators.	**Low**	Section 5.5.6 Section 6.6
Waste water				No effect is predicted	• Not applicable.		
Lowering or contamination of water table				No effect is predicted	• Not applicable.		
Traffic mortality				No effect is predicted	• Not applicable.		

Table 28 Project Risk – Great Desert Skink, Brush-tailed Mulgara, Greater Bilby, Princess Parrot, species present within the Borefield.

Source of Impact	Likelihood	Consequence	Severity	Comments	Minimising, mitigation and management actions	Residual Risk	Reference
Long term decrease in size of population							
Clearing – dispersal and foraging habitat	2	2	**Low**	The Brush-tailed Mulgara, Great Desert Skink, and Greater Bilby to lose 880.94 ha of known (for mulgara and Great Desert Skink) and possible (for Greater Bilby) breeding/foraging/dispersal habitat, equating to 2.12% of 41,568 ha of available habitat. The Princess Parrot to lose 998.15 ha of possible foraging and dispersal habitat, equating to 2.4 % of the approximately 41,568 ha (would be more than this as it also includes riparian habitats if the mine site). This suggests that it is **unlikely** that the planned removal of habitat for these species may result in a **minor** impact to the long-term size of the local population. For the Great Desert Skink, current plans are to avoid the active warren, if this changes, the risk severity could change to '**High**' for GDS.	• Minimise impact via actions in Section 6.1. Importantly for species such as the Great Desert Skink, avoid the known active warren for this species and for mulgara, implement clearing during autumn when breeding has ended. For borefield fauna in general, avoid clearing during the winter/spring months when animals (particularly reptiles) are inactive in burrows or breeding. A qualified ecologist on-site during the clearing would capture and translocate animals encountered during the clearing process. • Produce and apply dedicated Biodiversity Management Plan (BMP) and ensure appropriate construction, weed, weed hygiene, fire and rehabilitation management aspects are covered in an attempt to minimize and mitigate clearing effects on the threatened species populations of the area. • As part of BMP incorporate a monitoring program for threatened species (particularly mulgara and Great Desert Skink) using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor the impact that clearing has on local populations.	**Low**	Section 5.5.1 Section 6.1
Dust	1	1	Low	Dust emitted from the proposed mine is likely to have a negligible effect only on threatened species present within the borefield area. The GHD 2016 Air Quality report indicates that PM10 concentrations well below 50 ug/m^3 are likely to occur possibly over 12 km away from the nearest known mulgara habitat and approx. 25 km from the nearest Great Desert Skink record. It is **rare** that dust emitted from the proposed mine would have **insignificant** impacts to threatened species of the borefield area.	• Refer to Section 6.2. • The minimisation of dust emission controls as defined in a Dust Management Plan. • Produce and apply dedicated BMP and ensure appropriate dust controls are in place in an attempt to minimize and mitigate dust effects on the threatened species of the borefield area. • As part of BMP incorporate a monitoring program for threatened species (particularly mulgara and Great Desert Skink) using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor the impact that dust has on local populations.	Low	Section 5.5.2 Section 6.2
Noise	1	1	Low	Noise emitted from the proposed mine is likely to have a negligible effect only on threatened species present within the borefield area. The GHD 2016 Noise and Vibration report indicates that at a distance of 8 km (maximum distance that noise levels are provided in GHD noise report) most noise will be in the order of 15-31 dB(A). The lower end of this range is considered acceptable for human sleep. It is **rare** that noise emitted from the proposed mine would have **insignificant** impacts to threatened species populations in the borefield area.	• Refer to Section 6.3. • The implementation of noise controls as defined in a Noise Management Plan. • Produce and apply dedicated BMP and ensure appropriate noise controls are in place in an attempt to minimize and mitigate noise effects on the threatened species of the borefield area. • As part of BMP incorporate a monitoring program for threatened species (particularly mulgara and Great Desert Skink) using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor the impact that noise has on local populations.	Low	Section 5.5.3 Section 6.2

Light	2	2	**Low**	Light emitted from the proposed mine and borefield infrastructure could have a small effect on any of the nocturnal threatened fauna (e.g. Great Desert Skink, mulgara, bilby). It is **unlikely** that light emitted from the proposed mine would have **minor** impacts only to these species such that populations suffer a long-term decrease in size.	• Refer to Section 6.4. • As mentioned in the mitigation measures section of the report, avoiding unnecessary lighting at night when nocturnal animals are active and keeping lighting low and directed at operations rather than surrounding habitat will assist greatly in mitigating impacts. • Produce and apply dedicated BMP and ensure appropriate lighting controls are in place in an attempt to minimize and mitigate artificial light effects on the threatened species populations of the area.	**Low**	Section 5.5.4 Section 6.4
Unplanned Wildfire	3	4	**High**	It is **possible** that extensive unplanned wildfire as a result of mine activities may have a **major** impact on the long-term size of the Great Desert Skink and mulgara population in particular. The July 2015 baseline surveys did not record any Great Desert Skink active warrens in recently burnt habitats.	• Refer to Section 6.5. • A separate Bushfire Management Plan will be required to manage this risk; • Produce and apply dedicated BMP and ensure appropriate wildfire controls are in place in an attempt to minimize and mitigate the potential 'High' impacts on the Great Desert Skink and mulgara population of the area. • As part of BMP incorporate a monitoring program for Great Desert Skink and mulgara using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor possible impacts of fire (would include naturally occurring fire in addition).	**Medium**	Section 5.5.5 Section 6.5
Exotic plants and animals	3	4	**High**	It is **possible** that the introduction of exotic plants and animals as a result of mine activities may have a **major** impact on the long-term size of the Great Desert Skink and mulgara populations. An increase in the incidence of cats, foxes and potentially dingoes could result in increased predation, particularly of more vulnerable juveniles.	• Refer to Section 6.6. • Various design aspects will need to be considered for the mine such as a predator-proof compound to contain food waste. • Produce and apply dedicated BMP and ensure appropriate controls are in place to minimize and mitigate the potential 'High' impacts of exotic plants and animals on the Great Desert Skink, mulgara and other potential threatened species populations of the area. • As part of BMP incorporate a monitoring program for Great Desert Skink and mulgara using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor possible impacts of exotic plants and animals on the population. Part of this monitoring would include an assessment of the abundance of exotic/native predators.	**Low**	Section 5.5.6 Section 6.6
Waste water	1	1	**Low**	It is predicted that it is **rare** that the Weak Acid Dissociable (WAD) cyanide in onsite water storage facilities may be at levels sufficient to cause wildlife mortality and that there may be **insignificant** impacts from ingestion by the threatened species of the borefield.	• Refer to Section 6.7. • Avoid the possibility by maintaining WADCN levels below levels poisonous to wildlife, and prevent wildlife access to new tailings dams. • Produce and apply a Water Quality Monitoring and Management Plan. A Tailings Dam Wildlife Monitoring Program would be incorporated into a BMP and would be more broadly directed at fauna in general rather than just specifically threatened species.	**Low**	Section 5.5.8 Section 6.7
Lowering or contamination of water table	1	1	**Low**	It is predicted that it is **rare** that the lowering of the water table or contamination would have **insignificant** impacts on the threatened species population of the borefield such that they would decrease over time. There is an extremely low likelihood that any of the threatened species of the borefield would be adversely impacted by water table draw-downs or water table contamination as they are not dependent on GDEs or standing water.	• Refer to Section 6.8.	**Low**	Section 5.5.9 Section 6.8

Traffic mortality	3	2	**Medium**	It is predicted that it is **possible** that there will be some mortality from collisions with vehicles due to increased traffic that may have a **moderate** impact on species such as the mulgara and potentially Great Desert Skink.	• Refer to Section 6.9, with particular emphasis on measures such as driving during daylight hours only – this would greatly reduce the chance of vehicle strike with species such as Great Desert Skink and mulgara, which are predominantly nocturnal. • Produce and apply a Traffic and Road Safety Management Plan, a Weed Hygiene Procedure and provision of on-site wash down facilities. Aspects of these will be incorporated into a BMP.	**Low**	Section 5.5.10 Section 6.9
Reduce the area of occupancy of an important population							
Clearing – dispersal and foraging habitat	4	1	**Medium**	The Brush-tailed Mulgara, Great Desert Skink, and Greater Bilby to lose 880.94 ha of known (for mulgara and Great Desert Skink) and possible (for Greater Bilby) breeding/foraging/dispersal habitat, equating to 2.12% of 41,568 ha of available habitat. The Princess Parrot to lose 998.15 ha of possible foraging and dispersal habitat, equating to 2.4 % of the approximately 41,568 ha (would be more than this as it also includes riparian habitats if the mine site). This suggests that it is **likely** that the planned removal of habitat for these species may result in an **insignificant** impact to the area of occupancy of the local population. For the Great Desert Skink, current plans are to avoid the active warren, if this changes, the risk severity could change to '**Extreme**' for GDS.	• Minimise impact via actions in Section 6.1. Importantly for species such as the Great Desert Skink, avoid the known active warren for this species and for mulgara, implement clearing during autumn when breeding has ended. For borefield fauna in general, avoid clearing during the winter/spring months when animals (particularly reptiles) are inactive in burrows or breeding. A qualified ecologist on-site during the clearing would capture and translocate animals encountered during the clearing process. • Produce and apply dedicated Biodiversity Management Plan (BMP) and ensure appropriate construction, weed, weed hygiene, fire and rehabilitation management aspects are covered in an attempt to minimize and mitigate clearing effects on the threatened species populations of the area. • As part of BMP incorporate a monitoring program for threatened species (particularly mulgara and Great Desert Skink) using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor the impact that clearing has on local populations.	**Low**	Section 5.5.1 Section 6.1
Dust	1	1	Low	Dust emitted from the proposed mine is likely to have a negligible effect only on threatened species present within the borefield area. The GHD 2016 Air Quality report indicates that PM10 concentrations well below 50 ug/m^3 are likely to occur possibly over 12 km away from the nearest known mulgara habitat and approx. 25 km from the nearest Great Desert Skink record. It is **rare** that dust emitted from the proposed mine would have **insignificant** impacts to the area of occupancy of threatened species of the borefield area.	• Refer to Section 6.2. • The minimisation of dust emission controls as defined in a Dust Management Plan. • Produce and apply dedicated BMP and ensure appropriate dust controls are in place in an attempt to minimize and mitigate dust effects on the threatened species of the borefield area. • As part of BMP incorporate a monitoring program for threatened species (particularly mulgara and Great Desert Skink) using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor the impact that dust has on local populations.	Low	Section 5.5.2 Section 6.2
Noise	1	1	Low	Noise emitted from the proposed mine is likely to have a negligible effect only on threatened species present within the borefield area. The GHD 2016 Noise and Vibration report indicates that at a distance of 8 km (maximum distance that noise levels are provided in GHD noise report) most noise will be in the order of 15-31 dB(A). The lower end of this range is considered acceptable for human sleep. It is **rare** that noise emitted from the proposed mine would have **insignificant** impacts to the area of occupancy of threatened species populations in the borefield area.	• Refer to Section 6.3. • The implementation of noise controls as defined in a Noise Management Plan. • Produce and apply dedicated BMP and ensure appropriate noise controls are in place in an attempt to minimize and mitigate noise effects on the threatened species of the borefield area. • As part of BMP incorporate a monitoring program for threatened species (particularly mulgara and Great Desert Skink) using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor the impact that noise has on local populations.	Low	Section 5.5.3 Section 6.2

Light	2	2	**Low**	Light emitted from the proposed mine and borefield infrastructure could have a small effect on any of the nocturnal threatened fauna (e.g. Great Desert Skink, mulgara, bilby). It is **unlikely** that light emitted from the proposed mine would have **minor** impacts only to these species such that the area of occupancy of the species' is reduced.	• Refer to Section 6.4 • As mentioned in the mitigation measures section of the report, avoiding unnecessary lighting at night when nocturnal animals are active and keeping lighting low and directed at operations rather than surrounding habitat will assist greatly in mitigating impacts. • Produce and apply dedicated BMP and ensure appropriate lighting controls are in place in an attempt to minimize and mitigate artificial light effects on the threatened species populations of the area.	**Low**	Section 5.5.4 Section 6.4
Unplanned Wildfire	3	4	**High**	It is **possible** that extensive unplanned wildfire as a result of mine activities may have a **major** impact on the area of occupancy of the Great Desert Skink and mulgara population in particular. The July 2015 baseline surveys did not record any Great Desert Skink active warrens in recently burnt habitats.	• Refer to Section 6.5 • A separate Bushfire Management Plan will be required to manage this risk. • Produce and apply dedicated BMP and ensure appropriate wildfire controls are in place in an attempt to minimize and mitigate the potential 'High' impacts on the Great Desert Skink and mulgara population of the area. • As part of BMP incorporate a monitoring program for Great Desert Skink and mulgara using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor possible impacts of fire (would include naturally occurring fire in addition).	**Medium**	Section 5.5.5 Section 6.5
Exotic plants and animals	3	4	**High**	It is **possible** that the introduction of exotic plants and animals as a result of mine activities may have a **major** impact on the area of occupancy of the Great Desert Skink and mulgara populations. An increase in the incidence of cats, foxes and potentially dingoes could result in increased predation, particularly of more vulnerable juveniles.	• Refer to Section 6.6. • Various design aspects will need to be considered for the mine such as a predator-proof compound to contain food waste. • Produce and apply dedicated BMP and ensure appropriate controls are in place to minimize and mitigate the potential 'High' impacts of exotic plants and animals on the Great Desert Skink, mulgara and other potential threatened species populations of the area. • As part of BMP incorporate a monitoring program for Great Desert Skink and mulgara using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor possible impacts of exotic plants and animals on the population. Part of this monitoring would include an assessment of the abundance of exotic/native predators.	**Low**	Section 5.5.6 Section 6.6
Waste water	1	1	**Low**	It is predicted that it is **rare** that the Weak Acid Dissociable (WAD) cyanide in onsite water storage facilities may be at levels sufficient to cause wildlife mortality and that there may be **insignificant** impacts from ingestion by the threatened species of the borefield such that the area of occupancy of a species is reduced.	• Refer to Section 6.7. • Avoid the possibility by maintaining WADCN levels below levels poisonous to wildlife, and prevent wildlife access to new tailings dams. • Produce and apply a Water Quality Monitoring and Management Plan. A Tailings Dam Wildlife Monitoring Program would be incorporated into a BMP and would be more broadly directed at fauna in general rather than just specifically threatened species.	**Low**	Section 5.5.8 Section 6.7
Lowering or contamination of water table	1	1	**Low**	It is predicted that it is **rare** that the lowering of the water table or contamination would have **insignificant** impacts on the threatened species population of the borefield such that the area of occupancy would be diminished. There is an extremely low likelihood that any of the threatened species of the borefield would be adversely impacted by water table draw-downs or water table contamination as they are not dependent on GDEs or standing water.	• Refer to Section 6.8.	**Low**	Section 5.5.9 Section 6.8

Traffic mortality	3	2	**Medium**	It is predicted that it is **possible** that there will be some mortality from collisions with vehicles due to increased traffic that may have a **moderate** impact on species such as the mulgara and potentially Great Desert Skink such that the area of occupancy is reduced.	• Refer to Section 6.9, with particular emphasis on measures such as driving during daylight hours only – this would greatly reduce the chance of vehicle strike with species such as Great Desert Skink and mulgara, which are predominantly nocturnal. • Produce and apply a Traffic and Road Safety Management Plan, a Weed Hygiene Procedure and provision of on-site wash down facilities. Aspects of these will be incorporated into a BMP.	**Low**	Section 5.5.10 Section 6.9
Fragment an existing population into two or more populations							
Clearing – dispersal and foraging habitat	2	2	**Low**	The Brush-tailed Mulgara, Great Desert Skink, and Greater Bilby to lose 880.94 ha of known (for mulgara and Great Desert Skink) and possible (for Greater Bilby) breeding/foraging/dispersal habitat, equating to 2.12% of 41,568 ha of available habitat. The Princess Parrot to lose 998.15 ha of possible foraging and dispersal habitat, equating to 2.4 % of the approximately 41,568 ha (would be more than this as it also includes riparian habitats if the mine site). This suggests that it is **unlikely** that the planned removal of habitat for these species may result in a **minor** impact such that populations are fragmented. For the Great Desert Skink, current plans are to avoid the active warren, if this changes, the risk severity could change to '**High**' for GDS.	• Minimise impact via actions in Section 6.1. Importantly for species such as the Great Desert Skink, avoid the known active warren for this species and for mulgara, implement clearing during autumn when breeding has ended. For borefield fauna in general, avoid clearing during the winter/spring months when animals (particularly reptiles) are inactive in burrows or breeding. A qualified ecologist on-site during the clearing would capture and translocate animals encountered during the clearing process. • Produce and apply dedicated Biodiversity Management Plan (BMP) and ensure appropriate construction, weed, weed hygiene, fire and rehabilitation management aspects are covered in an attempt to minimize and mitigate clearing effects on the threatened species populations of the area. • As part of BMP incorporate a monitoring program for threatened species (particularly mulgara and Great Desert Skink) using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor the impact that clearing has on local populations.	**Low**	Section 5.5.1 Section 6.1
Dust	1	1	Low	Dust emitted from the proposed mine is likely to have a negligible effect only on threatened species present within the borefield area. The GHD 2016 Air Quality report indicates that PM10 concentrations well below 50 ug/m^3 are likely to occur possibly over 12 km away from the nearest known mulgara habitat and approx. 25 km from the nearest Great Desert Skink record. It is **rare** that dust emitted from the proposed mine would have **insignificant** impacts to threatened species of the borefield area such that fragmentation of populations occur.	• Refer to Section 6.2. • The minimisation of dust emission controls as defined in a Dust Management Plan. • Produce and apply dedicated BMP and ensure appropriate dust controls are in place in an attempt to minimize and mitigate dust effects on the threatened species of the borefield area. • As part of BMP incorporate a monitoring program for threatened species (particularly mulgara and Great Desert Skink) using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor the impact that dust has on local populations.	Low	Section 5.5.2 Section 6.2
Noise	1	1	Low	Noise emitted from the proposed mine is likely to have a negligible effect only on threatened species present within the borefield area. The GHD 2016 Noise and Vibration report indicates that at a distance of 8 km (maximum distance that noise levels are provided in GHD noise report) most noise will be in the order of 15-31 dB(A). The lower end of this range is considered acceptable for human sleep. It is **rare** that noise emitted from the proposed mine would have **insignificant** impacts to threatened species populations in the borefield area such that fragmentation of populations occur.	• Refer to Section 6.3. • The implementation of noise controls as defined in a Noise Management Plan. • Produce and apply dedicated BMP and ensure appropriate noise controls are in place in an attempt to minimize and mitigate noise effects on the threatened species of the borefield area. • As part of BMP incorporate a monitoring program for threatened species (particularly mulgara and Great Desert Skink) using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor the impact that noise has on local populations.	Low	Section 5.5.3 Section 6.2

Light	2	2	**Low**	Light emitted from the proposed mine and borefield infrastructure could have a small effect on any of the nocturnal threatened fauna (e.g. Great Desert Skink, mulgara, bilby). It is **unlikely** that light emitted from the proposed mine would have **minor** impacts only to these species such that populations become fragmented.	• Refer to Section 6.4. • As mentioned in the mitigation measures section of the report, avoiding unnecessary lighting at night when nocturnal animals are active and keeping lighting low and directed at operations rather than surrounding habitat will assist greatly in mitigating impacts. • Produce and apply dedicated BMP and ensure appropriate lighting controls are in place in an attempt to minimize and mitigate artificial light effects on the threatened species populations of the area.	**Low**	Section 5.5.4 Section 6.4
Unplanned Wildfire	3	4	**High**	It is **possible** that extensive unplanned wildfire as a result of mine activities may have a **major** impact on the long-term size of the Great Desert Skink and mulgara population in particular with a possibility that populations could become isolated and therefore fragmented. The July 2015 baseline surveys did not record any Great Desert Skink active warrens in recently burnt habitats.	• Refer to Section 6.5. • A separate Bushfire Management Plan will be required to manage this risk. • Produce and apply dedicated BMP and ensure appropriate wildfire controls are in place in an attempt to minimize and mitigate the potential 'High' impacts on the Great Desert Skink and mulgara population of the area. • As part of BMP incorporate a monitoring program for Great Desert Skink and mulgara using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor possible impacts of fire (would include naturally occurring fire in addition).	**Medium**	Section 5.5.5 Section 6.5
Exotic plants and animals	3	4	**High**	It is **possible** that the introduction of exotic plants and animals as a result of mine activities may have a **major** impact on Great Desert Skink and mulgara populations such that they become fragmented. An increase in the incidence of cats, foxes and potentially dingoes could result in increased predation, particularly of more vulnerable juveniles.	• Refer to Section 6.6. • Various design aspects will need to be considered for the mine such as a predator-proof compound to contain food waste. • Produce and apply dedicated BMP and ensure appropriate controls are in place to minimize and mitigate the potential 'High' impacts of exotic plants and animals on the Great Desert Skink, mulgara and other potential threatened species populations of the area. • As part of BMP incorporate a monitoring program for Great Desert Skink and mulgara using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor possible impacts of exotic plants and animals on the population. Part of this monitoring would include an assessment of the abundance of exotic/native predators.	**Low**	Section 5.5.6 Section 6.6
Waste water	1	1	**Low**	It is predicted that it is **rare** that the Weak Acid Dissociable (WAD) cyanide in onsite water storage facilities may be at levels sufficient to cause wildlife mortality and that there may be **insignificant** impacts from ingestion by the threatened species of the borefield. This impact is unlikely to lead to population fragmentation.	• Refer to Section 6.7. • Avoid the possibility by maintaining WADCN levels below levels poisonous to wildlife, and prevent wildlife access to new tailings dams. • Produce and apply a Water Quality Monitoring and Management Plan. A Tailings Dam Wildlife Monitoring Program would be incorporated into a BMP and would be more broadly directed at fauna in general rather than just specifically threatened species.	**Low**	Section 5.5.8 Section 6.7
Lowering or contamination of water table	1	1	**Low**	It is predicted that it is **rare** that the lowering of the water table or contamination would have **insignificant** impacts on the threatened species population pf the borefield such that they would become fragmented. There is an extremely low likelihood that any of the threatened species of the borefield would be adversely impacted by water table draw-downs or water table contamination as they are not dependent on GDEs or standing water.	• Refer to Section 6.8.	**Low**	Section 5.5.9 Section 6.8

Traffic mortality	3	2	**Medium**	It is predicted that it is **possible** that there will be some mortality from collisions with vehicles due to increased traffic that may have a **moderate** impact on species such as the mulgara and potentially Great Desert Skink leading to fragmentation of the population.	• Refer to Section 6.9, with particular emphasis on measures such as driving during daylight hours only – this would greatly reduce the chance of vehicle strike with species such as Great Desert Skink and mulgara, which are predominantly nocturnal. • Produce and apply a Traffic and Road Safety Management Plan, a Weed Hygiene Procedure and provision of on-site wash down facilities. Aspects of these will be incorporated into a BMP.	**Low**	Section 5.5.10 Section 6.9
Adversely affect habitat critical to the survival of a species							
Clearing – dispersal and foraging habitat	2	2	**Low**	The Brush-tailed Mulgara, Great Desert Skink, and Greater Bilby to lose 880.94 ha of known (for mulgara and Great Desert Skink) and possible (for Greater Bilby) breeding/foraging/dispersal habitat, equating to 2.12% of 41,568 ha of available habitat. The Princess Parrot to lose 998.15 ha of possible foraging and dispersal habitat, equating to 2.4 % of the approximately 41,568 ha (would be more than this as it also includes riparian habitats if the mine site). This suggests that it is **unlikely** that the planned removal of habitat for these species may result in a **minor** impact to habitat critical to the survival of a species. For the Great Desert Skink, current plans are to avoid the active warren, if this changes, the risk severity could change to '**High**' for GDS.	• Minimise impact via actions in Section 6.1. Importantly for species such as the Great Desert Skink, avoid the known active warren for this species. Although some habitat for Brush-tailed Mulgara would be removed, they are likely to persist within the broader borefield area at a similar density of 2.5 active burrows per ha, therefore habitat removed would not be critical to the survival of the population. A qualified ecologist on-site during the clearing would capture and translocate animals encountered during the clearing process. • Produce and apply dedicated Biodiversity Management Plan (BMP) and ensure appropriate construction, weed, weed hygiene, fire and rehabilitation management aspects are covered in an attempt to minimize and mitigate clearing effects on the threatened species populations of the area. • As part of BMP incorporate a monitoring program for threatened species (particularly mulgara and Great Desert Skink) using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor the impact that clearing has on local populations.	**Low**	Section 5.5.1 Section 6.1
Dust	1	1	Low	Dust emitted from the proposed mine is likely to have a negligible effect only on threatened species present within the borefield area. The GHD 2016 Air Quality report indicates that PM10 concentrations well below 50 ug/m^3 are likely to occur possibly over 12 km away from the nearest known mulgara habitat and approx. 25 km from the nearest Great Desert Skink record. It is **rare** that dust emitted from the proposed mine would have **insignificant** impacts to threatened species of the borefield area such that critical habitat is affected.	• Refer to Section 6.2. • The minimisation of dust emission controls as defined in a Dust Management Plan. • Produce and apply dedicated BMP and ensure appropriate dust controls are in place in an attempt to minimize and mitigate dust effects on the threatened species of the borefield area. • As part of BMP incorporate a monitoring program for threatened species (particularly mulgara and Great Desert Skink) using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor the impact that dust has on local populations.	Low	Section 5.5.2 Section 6.2
Noise	1	1	Low	Noise emitted from the proposed mine is likely to have a negligible effect only on threatened species present within the borefield area. The GHD 2016 Noise and Vibration report indicates that at a distance of 8 km (maximum distance that noise levels are provided in GHD noise report) most noise will be in the order of 15-31 dB(A). The lower end of this range is considered acceptable for human sleep. It is **rare** that noise emitted from the proposed mine would have **insignificant** impacts to threatened species populations in the borefield area such that critical habitat is affected.	• Refer to Section 6.3. • The implementation of noise controls as defined in a Noise Management Plan. • Produce and apply dedicated BMP and ensure appropriate noise controls are in place in an attempt to minimize and mitigate noise effects on the threatened species of the borefield area. • As part of BMP incorporate a monitoring program for threatened species (particularly mulgara and Great Desert Skink) using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor the impact that noise has on local populations.	Low	Section 5.5.3 Section 6.2

Light	2	2	**Low**	Light emitted from the proposed mine and borefield infrastructure could have a small effect on any of the nocturnal threatened fauna (e.g. Great Desert Skink, mulgara, bilby). It is **unlikely** that light emitted from the proposed mine would have **minor** impacts only to habitat critical to these species.	• Refer to Section 6.4. • As mentioned in the mitigation measures section of the report, avoiding unnecessary lighting at night when nocturnal animals are active and keeping lighting low and directed at operations rather than surrounding habitat will assist greatly in mitigating impacts. • Produce and apply dedicated BMP and ensure appropriate lighting controls are in place in an attempt to minimize and mitigate artificial light effects on the threatened species populations of the area.	**Low**	Section 5.5.4 Section 6.4
Unplanned Wildfire	3	4	**High**	It is **possible** that extensive unplanned wildfire as a result of mine activities may have a **major** impact on habitat critical to Great Desert Skink and mulgara in particular. The July 2015 baseline surveys did not record any Great Desert Skink active warrens in recently burnt habitats.	• Refer to Section 6.5. • A separate Bushfire Management Plan will be required to manage this risk. • Produce and apply dedicated BMP and ensure appropriate wildfire controls are in place in an attempt to minimize and mitigate the potential 'High' impacts on the Great Desert Skink and mulgara habitat. • As part of BMP incorporate a monitoring program for Great Desert Skink and mulgara using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor possible impacts of fire (would include naturally occurring fire in addition).	**Medium**	Section 5.5.5 Section 6.5
Exotic plants and animals	3	4	**High**	It is **possible** that the introduction of exotic plants and animals as a result of mine activities may have a **major** impact on habitat critical to the survival of Great Desert Skink and mulgara populations. An increase in the incidence of cats, foxes and potentially dingoes could result in increased predation, particularly of more vulnerable juveniles.	• Refer to Section 6.6. • Various design aspects will need to be considered for the mine such as a predator-proof compound to contain food waste. • Produce and apply dedicated BMP and ensure appropriate controls are in place to minimize and mitigate the potential 'High' impacts of exotic plants and animals on the Great Desert Skink, mulgara and other potential threatened species populations of the area. • As part of BMP incorporate a monitoring program for Great Desert Skink and mulgara using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor possible impacts of exotic plants and animals on the population. Part of this monitoring would include an assessment of the abundance of exotic/native predators.	**Low**	Section 5.5.6 Section 6.6
Waste water				No effect is predicted	• Not applicable.		
Lowering or contamination of water table				No effect is predicted	• Not applicable.		
Traffic mortality				No effect is predicted	• Not applicable.		
Disrupt the breeding cycle of a population							

Clearing – dispersal and foraging habitat	2	2	**Low**	The Brush-tailed Mulgara, Great Desert Skink, and Greater Bilby to lose 880.94 ha of known (for mulgara and Great Desert Skink) and possible (for Greater Bilby) breeding/foraging/dispersal habitat, equating to 2.12% of 41,568 ha of available habitat. The Princess Parrot to lose 998.15 ha of possible foraging and dispersal habitat, equating to 2.4 % of the approximately 41,568 ha (would be more than this as it also includes riparian habitats if the mine site). This suggests that it is **unlikely** that the planned removal of habitat for these species may result in a **minor** impact to the breeding cycle for the above species. For the Great Desert Skink, current plans are to avoid the active warren, if this changes, the risk severity could change to '**High**' for GDS.	• Minimise impact via actions in Section 6.1. Importantly for species such as the Great Desert Skink, avoid the known active warren for this species and for mulgara, implement clearing during autumn when breeding has ended. For borefield fauna in general, avoid clearing during the winter/spring months when animals (particularly reptiles) are inactive in burrows or breeding. A qualified ecologist on-site during the clearing would capture and translocate animals encountered during the clearing process. • Produce and apply dedicated Biodiversity Management Plan (BMP) and ensure appropriate construction, weed, weed hygiene, fire and rehabilitation management aspects are covered in an attempt to minimize and mitigate clearing effects on the threatened species populations of the area. • As part of BMP incorporate a monitoring program for threatened species (particularly mulgara and Great Desert Skink) using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor the impact that clearing has on local populations.	**Low**	Section 5.5.1 Section 6.1
Dust	1	1	Low	Dust emitted from the proposed mine is likely to have a negligible effect only on threatened species present within the borefield area. The GHD 2016 Air Quality report indicates that PM10 concentrations well below 50 ug/m^3 are likely to occur possibly over 12 km away from the nearest known mulgara habitat and approx. 25 km from the nearest Great Desert Skink record. It is **rare** that dust emitted from the proposed mine would have **insignificant** impacts to threatened species of the borefield area such that the breeding cycle is affected.	• Refer to Section 6.2. • The minimisation of dust emission controls as defined in a Dust Management Plan. • Produce and apply dedicated BMP and ensure appropriate dust controls are in place in an attempt to minimize and mitigate dust effects on the threatened species of the borefield area. • As part of BMP incorporate a monitoring program for threatened species (particularly mulgara and Great Desert Skink) using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor the impact that dust has on local populations.	Low	Section 5.5.2 Section 6.2
Noise	1	1	Low	Noise emitted from the proposed mine is likely to have a negligible effect only on threatened species present within the borefield area. The GHD 2016 Noise and Vibration report indicates that at a distance of 8 km (maximum distance that noise levels are provided in GHD noise report) most noise will be in the order of 15-31 dB(A). The lower end of this range is considered acceptable for human sleep. It is **rare** that noise emitted from the proposed mine would have **insignificant** impacts to threatened species populations in the borefield area such that the breeding cycle is affected.	• Refer to Section 6.3. • The implementation of noise controls as defined in a Noise Management Pla.; • Produce and apply dedicated BMP and ensure appropriate noise controls are in place in an attempt to minimize and mitigate noise effects on the threatened species of the borefield area. • As part of BMP incorporate a monitoring program for threatened species (particularly mulgara and Great Desert Skink) using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor the impact that noise has on local populations.	Low	Section 5.5.3 Section 6.2
Light	2	2	**Low**	Light emitted from the proposed mine and borefield infrastructure could have a small effect on any of the nocturnal threatened fauna (e.g. Great Desert Skink, mulgara, bilby). It is **unlikely** that light emitted from the proposed mine would have **minor** impacts only to these species such that the breeding cycle is affected.	• Refer to Section 6.4. • As mentioned in the mitigation measures section of the report, avoiding unnecessary lighting at night when nocturnal animals are active and keeping lighting low and directed at operations rather than surrounding habitat will assist greatly in mitigating impacts. • Produce and apply dedicated BMP and ensure appropriate lighting controls are in place in an attempt to minimize and mitigate artificial light effects on the threatened species populations of the area.	**Low**	Section 5.5.4 Section 6.4

Unplanned Wildfire	3	4	**High**	It is **possible** that extensive unplanned wildfire as a result of mine activities may have a **major** impact on the breeding cycle of the Great Desert Skink and mulgara population in particular. The July 2015 baseline surveys did not record any Great Desert Skink active warrens in recently burnt habitats.	• Refer to Section 6.5. • A separate Bushfire Management Plan will be required to manage this risk. • Produce and apply dedicated BMP and ensure appropriate wildfire controls are in place in an attempt to minimize and mitigate the potential 'High' impacts on the Great Desert Skink and mulgara population of the area. • As part of BMP incorporate a monitoring program for Great Desert Skink and mulgara using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor possible impacts of fire (would include naturally occurring fire in addition).	**Medium**	Section 5.5.5 Section 6.5
Exotic plants and animals	3	4	**High**	It is **possible** that the introduction of exotic plants and animals as a result of mine activities may have a **major** impact on the breeding cycle of the Great Desert Skink and mulgara populations. An increase in the incidence of cats, foxes and potentially dingoes could result in increased predation, particularly of more vulnerable juveniles.	• Refer to Section 6.6. • Various design aspects will need to be considered for the mine such as a predator-proof compound to contain food waste. • Produce and apply dedicated BMP and ensure appropriate controls are in place to minimize and mitigate the potential 'High' impacts of exotic plants and animals on the Great Desert Skink, mulgara and other potential threatened species populations of the area. • As part of BMP incorporate a monitoring program for Great Desert Skink and mulgara using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor possible impacts of exotic plants and animals on the population. Part of this monitoring would include an assessment of the abundance of exotic/native predators.	**Low**	Section 5.5.6 Section 6.6
Waste water				No effect is predicted	• Not applicable.		
Lowering or contamination of water table							
Traffic mortality	3	2	**Medium**	It is predicted that it is **possible** that there will be some mortality from collisions with vehicles due to increased traffic that may have a **minor** impact on breeding cycle of species such as the mulgara and potentially Great Desert Skink.	• Refer to Section 6.9, with particular emphasis on measures such as driving during daylight hours only – this would greatly reduce the chance of vehicle strike with species such as Great Desert Skink and mulgara, which are predominantly nocturnal. • Produce and apply a Traffic and Road Safety Management Plan, a Weed Hygiene Procedure and provision of on-site wash down facilities. Aspects of these will be incorporated into a BMP.	**Low**	Section 5.5.10 Section 6.9
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline							

Clearing – dispersal and foraging habitat	2	2	**Low**	The Brush-tailed Mulgara, Great Desert Skink, and Greater Bilby to lose 880.94 ha of known (for mulgara and Great Desert Skink) and possible (for Greater Bilby) breeding/foraging/dispersal habitat, equating to 2.12% of 41,568 ha of available habitat. The Princess Parrot to lose 998.15 ha of possible foraging and dispersal habitat, equating to 2.4 % of the approximately 41,568 ha (would be more than this as it also includes riparian habitats if the mine site). This suggests that it is **unlikely** that the planned removal of habitat for these species may result in a **minor** impact to habitat quality for the above species. For the Great Desert Skink, current plans are to avoid the active warren, if this changes, the risk severity could change to '**High**' for GDS.	• Minimise impact via actions in Section 6.1. Importantly for species such as the Great Desert Skink, avoid the known active warren for this species and for mulgara, implement clearing during autumn when breeding has ended. For borefield fauna in general, avoid clearing during the winter/spring months when animals (particularly reptiles) are inactive in burrows or breeding. A qualified ecologist on-site during the clearing would capture and translocate animals encountered during the clearing process • Produce and apply dedicated Biodiversity Management Plan (BMP) and ensure appropriate construction, weed, weed hygiene, fire and rehabilitation management aspects are covered in an attempt to minimize and mitigate clearing effects on the threatened species populations of the area. • As part of BMP incorporate a monitoring program for threatened species (particularly mulgara and Great Desert Skink) using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor the impact that clearing has on local populations.	**Low**	Section 5.5.1 Section 6.1
Dust	1	1	Low	Dust emitted from the proposed mine is likely to have a negligible effect only on threatened species present within the borefield area. The GHD 2016 Air Quality report indicates that PM10 concentrations well below 50 ug/m^3 are likely to occur possibly over 12 km away from the nearest known mulgara habitat and approx. 25 km from the nearest Great Desert Skink record. It is **rare** that dust emitted from the proposed mine would have **insignificant** impacts to threatened species of the borefield area such that species would decline.	• Refer to Section 6.2. • The minimisation of dust emission controls as defined in a Dust Management Plan. • Produce and apply dedicated BMP and ensure appropriate dust controls are in place in an attempt to minimize and mitigate dust effects on the threatened species of the borefield area. • As part of BMP incorporate a monitoring program for threatened species (particularly mulgara and Great Desert Skink) using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor the impact that dust has on local populations.	Low	Section 5.5.2 Section 6.2
Noise	1	1	Low	Noise emitted from the proposed mine is likely to have a negligible effect only on threatened species present within the borefield area. The GHD 2016 Noise and Vibration report indicates that at a distance of 8 km (maximum distance that noise levels are provided in GHD noise report) most noise will be in the order of 15-31 dB(A). The lower end of this range is considered acceptable for human sleep. It is **rare** that noise emitted from the proposed mine would have **insignificant** impacts to threatened species populations in the borefield area such that species would decline.	• Refer to Section 6.3. • The implementation of noise controls as defined in a Noise Management Plan. • Produce and apply dedicated BMP and ensure appropriate noise controls are in place in an attempt to minimize and mitigate noise effects on the threatened species of the borefield area. • As part of BMP incorporate a monitoring program for threatened species (particularly mulgara and Great Desert Skink) using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor the impact that noise has on local populations.	Low	Section 5.5.3 Section 6.2
Light	2	1	**Low**	Light emitted from the proposed mine and borefield infrastructure could have a small effect on any of the nocturnal threatened fauna (e.g. Great Desert Skink, mulgara, bilby). It is **unlikely** that light emitted from the proposed mine would have **insignificant** impacts to habitat quality for these species.	• Refer to Section 6.4. • As mentioned in the mitigation measures section of the report, avoiding unnecessary lighting at night when nocturnal animals are active and keeping lighting low and directed at operations rather than surrounding habitat will assist greatly in mitigating impacts. • Produce and apply dedicated BMP and ensure appropriate lighting controls are in place in an attempt to minimize and mitigate artificial light effects on the threatened species populations of the area.	**Low**	Section 5.5.4 Section 6.4

Unplanned Wildfire	3	4	**High**	It is **possible** that extensive unplanned wildfire as a result of mine activities may have a **major** impact on habitat quality for the Great Desert Skink and mulgara population in particular. The July 2015 baseline surveys did not record any Great Desert Skink active warrens in recently burnt habitats.	• Refer to Section 6.5. • A separate Bushfire Management Plan will be required to manage this risk. • Produce and apply dedicated BMP and ensure appropriate wildfire controls are in place in an attempt to minimize and mitigate the potential 'High' impacts on the Great Desert Skink and mulgara population of the area. • As part of BMP incorporate a monitoring program for Great Desert Skink and mulgara using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor possible impacts of fire (would include naturally occurring fire in addition).	**Medium**	Section 5.5.5 Section 6.5
Exotic plants and animals	3	4	**High**	It is **possible** that the introduction of exotic plants and animals as a result of mine activities may have a **major** impact on habitat quality of the Great Desert Skink and mulgara populations. An increase in the incidence of cats, foxes and potentially dingoes could result in increased predation, particularly of more vulnerable juveniles.	• Refer to Section 6.6. • Various design aspects will need to be considered for the mine such as a predator-proof compound to contain food waste. • Produce and apply dedicated BMP and ensure appropriate controls are in place to minimize and mitigate the potential 'High' impacts of exotic plants and animals on the Great Desert Skink, mulgara and other potential threatened species populations of the area. • As part of BMP incorporate a monitoring program for Great Desert Skink and mulgara using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor possible impacts of exotic plants and animals on the population. Part of this monitoring would include an assessment of the abundance of exotic/native predators.	**Low**	Section 5.5.6 Section 6.6
Waste water				No effect is predicted	• Not applicable.		
Lowering or contamination of water table				No effect is predicted			
Traffic mortality	3	2	**Medium**	It is predicted that it is **possible** that there will be some mortality from collisions with vehicles due to increased traffic that may have a **minor** impact on habitat quality/availability of species such as the mulgara and potentially Great Desert Skink.	• Refer to Section 6.9, with particular emphasis on measures such as driving during daylight hours only – this would greatly reduce the chance of vehicle strike with species such as Great Desert Skink and mulgara, which are predominantly nocturnal. • Produce and apply a Traffic and Road Safety Management Plan, a Weed Hygiene Procedure and provision of on-site wash down facilities. Aspects of these will be incorporated into a BMP.	**Low**	Section 5.5.10 Section 6.9

Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat							
Clearing – dispersal and foraging habitat	2	2	**Low**	The Brush-tailed Mulgara, Great Desert Skink, and Greater Bilby to lose 880.94 ha of known (for mulgara and Great Desert Skink) and possible (for Greater Bilby) breeding/foraging/dispersal habitat, equating to 2.12% of 41,568 ha of available habitat. The Princess Parrot to lose 998.15 ha of possible foraging and dispersal habitat, equating to 2.4 % of the approximately 41,568 ha (would be more than this as it also includes riparian habitats if the mine site). This suggests that it is **unlikely** that the planned removal of habitat for these species may result in a **minor** impact to the long-term size of the local population through the introduction of invasive species. Clearing could potentially allow exotic predators more easier access to some areas (i.e. increase 'edge effects').	• Minimise impact via actions in Section 6.1. Importantly for species such as the Great Desert Skink, avoid the known active warren for this species and for mulgara, implement clearing during autumn when breeding has ended. For borefield fauna in general, avoid clearing during the winter/spring months when animals (particularly reptiles) are inactive in burrows or breeding. A qualified ecologist on-site during the clearing would capture and translocate animals encountered during the clearing process. • Produce and apply dedicated Biodiversity Management Plan (BMP) and ensure appropriate construction, weed, weed hygiene, fire and rehabilitation management aspects are covered in an attempt to minimize and mitigate clearing effects on the threatened species populations of the area. • As part of BMP incorporate a monitoring program for threatened species (particularly mulgara and Great Desert Skink) using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor the impact that clearing has on local populations.	**Low**	Section 5.5.1 Section 6.1
Dust				No effect is predicted	• Not applicable.		
Noise				No effect is predicted	• Not applicable.		
Light				No effect is predicted	• Not applicable.		
Unplanned Wildfire	2	3	**Medium**	It is **unlikely** that extensive unplanned wildfire as a result of mine activities may have a **moderate** impact on the Great Desert Skink and mulgara population in particular, leading to possible increases in invasive predators such as feral cats/foxes. The July 2015 baseline surveys did not record any Great Desert Skink active warrens in recently burnt habitats.	• Refer to Section 6.5. • A separate Bushfire Management Plan will be required to manage this risk. • Produce and apply dedicated BMP and ensure appropriate wildfire controls are in place in an attempt to minimize and mitigate the potential impacts on the Great Desert Skink and mulgara population of the area. • As part of BMP incorporate a monitoring program for Great Desert Skink and mulgara using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor possible impacts of fire (would include naturally occurring fire in addition).	**Low**	Section 5.5.5 Section 6.5
Exotic plants and animals	3	4	**High**	It is **possible** that the introduction of exotic plants and animals as a result of mine activities may have a **major** impact on Great Desert Skink and mulgara populations. An increase in the incidence of cats, foxes and potentially dingoes could result in increased predation, particularly of more vulnerable juveniles.	• Refer to Section 6.6. • Various design aspects will need to be considered for the mine such as a predator-proof compound to contain food waste. • Produce and apply dedicated BMP and ensure appropriate controls are in place to minimize and mitigate the potential impacts of exotic plants and animals on the Great Desert Skink, mulgara and other potential threatened species populations of the area. • As part of BMP incorporate a monitoring program for Great Desert Skink and mulgara using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor possible impacts of exotic plants and animals on the population. Part of this monitoring would include an assessment of the abundance of exotic/native predators.	**Low**	Section 5.5.6 Section 6.6
Waste water				No effect is predicted	• Not applicable.		

Lowering or contamination of water table				No effect is predicted	• Not applicable.			
Traffic mortality				No effect is predicted	• Not applicable.			
Introduce disease that may cause the species to decline								
Clearing – dispersal and foraging habitat	1	1	**Low**	The Brush-tailed Mulgara, Great Desert Skink, and Greater Bilby to lose 880.94 ha of known (for mulgara and Great Desert Skink) and possible (for Greater Bilby) breeding/foraging/dispersal habitat, equating to 2.12% of 41,568 ha of available habitat. The Princess Parrot to lose 998.15 ha of possible foraging and dispersal habitat, equating to 2.4 % of the approximately 41,568 ha (would be more than this as it also includes riparian habitats if the mine site). This suggests that it is **rare** that the planned removal of habitat for these species may result in an **insignificant** impact to the various threatened species populations due to introduced disease.	• Minimise impact via actions in Section 6.1. Importantly for species such as the Great Desert Skink, avoid the known active warren for this species and for mulgara, implement clearing during autumn when breeding has ended. For borefield fauna in general, avoid clearing during the winter/spring months when animals (particularly reptiles) are inactive in burrows or breeding. A qualified ecologist on-site during the clearing would capture and translocate animals encountered during the clearing process. • Produce and apply dedicated Biodiversity Management Plan (BMP) and ensure appropriate construction, weed, weed hygiene, fire and rehabilitation management aspects are covered in an attempt to minimize and mitigate clearing effects on the threatened species populations of the area. • As part of BMP incorporate a monitoring program for threatened species (particularly mulgara and Great Desert Skink) using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor the impact that clearing has on local populations.	**Low**	Section 5.5.1 Section 6.1
Dust				No effect is predicted	• Not applicable.			
Noise				No effect is predicted	• Not applicable.			
Light				No effect is predicted	• Not applicable.			
Unplanned Wildfire	1	1	**Low**	It is **rare** that extensive unplanned wildfire as a result of mine activities may have an **insignificant** impact on the Great Desert Skink and mulgara populations as a result of introduced disease.	• Refer to Section 6.5. • A separate Bushfire Management Plan will be required to manage this risk. • Produce and apply dedicated BMP and ensure appropriate wildfire controls are in place in an attempt to minimize and mitigate the potential impacts on the Great Desert Skink and mulgara population of the area. • As part of BMP incorporate a monitoring program for Great Desert Skink and mulgara using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor possible impacts of fire (would include naturally occurring fire in addition).	**Low**	Section 5.5.5 Section 6.5

Exotic plants and animals	2	2	**Low**	It is **unlikely** that the introduction of exotic plants and animals as a result of mine activities may have a **minor** impact on the Great Desert Skink and mulgara populations due to the introduction of disease.	• Refer to Section 6.6. • Various design aspects will need to be considered for the mine such as a predator-proof compound to contain food waste. • Produce and apply dedicated BMP and ensure appropriate controls are in place to minimize and mitigate the potential impacts of exotic plants and animals on the Great Desert Skink, mulgara and other potential threatened species populations of the area. • As part of BMP incorporate a monitoring program for Great Desert Skink and mulgara using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor possible impacts of exotic plants and animals on the population. Part of this monitoring would include an assessment of the abundance of exotic/native predators.	**Low**	Section 5.5.6 Section 6.6
Waste water				No effect is predicted	• Not applicable.		
Lowering or contamination of water table				No effect is predicted	• Not applicable.		
Traffic mortality				No effect is predicted	• Not applicable.		
Interfere with the recovery of the species							
Clearing – dispersal and foraging habitat	2	2	**Low**	The Brush-tailed Mulgara, Great Desert Skink, and Greater Bilby to lose 880.94 ha of known (for mulgara and Great Desert Skink) and possible (for Greater Bilby) breeding/foraging/dispersal habitat, equating to 2.12% of 41,568 ha of available habitat. The Princess Parrot to lose 998.15 ha of possible foraging and dispersal habitat, equating to 2.4 % of the approximately 41,568 ha (would be more than this as it also includes riparian habitats if the mine site). This suggests that it is **unlikely** that the planned removal of habitat for these species may result in a **minor** impact to habitat quality for the above species. For the Great Desert Skink, current plans are to avoid the active warren, if this changes, the risk severity could change to '**medium**' for GDS.	• Minimise impact via actions in Section 6.1. • Produce and apply dedicated Biodiversity Management Plan (BMP) and ensure appropriate construction, weed, weed hygiene, fire and rehabilitation management aspects are covered in an attempt to minimize and mitigate clearing effects on the threatened species populations of the area. • As part of BMP incorporate a monitoring program for threatened species (particularly mulgara and Great Desert Skink) using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor the impact that clearing has on local populations.	**Low**	Section 5.5.1 Section 6.1
Dust	1	1	Low	Dust emitted from the proposed mine is likely to have a negligible effect only on threatened species present within the borefield area. The GHD 2016 Air Quality report indicates that PM10 concentrations well below 50 ug/m^3 are likely to occur possibly over 12 km away from the nearest known mulgara habitat and approx. 25 km from the nearest Great Desert Skink record. It is **rare** that dust emitted from the proposed mine would have **insignificant** impacts to threatened species of the borefield area such that species recovery is affected.	• Refer to Section 6.2. • The minimisation of dust emission controls as defined in a Dust Management Plan. • Produce and apply dedicated BMP and ensure appropriate dust controls are in place in an attempt to minimize and mitigate dust effects on the threatened species of the borefield area. • As part of BMP incorporate a monitoring program for threatened species (particularly mulgara and Great Desert Skink) using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor the impact that dust has on local populations.	Low	Section 5.5.2 Section 6.2

Noise	1	1	Low	Noise emitted from the proposed mine is likely to have a negligible effect only on threatened species present within the borefield area. The GHD 2016 Noise and Vibration report indicates that at a distance of 8 km (maximum distance that noise levels are provided in GHD noise report) most noise will be in the order of 15-31 dB(A). The lower end of this range is considered acceptable for human sleep. It is **rare** that noise emitted from the proposed mine would have **insignificant** impacts to threatened species populations in the borefield area such that species recovery would be affected.	• Refer to Section 6.3. • The implementation of noise controls as defined in a Noise Management Plan. • Produce and apply dedicated BMP and ensure appropriate noise controls are in place in an attempt to minimize and mitigate noise effects on the threatened species of the borefield area. • As part of BMP incorporate a monitoring program for threatened species (particularly mulgara and Great Desert Skink) using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor the impact that noise has on local populations.	Low	Section 5.5.3 Section 6.2
Light	1	1	**Low**	Light emitted from the proposed mine and borefield infrastructure could have a small effect on any of the nocturnal threatened fauna (e.g. Great Desert Skink, mulgara, bilby). It is **rare** that light emitted from the proposed mine would have **insignificant** impacts to habitat quality for these species.	• Refer to Section 6.4. • As mentioned in the mitigation measures section of the report, avoiding unnecessary lighting at night when nocturnal animals are active and keeping lighting low and directed at operations rather than surrounding habitat will assist greatly in mitigating impacts. • Produce and apply dedicated BMP and ensure appropriate lighting controls are in place in an attempt to minimize and mitigate artificial light effects on the threatened species populations of the area.	**Low**	Section 5.5.4 Section 6.4
Unplanned Wildfire	2	3	**Medium**	It is **unlikely** that extensive unplanned wildfire as a result of mine activities may have a **moderate** impact on the recovery of the Great Desert Skink in particular.	• Refer to Section 6.5. • A separate Bushfire Management Plan will be required to manage this risk. • Produce and apply dedicated BMP and ensure appropriate wildfire controls are in place in an attempt to minimize and mitigate the potential 'Medium' impacts on the Great Desert Skink and mulgara population of the area. • As part of BMP incorporate a monitoring program for Great Desert Skink and mulgara using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor possible impacts of fire (would include naturally occurring fire in addition).	**Low**	Section 5.5.5 Section 6.5
Exotic plants and animals	2	2	**Low**	It is **unlikely** that the introduction of exotic plants and animals as a result of mine activities may have a **minor** impact on habitat quality of the Great Desert Skink and mulgara populations. An increase in the incidence of cats, foxes and potentially dingoes could result in increased predation, particularly of more vulnerable juveniles.	• Refer to Section 6.6. • Various design aspects will need to be considered for the mine such as a predator-proof compound to contain food waste. • Produce and apply dedicated BMP and ensure appropriate controls are in place to minimize and mitigate the potential 'High' impacts of exotic plants and animals on the Great Desert Skink, mulgara and other potential threatened species populations of the area. • As part of BMP incorporate a monitoring program for Great Desert Skink and mulgara using the recent July 2015 survey as baseline data (see Section 3.3.4) to monitor possible impacts of exotic plants and animals on the population. Part of this monitoring would include an assessment of the abundance of exotic/native predators.	**Low**	Section 5.5.6 Section 6.6
Waste water				No effect is predicted	• Not applicable.		
Lowering or contamination of water table				No effect is predicted	• Not applicable.		
Traffic mortality				No effect is predicted	• Not applicable.		

7. Conclusions and recommendations

7.1 Conclusions

7.1.1 General fauna and habitat diversity in the study area

Across the 2010 and 2015 surveys, 174 native terrestrial fauna species were recorded, including 25 mammals, 103 birds, 41 reptiles, three frogs. Five introduced fauna species (all mammals) were recorded overall. These results resemble those reported for the Burt Plain Bioregion and the DLRM list, which suggests that the surveys have adequately described the fauna of the Study area. Greater survey effort is likely to result in more species being recorded.

Six fauna habitats were identified for the Study area:

- Mulga woodland
- Spinifex grassland on sandplain
- Rocky rises
- Acacia and mallee shrubland/woodland
- Riparian woodland
- Non-spinifex grassland (occasionally with sparse open woodland).

Four of those dominate the Study area, as follows:

- Mulga woodland dominates the central part of the Study area, including the Processing Site area, the northern extent of the proposed water supply pipelines, and much of the access road to/from the Stuart Highway
- Spinifex grassland on sandplain dominates the southern and western parts of the Study area, including the Borefield area and the southern extent of the proposed water supply pipelines
- Rocky habitat dominates the northern part of the Study area, particularly the Mine Site area. Smaller rocky outcrops occur along the northern boundary of the Processing Site area.
- Acacia and mallee shrubland/woodland patches occur throughout the Study area, interspersed between larger patches of other habitats. In many areas, habitats merge with others, and fire history strongly influences shrubbiness.

All of these habitats had relatively diverse fauna. Mulga had the largest species count, influenced by large species numbers of mammals and birds in particular. Spinifex grassland on sandplain was also species rich, influenced by relatively high diversity of mammals and reptiles. Rocky habitats were moderately species-rich for fauna. Note that mulga and spinifex grassland received higher overall survey effort than other habitats, because they had the largest areas within the proposed impact areas.

A large proportion (~40%) of fauna in the Study area are highly specific to particular habitats. This result was influenced strongly by mammals and reptiles, and far less so by the relatively mobile bird fauna. Spinifex grassland on sandplain and rocky habitats had the highest levels of habitat specificity among fauna, particularly with reptiles. Overall, 34.1% of all recorded reptiles were found only in sandplain spinifex habitat, and 17.1% were found only in rocky habitats (combined, >50% of all reptiles).

7.1.2 Threatened fauna in the study area

Twenty-seven fauna species that do occur or could occur within the Study area are listed as threatened (or as a related category of conservation concern) under the EPBC Act and/or TPWC Act. These include nine species (four mammals, four birds and one reptile) that were recorded in the Study area, and 18 others (six mammals, nine birds and three reptiles) that were not. All 27 species are identified and evaluated in the report. They include habitat specialists and habitat generalists, and all habitats have similar likelihood of supporting threatened fauna species.

Four of the threatened species that do occur or could occur within the Study area are listed as Vulnerable or Endangered under the EPBC Act:

- **Four mammals** –
  - Black-footed Rock-wallaby, *Petrogale lateralis MacDonnell Ranges race* (Vulnerable)
  - Bilby, *Macrotis lagotis* (Vulnerable)
- **One bird** - Princess Parrot, *Polytelis alexandrae* (Vulnerable)
- **One reptile** - Great Desert Skink, *Liopholis kintorei* (Vulnerable).

If the project results in significant residual impacts on any of these species, then compensatory offsets may be considered under the EPBC Act, in accordance with DSEWPaC (2012). According to the EPBC Act website, offsets are 'measures that compensate for the residual impacts of an action on the environment, after avoidance and mitigation measures are taken.'

To minimise or avoid significant impacts, mitigation measures (see Section 6) will need to be implemented during all construction and operations activities in habitats that are most likely to support these species.

One of these species (Black-footed Rock-wallaby) is typically restricted to rocky habitats, which occur mainly in the Mine Site area and in isolated outcrops in the borefield area (e.g. Reaphook Hills).

Another species (Great Desert Skink) is restricted to sandy habitats, which occur throughout the borefield area and along the southern extent of the proposed water supply pipelines.

Two species (Bilby and Princess Parrot) are more general in their habitat use across arid Australia, and could occur in any part of the Study area. That said, the bilby (a burrowing species) is probably more likely to use sandy habitats (rather than rocky habitats or habitats with heavier clay soils), which are more conducive to digging. Therefore, both the bilby and also the Princess Parrot are more likely to occur within the sandy habitats of the borefield.

Minimising impacts on all these species and their habitats will serve to minimise impacts on most if not all other threatened and near threatened (i.e. as listed under the TPWC Act) species also.

7.1.3 Main impacts that the project poses to fauna

Identified potential sources of impact are:

- Clearing of breeding and/foraging habitat
- Dust generated by mining and processing activities
- Noise generated by mining and processing activities
- Artificial light generated by mining and processing activities
- Unplanned wildfire
- Introduction and/or spread of exotic plants and animals

- Poisoning from drinking contaminated water
- Lowering or contamination of the water table
- Injury and death from collisions with vehicles.

7.1.4 Impact assessment process

Risk assessments were conducted for EPBC listed species Black-footed Rock-wallaby, Great Desert Skink, bilby and Princess Parrot, and for one TPWC listed species (Brush-tailed Mulgara) which was recorded within the Study area (see section 1.5.1 for rationale).

Table 27, which presents the risk assessment for Black-footed Rock-wallaby indicates that the most serious risk to this species is likely to come from unplanned wildfire and exotic flora/fauna. Both have the potential if unmitigated to exert a **High** risk on population size, critical habitat, breeding cycles and lead to population decline and inhibit species recovery. However, the implementation of mitigation and management measures presented in Section 6 would reduce these impacts to a point where the residual risk would remain **Low** to **Medium**.

Table 28 which presents the risk assessment for threatened species present within the borefield (in particular species that were recorded including the Great Desert Skink and Brush-tailed Mulgara) indicates that the most serious risk to these species is likely to come from unplanned wildfire and exotic flora/fauna. Both have the potential if unmitigated to exert a **High** risk on population size, critical habitat, breeding cycles and lead to population decline and inhibit species recovery. There is also a **Medium** risk posed by vehicle strike for vehicles travelling around the borefield at night. However, the implementation of mitigation and management measures presented in Section 6 would reduce these impacts to a point where the residual risk would remain **Low** to **Medium**.

In summary, the implementation of mitigation/management measures would allow impacts to be managed to a point where a significant impact on the threatened species that are known or have the potential to occur on the Nolans site would be unlikely.

7.2 Recommendations

This assessment resulted in the detection of three EPBC Act-listed fauna species in the study area, and identified three others that could occur there also. Recommendations made here focus on those species. In particular, they focus on the mitigation and management of impacts to these species during the construction and operation of the proposed mine.

We recommend the following:

- Prepare a Biodiversity Management Plan that documents possible sources of impact on fauna, mitigation efforts required to avoid or minimise impacts, and monitoring required to demonstrate that the project does not result in significant impacts on threatened fauna. Specific species to be addressed include Black-footed Rock-wallaby, Brush-tailed Mulgara and Great Desert Skink.
- Given the potential for all habitats within the Study area to support threatened fauna species, construction and operation of the mine across the entire Study area must be kept within the minimal possible area, and not extend into habitat areas that were not already disturbed. If additional space is required, previously disturbed areas should be considered before undisturbed habitats in all instances.

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9. Acknowledgements

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- Dr Richard C. Willan from the Museum and Art Gallery Northern Territory for identification of land snails collected from the Study area
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The contents and views expressed within this report are entirely those of GHD Pty Ltd and should not be considered to reflect the views of the parties listed above.

Appendices

Appendix A - Legislation relevant to the biodiversity fauna assessment

Commonwealth Legislation

Environment Protection and Biodiversity Conservation Act 1999

Under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), any development requires formal assessment if it has the potential to impact significantly on one or more Matters of National Environmental Significance (MNES). MNES include:

- World Heritage properties
- National Heritage places
- Wetlands of international importance (listed under the Ramsar Convention)
- Listed threatened species and ecological communities
- Migratory species protected under international agreements
- Commonwealth marine areas
- The Great Barrier Reef Marine Park
- Nuclear actions (including uranium mines)
- A water resource, in relation to coal seam gas development and large coal mining development.

MNES relating to fauna are relevant to the Nolans Rare Earths Project. Consequently, a referral under the EPBC Act was submitted to the Commonwealth Department of the Environment (DotE) on 18 February 2015. On 16 March 2015, the Commonwealth Minister for the Environment determined that the action (Project) is a "controlled action" and requires formal assessment and approval under the EPBC Act.

The Project will be assessed at the level of Environmental Impact Statement (EIS) under the Northern Territory *Environmental Assessment Act 1982*. This will be done under the NT/Commonwealth bilateral environmental assessment process.

Note that significant residual impacts (i.e. the impacts that eventuate *after* mitigation and avoidance measures have been implemented) on any MNES is likely to require compensatory offsets in accordance with DSEWPaC (2012).

Northern Territory Legislation

Environmental Assessment Act 1982 and Environmental Assessment Administrative Procedures 1984

The *Environmental Assessment Act 1982* (EA Act) and Environmental Assessment Administrative Procedures 1984 ensure each matter affecting the environment is fully examined and taken into account in relation to:

- formulation of proposals
- carrying out of works and other projects
- negotiation, operation and enforcement of agreements and arrangements (including agreements and arrangements with authorities of the Commonwealth, the states and other territories)

- making of, or the participation in the making of, decisions and recommendations
- incurring of expenditure.

In March 2008, Arafura submitted a NOI to the former NT Department of Natural Resources, Environment and the Arts for consideration under the Environmental Assessment Act (EA Act). The then Minister decided that the Project required assessment under the EA Act at the level of an EIS, and issued EIS guidelines for the Project.

In August 2008, a referral for the Project (EPBC 2008/4371) was submitted to the former Department of Environment Water Heritage and Arts for consideration under the EPBC Act. The then Australian Government Minister determined the Project to be a controlled action and that assessment and approval was required. The Project was to be assessed under a Bilateral Agreement between the Australian and the NT Governments.

In December 2014, Arafura lodged an alteration to the Project to the NT EPA.

Pursuant to clause 14A of the Environmental Assessment Administrative Procedures (EAAP), the NT EPA considered the alteration and decided that the Project has been altered in such a manner that the potential environmental significance is changed.

The changes to the scope and potential environmental impacts of the Project are such that the NT EPA deemed it necessary to issue a revised Terms of Reference. The Terms of Reference were issued in May 2015.

Territory Parks and Wildlife Conservation Act 2006

The extended title of the TPWC Act is:

> "An Act to make provision for and in relation to the establishment of Territory Parks and other Parks and Reserves, and the study, protection, conservation and sustainable utilisation of wildlife".

The TPWC Act has provisions for parks and reserves, animals and plants (including wildlife and protected wildlife).

The TPWC Act defines wildlife as that being in a park, reserve, sanctuary, wilderness zone or area of essential habitat, or is a vertebrate that is indigenous to Australia (other than fish), or is specifically prescribed as being protected by the TPWC Regulations. Protected wildlife is protected whether or not the property with the wildlife is vested in the Territory.

The TPWC Act prohibits the intentional killing of any terrestrial or marine vertebrate (with the exception of fish).

All threatened species are classed as protected wildlife. The TPWC Act precludes the taking of and interference with protected species of wildlife. The Act includes "Principles of Management". These require that a threatened species be managed in a manner that "maintains or increases their population or the extent of their distribution at or to a sustainable level". Threatened species are defined under the Territory's Wildlife regulations as being species that are 'extinct", "critically endangered", "endangered" and "vulnerable".

This study assesses the likelihood that fauna listed under the TPWC Act occur within the Study area and their potential to be impacted by the proposal.

Mining Management Act 2001

The *Mining Management Act 2001* provides for authorisation of mining activities, management of mining sites, protection of the environment on mining sites and related purposes. The Act is administered by Department of Mines and Energy (DME). The objectives of the Act are:

- ensure the development of the Territory's mineral resources in accordance with environmental standards consistent with best practice in the mining industry
- protect the environment by:
  - requiring authorisation for and monitoring of mining activities
  - requiring appropriate management of mining sites through implementation of management systems
  - facilitating consultation and cooperation between management and workers in implementing environment protection management systems
  - implementing audits, inspections, investigations, monitoring and reporting to ensure compliance with agreed standards and criteria
  - specifying the obligations of all persons on mining sites with respect to protection of the environment.
- assist the mining industry to introduce programs of continuous improvement to achieve best practice environmental management
- enable persons connected with the mining industry to participate in the implementation of this Act through the establishment of a Mining Board to advise the Minister on:
  - guidelines for the industry
  - specification of competencies required by persons involved in the industry
  - best practice in mining activities
  - minimising the liability of the Territory by requiring the payment of security to provide for the rehabilitation of mining sites or to rectify environmental harm caused by mining activities.

The Mining Management Amendment Bill 2011 was passed and came into force on 1 July 2012. Key changes include:

- enabling the Chief Executive Officer (CEO) of DME to require investigations of less-serious environmental incidents that do not result in material environmental harm (in addition to the current requirements for incidents causing material environmental harm)
- allowing the publication of reports by operators or mining officers following environmental incidents
- obligation for mining operations on mineral leases to publically report environmental performance in the form of an Environmental Mining Report (EMR) which forms part of the annually submitted Mining Management Plan (MMP)
- introducing new environmental offences and confirming the application of Part IIAA of the Criminal Code Act (NT) (the Criminal Code) to offences under the Act
- Community Benefits Plan (CBP) required for authorisation of a new mine.

Approval for the proposed work is required from the Minister of Primary Industry, Fisheries and Resources. The environmental assessment process will allow the Minister to be informed of potential environmental impacts and proposed management to assist in the decision making process.

An approved Mining Management Plan will be required prior to commencement of proposed works if the Project is approved. The Minster will require security for potential costs of rectifying environmental harm and rehabilitating the site.

Northern Territory Environment Protection Authority Act 2012

The *Northern Territory Environment Protection Authority Act 2012* commenced on 1 January 2013. The Act establishes the new Northern Territory Environment Protection Authority (NT EPA) as an independent regulatory authority and makes consequential amendments to the Waste Management and Pollution Control Act and the Environmental Assessment Act.

Amendments to the Waste Management and Pollution Control Act identify the NT EPA as the entity responsible for administration of the regulatory functions of that Act.

Amendments to the Environmental Assessment Act identify the NT EPA as the entity responsible for administration of the assessment functions and impose additional transparency and reporting responsibilities on the Environment Minister and the responsible Minister for specific projects (NT Government 2012).

Planning Act 2009

The *Planning Act 2009* defines "development" as an activity that involves carrying out works on land, including clearing of native vegetation. "Works" is defined as any activity on land other than mining or agriculture, resulting in a physical change to the land or a part of the land.

The planning scheme requires native vegetation to be cleared in accordance with the Land Clearing Guidelines 2010 (NRETAS 2010), which contain guidelines for clearing, including the submission of a property management plan by the applicant. The Land Clearing Guidelines do not apply to this project, because the proposed works are being undertaken as part of a mining operation. However, one of the requirements stipulated in the Environmental Impact Statement (EIS) guidelines (NT EPA 2013) is to discuss proposed clearing with regard to issues raised and recommendations contained in the Clearing Guidelines.

Other Legislation

Other legislation that may be applicable to the Project includes:

- *Weeds Management Act 2001*
- *Bushfires Act 2009*
- *Soil Conservation and Land Utilisation Act 1980*.

Northern Territory Policies and Guidelines

Northern Territory Environment Protection Authority Draft Guidelines

This biodiversity assessment was prepared in accordance with the guidelines outlined below:

- Guidelines on Environmental Offsets and Associated Approval Conditions
- Guidelines on Assessment of Impacts on Terrestrial Biodiversity.

The NT Government has developed standardised methods for surveying terrestrial fauna and flora in the Northern Territory. These guidelines were complied with when undertaking this assessment.

Appendix B – Images of 2015 and 2010 fauna survey sites

2015 sites

Mulga shrubland; Fauna survey site 1

Mulga shrubland; Fauna survey site 2

Rocky habitat; Fauna survey site 3

Shrubland/woodland; Fauna survey site 4

Rocky habitat; Fauna survey site 5

Shrubland/woodland; Fauna survey site 6

Mulga shrubland; Fauna survey site 7

Mulga shrubland; Fauna survey site 8

Sandplain spinifex; Fauna survey site 9

Sandplain spinifex; Fauna survey site 10

Sandplain spinifex; Fauna survey site 11

Sandplain spinifex; Fauna survey site 12

Sandplain spinifex; Fauna survey site 13

2010 sites

Mulga woodland/shrubland on sandy red earths; representative of sites M01, M06, T08 and T10.

Rocky rise, with Acacia shrubland and Triodia; site M02.

Rocky rise, with mallee/Acacia shrubland and Triodia; site M03.

Open grassy woodland on alluvial plains; representative of sites M04 and T07.

Riparian woodland; site M05

Triodia hummock grassland on sand plains; site T09.

Hakea/Senna shrubland on calcareous alluvial plains and low rises; representative of 2010 fauna survey sites T11 and T12.

Appendix C – Results of the EPBC Act protected matters search

Australian Government

Department of the Environment

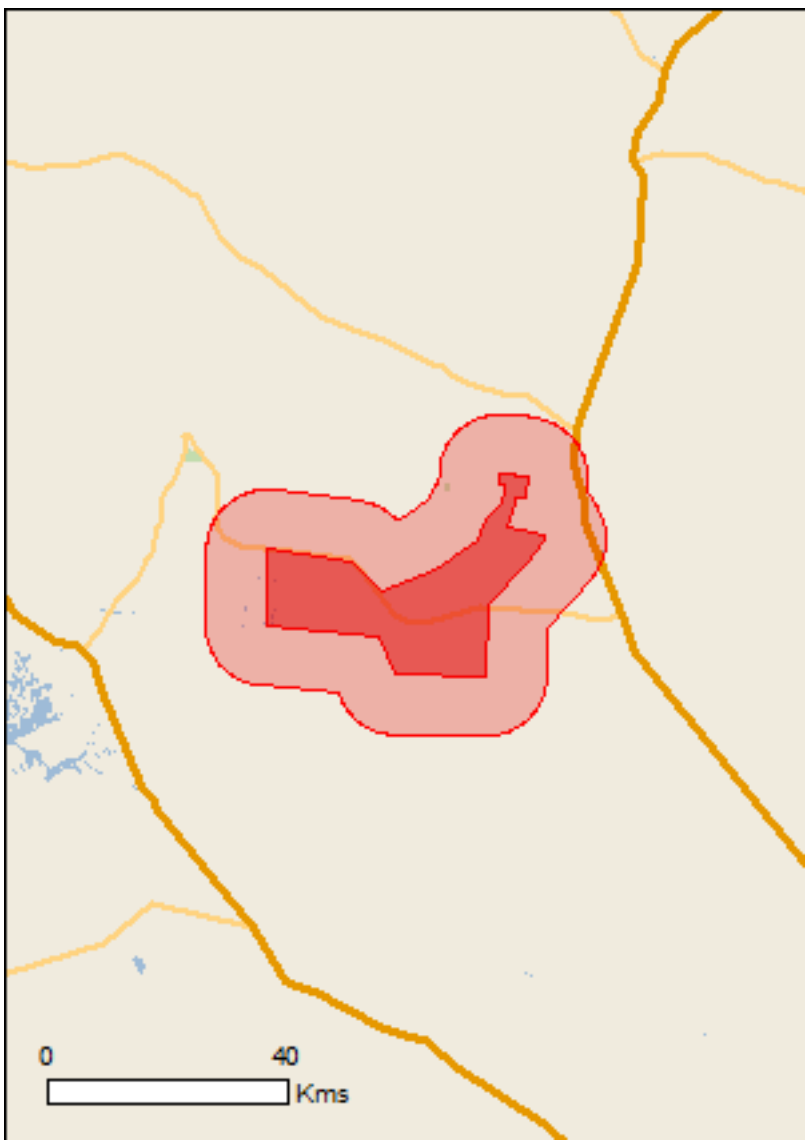
EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

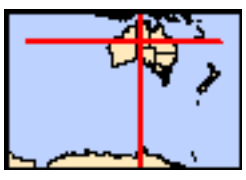
Report created: 06/02/15 12:48:31



This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2010

Coordinates

Buffer: 10.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Areas:	None
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	7
Listed Migratory Species:	7

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place and the heritage values of a place on the Register of the National Estate.

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	7
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Commonwealth Reserves Marine	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

Place on the RNE:	1
State and Territory Reserves:	1
Regional Forest Agreements:	None
Invasive Species:	12
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Listed Threatened Species		[Resource Information]
Name	Status	Type of Presence
Birds		
Erythrotriorchis radiatus Red Goshawk [942]	Vulnerable	Species or species habitat may occur within area
Polytelis alexandrae Princess Parrot, Alexandra's Parrot [758]	Vulnerable	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Mammals		
Macrotis lagotis Greater Bilby [282]	Vulnerable	Species or species habitat likely to occur within area
Notoryctes typhlops Itjaritjari, Southern Marsupial Mole, Yitjarritjarri [296]	Endangered	Species or species habitat likely to occur within area
Petrogale lateralis MacDonnell Ranges race Warru, Black-footed Rock-wallaby (MacDonnell Ranges race) [66649]	Vulnerable	Species or species habitat likely to occur within area
Reptiles		
Liopholis kintorei Great Desert Skink, Tjakura, Warrarna, Mulyamiji [83160]	Vulnerable	Species or species habitat may occur within area

Listed Migratory Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species

Name	Threatened	Type of Presence
		habitat likely to occur within area
Migratory Terrestrial Species		
[Merops ornatus](#) Rainbow Bee-eater [670]		Species or species habitat may occur within area
Migratory Wetlands Species		
[Ardea alba](#) Great Egret, White Egret [59541]		Species or species habitat likely to occur within area
[Ardea ibis](#) Cattle Egret [59542]		Species or species habitat may occur within area
[Charadrius veredus](#) Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
[Glareola maldivarum](#) Oriental Pratincole [840]		Species or species habitat may occur within area
[Rostratula benghalensis (sensu lato)](#) Painted Snipe [889]	Endangered*	Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Birds		
[Apus pacificus](#) Fork-tailed Swift [678]		Species or species habitat likely to occur within area
[Ardea alba](#) Great Egret, White Egret [59541]		Species or species habitat likely to occur within area
[Ardea ibis](#) Cattle Egret [59542]		Species or species habitat may occur within area
[Charadrius veredus](#) Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
[Glareola maldivarum](#) Oriental Pratincole [840]		Species or species habitat may occur within area
[Merops ornatus](#) Rainbow Bee-eater [670]		Species or species habitat may occur within area
[Rostratula benghalensis (sensu lato)](#) Painted Snipe [889]	Endangered*	Species or species habitat may occur within area

Extra Information

Places on the RNE [Resource Information]

Note that not all Indigenous sites may be listed.

Name	State	Status
Historic		
Annas Reservoir Historic Reserve	NT	Registered

State and Territory Reserves [Resource Information]

Name	State
Anna's Reservoir	NT

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Camelus dromedarius Dromedary, Camel [7]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species

Name	Status	Type of Presence
		habitat likely to occur within area
[Cylindropuntia spp.](#) Prickly Pears [85131]		Species or species habitat likely to occur within area
[Opuntia spp.](#) Prickly Pears [82753]		Species or species habitat likely to occur within area
[Parkinsonia aculeata](#) Parkinsonia, Jerusalem Thorn, Jelly Bean Tree, Horse Bean [12301]		Species or species habitat likely to occur within area
Reptiles		
[Hemidactylus frenatus](#) Asian House Gecko [1708]		Species or species habitat likely to occur within area

Coordinates

-22.5662530931 133.217235194,-22.5665208879 133.241541187,-22.5701327521 133.241495364,-22.5703233244 133.258996361,-22.5974125046 133.25865581, -22.5972323303 133.242123856,-22.6062619559 133.242009146,-22.6391543781 133.229546406,-22.648097759 133.283453226,-22.6552052451 133.286827973, -22.6889349809 133.255233247,-22.7442544784 133.200472989,-22.8432263445 133.198479689,-22.8416302115 133.062569498,-22.7912052 133.0390195, -22.7742282844 132.868057999,-22.6694839696 132.869680932,-22.684633041 132.997591666,-22.7275809917 133.069927692,-22.6957849226 133.122127951, -22.6560125807 133.185003185,-22.6278573255 133.1964526,-22.6060369492 133.221558722,-22.5880316456 133.226801181,-22.5790020893 133.226795787, -22.5788894444 133.217072566,-22.5662530931 133.217235194

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World Heritage properties, Register of the National Estate properties, Wetlands of International Importance (Ramsar Convention) sites, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

For species where the distributions are well known, maps are digitised from sources such as recovery plans and detailed habitat studies. Where appropriate, core breeding, foraging and roosting areas are indicated under 'type of presence'. For species whose distributions are less well known, point locations are collated from government wildlife authorities, museums, and non-government organisations; bioclimatic distribution models are generated and these validated by experts. In some cases, the distribution maps are based solely on expert knowledge.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Department of Environment, Climate Change and Water, New South Wales
-Department of Sustainability and Environment, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment and Natural Resources, South Australia
-Parks and Wildlife Service NT, NT Dept of Natural Resources, Environment and the Arts
-Environmental and Resource Management, Queensland
-Department of Environment and Conservation, Western Australia
-Department of the Environment, Climate Change, Energy and Water
-Birds Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-SA Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Atherton and Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
-State Forests of NSW
-Geoscience Australia
-CSIRO
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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Appendix D – Threatened, Near Threatened and Data Deficient fauna species identified for the Study area.

Conservation Status:

EPBC Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*

TPWC *Territory Parks and Wildlife Conservation Act 2006*

EX	Extinct	EW	Extinct in the wild	CR	Critically endangered	NT	Lower risk - near threatened
EN	Endangered	DD	Data deficient	VU	Vulnerable	RX	Regionally extinct

PMST	Identified by the PMST search tool of the EPBC Act	GHD	Detected during 2010/11 or 2015 survey
LRMDLRM	Recorded on the DLRM list (within 20 km of Study area)	BPB	Recorded on the list for the Burt Plain Bioregion

Likelihood of occurrence of fauna is assessed on a 4-tier scale:

1: **Present** – observed during 2015 baseline fauna survey

2: **Possible** - suitable habitat occurs within the Study area, and site is within species' normal range

3: **Unlikely** - suitable habitat does not occur within the Study area, or suitable habitat present but substantially modified or degraded. Species not recorded for over 30 years

4: **Highly unlikely** – no suitable habitat within the Study area and site is outside species' normal range.

Species	EPBC	TPWC	Source	Most recent (DLRM or other)	Likelihood of occurrence within the study area	Comments
MAMMALS						
Central rock-rat *Zyzomys pedunculatus*	EN	EN	BPB	-	**Unlikely** – all areas	None were recorded during the GHD field surveys, nor during previous field surveys at the site (Low Ecological Services 2007). The only known extant populations occur within the McDonnell Ranges. The rocky hills occurring at the site and in the surrounds (to the west of the Stuart Highway) could potentially provide suitable habitat for this species. There is a low possibility that a population could persist in the area and have escaped detection due to a lack of survey effort within elevated rocky outcrops, although this is a remote possibility.

Species	EPBC	TPWC	Source	Most recent (DLRM or other)	Likelihood of occurrence within the study area	Comments
Southern Marsupial Mole *Notoryctes typhlops*	-	VU	BPB	-	**Unlikely** - Mine site and Processing site **Possible** - Borefield area	Not recorded during the 2010 or 2015 surveys, and no records exist for the Study area. However, poorly known species and rarely seen because of its subterranean habits. Sandplain habitat in the southern part of the Study area is potentially suitable, but is marginal rather than high quality. Habitat present at the mine site is likely to be too wooded and/or rocky, and the Processing site is shallow basement rock and no dunes are present. Low likelihood of species persisting in soft sandy areas in river flats. This species may be present in the southern part of the Study area, but is expected to occur in very low densities, to the point that it is likely to be barely detectable. Targeted surveys require high-impact soil disturbance, resulting in occasional (~15%) detection of tracks/tunnels rather than moles themselves (Watson 2006). Thus, targeted surveys are not recommended here, because they are considered likely to result in a Type II error (false negative; i.e. failure to detect the species when the species is present), and are unlikely to provide useful information on the species' distribution or population size that can be translated into more effective mitigation for the species. Impacts on this subterranean species are possible where sub-surface soil/sand disturbance occurs. This is expected to be in the actual bore locations within the borefield, and along the southern extent of the proposed water supply pipelines, except where the pipe is installed within an existing track/roadway.
Golden bandicoot *Isoodon auratus*	VU	EN	BPB	-	**Highly Unlikely** – all areas	Range has contracted considerably across the Northern Territory, and is now restricted to a small island off Arnhem land (Woinarski *et al* 2007). On this island, it uses heathland, shrubland on sandstone and sandsheets (Woinarski et al 2007). Its former use of habitat across the remainder of the state is poorly known.

Species	EPBC	TPWC	Source	Most recent (DLRM or other)	Likelihood of occurrence within the study area	Comments
Brush-tailed mulgara *Dasycercus blythi*	-	VU	GHD 2015	2015 GHD	**Present** - Borefield area **Unlikely** - Mine site and Processing site	Detected in borefield area with motion-sensing cameras (May 2015) and field surveys (July 2015). All spinifex-dominated areas in the sand plain areas likely to support this species. Areas with spinifex occurring at the mine site are likely to be too rocky to support this species. Targeted survey recommended in the sandplain areas (i.e. borefield area and southern extent of proposed water supply pipelines) to determine population size and distribution in areas proposed for impacts.
Crest-tailed mulgara *Dasycercus cristicauda*	VU	VU	BPB	-	**Unlikely** – all areas	None detected. May occur in the general area; but considered unlikely to occur within the Study area on the basis of habitat. The Crest-tailed Mulgara tends to occur on sand dunes that have a sparse cover of sandhill canegrass, or in areas around saltlakes with nitrebush (Van Dyck et al. 2013).
Greater Bilby (Bilby) *Macrotis lagotis*	VU	VU	PMST, BPB	-	**Possible** – all areas, but particularly in sandplain areas in southern parts of Study area	Not recorded during the 2010 or 2015 surveys, and no records exist for the Study area, although suitable habitat is present. Spinifex-dominated habitats within the study area provide potential habitat, including rocky areas and areas with a low shrub cover. Species occupies vegetation types including open tussock grassland on uplands and hills, mulga woodland/shrubland growing on ridges and rises, and hummock grassland in plains and alluvial areas (Southgate 1990b). In favourable conditions, populations can expand rapidly in abundance and occupied area (Woinarski et al. 2007). Species once widespread across NT, but populations declined dramatically following European settlement. The Bilby is now generally reported from the western deserts region of NT, although other sightings occur occasionally. Species considered likely to still be present in this part of NT, albeit probably in small numbers. Species known from the Burt Plain Bioregion.

Species	EPBC	TPWC	Source	Most recent (DLRM or other)	Likelihood of occurrence within the study area	Comments
Black-footed Rock-wallaby (MacDonnell Ranges race) *Petrogale lateralis*	VU	NT	GHD, DLRM, PMST, BPB	2011 GHD 1987 DLRM	**Present** - Mine site **Unlikely** - all other areas	Results from the scat analysis from samples collected (2011 survey) indicate that this species occasionally passes through the mine site itself. Follow up surveys in July 2015 confirmed a reproductive population in the vicinity of the mine site and surrounding ranges as well as occupying isolated outcrops in the southern borefield area (e.g. Reaphook Hills). Suitable habitat for this species is present within the rocky outcrops of the mine site, with habitat connectivity to other ranges nearby, suggesting that a larger population persists in the Reynolds Range area. Two waste rock dumps at the west of the mine site will directly impact a small area of likely habitat. Most of the habitat in the area surrounding the Mineral Lease will not be directly impacted by the project.
Common brushtail possum (central Aust population) *Trichosurus vulpecula vulpecula*	-	EN	BPB	-	**Possible** - Mine site and Processing site **Unlikely** - Borefield area	None were recorded during the GHD field surveys, nor during previous field surveys at the site (Low Ecological Services 2007). It is possible that a population persists at the site, although none have been confirmed from the local area since before the 1970s (Woinarski *et al* 2007). Suitable habitats within the Study area would include the creek-lines with large hollow-bearing trees, spinifex grasslands with a shrubby or treed overstorey and the rocky outcrop areas.
Pale field-rat *Rattus tunneyi*	-	VU	BPB	-	**Possible** - Mine site and Processing site **Unlikely** - Borefield area	None were recorded during the GHD field surveys, nor during previous field surveys at the site (Low Ecological Services 2007). The rocky hills occurring at the site and in the surrounds (to the west of the Stuart Highway) could potentially provide suitable habitat for this species. There is a possibility that a population could persist in the area and have escaped detection due to a lack of survey effort within elevated rocky outcrops.
Western antechinus (Kultarr) *Antechinomys laniger*	-	NT	BPB and Milligan 1980	1980	**Possible** - Borefield area **Unlikely** - Mine site and Processing site	None detected during GHD surveys or previous surveys at site. Appears to be little or no suitable habitat for this species within the mine site, using habitat requirements stated in Menkhorst and Knight (2004). Potentially suitable habitat in sandy/stony grassy plains.

Species	EPBC	TPWC	Source	Most recent (DLRM or other)	Likelihood of occurrence within the study area	Comments
Spectacled hare-wallaby *Lagorchestes conspicillatus*	-	NT	GHD 2015, BPB	2015	**Present** - Borefield area (tracks found in the during the GHD 2015 survey.) **Possible** – other areas	Tracks found in the Borefield area during the GHD 2015 survey. No animals were seen. Not recorded during previous field surveys at the site (Low Ecological Services 2007). Study area near southern limit of potential distribution (Menkhorst and Knight 2004). Although generally a low likelihood, there is a possibility of a population persisting at the site in spinifex-dominated areas, particularly areas with a dense mid-level, or sparse tree and shrub cover (Menkhorst and Knight 2004).
Northern Nailtail Wallaby *Onychogalea unguifera*	-	NT	GHD 2015	2015	**Present** – Processing Site area (tracks and scats found during the GHD 2015 survey.) **Possible** – other areas	Northern Nailtail Wallaby tracks and scats were recorded during the 2015 survey at one survey site around the processing site. Could occur anywhere in open woodland or shrubland.
Long-haired rat *Rattus villosissimus*	-	NT	BPB	-	**Possible** – all areas	None were recorded from the site during the present GHD surveys or from previous surveys (Low Ecological Services 2007). This species known from the Burt Plain Bioregion. During periods of extended dry, populations are thought to retreat to moist patches along streams and bore overflows, and then expand across most habitat types across a much broader area in when conditions are favourable (Menkhorst and Knight 2004). Surveys undertaken over the next 2-3 years (following the favourable rains in 2010) could therefore potentially detect the species at both the mine site and along the haul route.
Ghost bat *Macroderma gigas*	-	NT	BPB	-	**Highly Unlikely** – all areas	Presumed to have become extinct in the central area of Northern Territory, but still persists in tropical northern areas of the state (Menkhorst and Knight 2004). The caves in the rock outcrops could have been used as roost sites by the species.

Species	EPBC	TPWC	Source	Most recent (DLRM or other)	Likelihood of occurrence within the study area	Comments
Pig-footed bandicoot *Chaeropus ecaudatus*	EX	EX	DLRM, BPB	1891 DLRM	**Highly Unlikely** – all areas	After a long period of decline, presumed to have become extinct in the Northern Territory, and throughout its Australian range, in the 1950s (Woinarski et al 2007).
Desert bandicoot *Perameles eremiana*	EX	EX	BPB	-	**Highly Unlikely** – all areas	Presumed to become extinct in the Northern Territory, and throughout its Australian range, in the 1960s, with the last specimen collected in 1943 (Woinarski *et al* 2007). Could have occurred in sand plain habitats along the haul route.
Burrowing bettong (inland subspecies) *Bettongia lesueri graii*	EX	RX	BPB	-	**Highly Unlikely** – all areas	Presumed to become extinct in the Northern Territory, and throughout its Australian range, in the 1950s (Woinarski *et al* 2007). Could have occurred in a range of habitats types within the mine site and along the haul route.
Brush-tailed bettong *Bettongia penicillata*	EX	RX	BPB	-	**Highly Unlikely** – all areas	Presumed to become extinct in the Northern Territory in the 1950s (Woinarski *et al* 2007). Could have occurred in a range of habitats types within the mine site and along the haul route, with a higher likelihood of occurring in the sandplain area.
Central hare-wallaby *Lagorchestes asomatus*	EX	EX	BPB	-	**Highly Unlikely** – all areas	Presumed to become extinct in the Northern Territory, and throughout its Australian range, between 1940 and 1960 (Woinarski *et al* 2007). Little is known of its habitat preferences, but it is suspected to shelter under spinifex clumps (Woinarski *et al* 2007).
Crescent nailtail wallaby *Onychogalea lunata*	EX	EX	BPB	-	**Highly Unlikely** – all areas	Presumed to become extinct in the Northern Territory, and throughout its Australian range, in the 1960s (Woinarski *et al* 2007). Within the Study area, it could have occurred within the mulga-dominated habitats.
Long-tailed hopping-mouse *Notomys longicaudatus*	EX	EX	BPB	-	**Highly Unlikely** – all areas	The last specimen was collected in 1901-02, and it is presumed to have become extinct in the Northern Territory, and throughout its Australian range, in the subsequent decades (Woinarski *et al* 2007). Little is known of this species, and it is not certain if the Study area would have contained suitable habitat for it.

Species	EPBC	TPWC	Source	Most recent (DLRM or other)	Likelihood of occurrence within the study area	Comments
Lesser stick-nest rat *Leporillus apicalis*	EX	EX	BPB	-	**Highly Unlikely** – all areas	Presumed to have become extinct in the Northern Territory, and throughout its Australian range, by the 1940s (Woinarski *et al* 2007). The Study area appears to be at (or beyond) the northern extent of where this species occurred. Knowledge of the habitats requirements of this species is poor (Woinarski et al 2007). This species may have used the rocky outcrops within the Study area and surrounds.
Red-tailed phascogale *Phascogale calura*	EN	RX	BPB	-	**Highly Unlikely** – all areas	After a long period of decline, presumed to become extinct in the Northern Territory in the 1950s (Woinarski et al 2007). Within Study area, could have occurred in habitats with eucalypts, particularly bloodwoods.
Rufous hare-wallaby (central mainland form) (Mala) *Lagorchestes hirsutus*	EN	EW	BPB	-	**Highly Unlikely** – all areas	Was still common in the Tanami desert until the 1930s (Woinarski *et al* 2007). The last known wild colony was extinguished by wildfire in 1992 (Woinarski *et al* 2007). It survives in a semi-captive population in fenced enclosures at a couple of locations (the nearest at Uluru Kata Tjuta National Park), and as captive populations at a small number of wildlife sanctuaries (Woinarski *et al* 2007). If it had occurred within the Study area, it is likely to have used one or more of the spinifex-dominated habitats.
Western quoll *Dasyurus geoffroii*	VU	RX	BPB	-	**Highly Unlikely** – all areas	Once formerly common across central Australia, but presumed to have become extinct in the Northern Territory in the 1960s (Woinarski et al 2007). Formerly occupied a range of vegetation types, particularly areas unburnt for 20 years or more (Woinarski *et al* 2007).
BIRDS						

Species	EPBC	TPWC	Source	Most recent (DLRM or other)	Likelihood of occurrence within the study area	Comments
Night parrot *Pezoporus occidentalis*	EN	CR	BPB	-	**Unlikely** – all areas	None were recorded during the GHD field surveys. The night parrot forages for grass seeds on the ground at night, sheltering during the day in spinifex grasslands. The species prefers spinifex grasslands in stony or sandy areas and samphire and chenopod associations on floodplains, salt lakes and claypans. This species seems to prefer old-growth rather than younger or smaller spinifex. The last potential sighting in the Northern Territory was in January 1996, when two individuals were reported at a stock watering point on Newhaven Station, 350 km NW of Alice Springs (C.Pavey NRETA, Threatened Species Information Sheet – Night Parrot). Spinifex/sand plain habitats support potential habitat for this species. However, this species is extremely rare, and its rarity over the past many decades suggests that it is unlikely to be present.
Australian Painted Snipe *Rostratula australis*	EN	VU	PMST, BPB	-	**Unlikely** – all areas	No records exist for the Study area. None were detected during the GHD surveys. The ephemeral waterways and associated floodplains within the mine site do not appear to provide preferred habitat. The Nolan Bore pond appears to be too small, and is regularly disturbed by cattle. Waterbodies within the study area and nearby are ephemeral. There is little or no suitable habitat for this species elsewhere within the study area.
Malleefowl *Leipoa ocellata*	VU	CR	DLRM, BPB	No date	**Highly Unlikely** – all areas	One record exists within 10 km of the Study area along the Stuart Highway, though it is not a reliable record and has no date recorded. In the fauna database it has a comment, “Observation location guessed from map - awaiting proper co-ords”. It is thought that Malleefowl could be extinct in the Northern Territory (Benshemesh 2000). There have been no confirmed records from within the Northern Territory since the 1950s (Woinarski *et al* 2007). However, as there are large parts of its range that have not been adequately surveyed, the potential for a small population to persist remains (Woinarski et al 2007), albeit small.

Species	EPBC	TPWC	Source	Most recent (DLRM or other)	Likelihood of occurrence within the study area	Comments
Princess Parrot *Polytelis alexandrae*	VU	VU	PMST, BPB	-	**Unlikely** – Mine site **Possible** – all other areas	Not recorded during the 2010 or 2015 surveys, and no records exist for the Study area, although suitable habitat is present. Species has patchy and irregular distribution in arid Australia. In NT, it occurs in the southern section of the Tanami Desert south to Angas Downs and Yulara and east to Alice Springs. The exact distribution within this range is not well understood. Few locations exist in the Northern Territory where the species is regularly seen, and even then there may be long intervals (up to 20 years) between records. Most records from the MacDonnell Ranges Bioregion are during dry periods (DLRM 2006). Species considered unlikely to use habitats within the mine site due to the absence of dune and swale habitats (although species has been recorded in riverine, woodland and shrubland habitat occasionally; Woinarski et al. 2007). Sandplain habitats in the borefield area provide potential foraging habitat for this species, with potential nesting sites also occurring in the sparse hollow-bearing trees. Possible occasional visitor.
Red Goshawk *Erythrotriorchis radiatus*	VU	VU	PMST, BPB	-	**Unlikely** – all areas	No records exist for the Study area. Most NT records are from the northern tropical parts of the NT, with occasional observations of the species in central Australia (Woinarski et al. 2007). Tends to prefer tall open eucalypt forest and riparian areas in northern Australia. There appears to be little or no suitable habitat for this species in the Study area.
Grey falcon *Falco hypoleucos*	-	VU	BPB; and Milligan 1980	1980	**Possible** – all areas	None recorded during the GHD surveys. Species favours lightly timbered Acacia scrub, spinifex and tussock grasslands (Blakers *et al*., 1987). Preys primarily on birds, especially parrots and pigeons, while reptiles and mammals are also captured (DECC website 2010). This species could potentially use most habitats in the study area, particularly habitats within the mine site area (where it could even breed within the high rocky outcrops).

Species	EPBC	TPWC	Source	Most recent (DLRM or other)	Likelihood of occurrence within the study area	Comments
Redthroat *Pyrrholaemus brunneus*	-	NT	DLRM, BPB and Low 2007	2006 DLRM; And Low 2007	**Possible** – all areas	There is one record of this species in the Study area in 2006. Habitat includes inland scrubs, mulga and other acacias which are present in the Study area.
Emu *Dromaius novaehollandiae*	-	NT	GHD 2015, BPB	2015	**Present** – Borefield area **Possible** - all other areas	Tracks recorded in sandplain spinifex habitat during the GHD 2015 survey. Potential habitat throughout all study area.
Australian bustard *Ardeotis australis*	-	NT	GHD 2010, 2015; DLRM, BPB	2015 GHD; 1985 DLRM	**Present/possible** – all areas	Three Australian bustards detected in open grassland along the haul route (GHD 2010), approximately 10 km west of the eastern extent. This habitat occurs sporadically in the area, and provides suitable habitat for this species (Woinarski *et al* 2007). After fire, the species may use a wide range of open habitats, even woodland areas (Woinarski et al 2007).
Flock bronzewing *Phaps histrionica*	-	NT	GHD 2010; BPB	2010	**Present/possible** – all areas	During GHD 2010 surveys, two flock bronzewings were observed in sand plain habitat at the far eastern end of the haul route. Similar habitats are common within the Study area. Spinifex-dominated grasslands and sparse mulga shrublands are amongst habitats known to be used by the species, but are probably not considered to be amongst the habitats in which the species is most commonly detected (Higgins and Davies 1996).
Square-tailed kite *Lophoictinia isura*	-	NT	BPB	-	**Possible** – all areas	None were recorded during the GHD surveys, and no historical records exist within 20 km of the study area. This species tends to favour dry woodland and open forests, with a particular preference for timbered watercourses. This species could potentially occur within woodland habitats, particularly along the creek-lines that run through the mine site, although its' occurrence is likely to be relatively infrequent. This species has occasionally been recorded in more open habitats such as chenopod shrublands. It is possible that the square-tailed kite could occasionally be present, though probably only very rarely as this represents marginal habitat.

Species	EPBC	TPWC	Source	Most recent (DLRM or other)	Likelihood of occurrence within the study area	Comments
Red-tailed Black-cockatoo *Calyptorhynchus banksii samueli*	-	NT	BPB; and Milligan 1980	1980	**Possible** – mine site and processing site **Unlikely** - borefield area	Red-tailed black cockatoos prefer Eucalypt woodlands bordering watercourses but are also located in dense eucalypt forests, woodlands dominated by Acacia and recently burnt shrubland and timbered grassland. The species is highly dependent on large, old eucalypts for nesting hollows. This species could occasionally be present within the mine site and processing site, although probably only when suitable resources are present. The river red gums within the mine site are probably not sufficiently large enough to support breeding activity.
Scarlet-chested parrot *Neophema splendida*	-	NT	BPB	-	**Possible** – all areas	None were recorded during the GHD field surveys. The scarlet-chested parrot inhabits semi-arid areas with mallee and mulga scrublands/open woodlands with spinifex and saltbush ground covers. The species occurs in both recently burnt and older growth mallee. This is an irruptive species and although not likely to be resident within the study area, could occur within any of the habitats under suitable conditions.
Striated grasswren *Amytornis striatus*	-	NT	BPB	-	**Possible** – all areas	None were recorded during the GHD field surveys. Formerly distributed across much of the spinifex hummock grasslands of central Australia. The south-eastern subspecies *Amytornis striatus striatus* occurs in the southern half of the Northern Territory where it is scarce. There, most recent records are from the Finke Bioregion to the south of Alice Springs (1987 and 1996) and from the Burt Plain Bioregion. The species is confined to areas with mature Spinifex, usually in association with mallee eucalypts and sandy soils (DECCW website 2010). This species could possibly occur within spinifex/mallee, spinifex/acacia associations in rocky outcrops dotted throughout the mine site, and possibly across the broader sand plain habitats of the study area.
Clamorous reed-warbler *Acrocephalus australis*	-	NT	BPB	-	**Highly Unlikely** – all areas	None were recorded during the GHD field surveys. The dense fringing emergent vegetation required by this species does not appear to be present within either the mine site or haul route.

Species	EPBC	TPWC	Source	Most recent (DLRM or other)	Likelihood of occurrence within the study area	Comments
Bush Stone-curlew *Burhinus grallarius*	-	NT	DLRM, BPB	2015 GHD 2006 DLRM; and Low 2007	**Present** - Processing site and Mine site **Possible** – all other areas	Detected during the GHD 2015 surveys and during previous surveys (Low Ecological Services 2007). Suitable habitat occurs across much of the Study area. There appears to be a healthy population as the GHD 2015 survey recorded a number of the species in the processing site area. Open woodland with scattered woody debris, preferred habitat for this species appears to be present within the mine site and could support a small transient population of this species.
Chestnut Quail-thrush *Cinclosoma castanotum*	-	NT	DLRM, BPB	No date	**Possible** – all areas	One record from the study area, though no date is specified in the fauna record database. None were recorded during the GHD field surveys. This species is endemic to arid and semi-arid southern Australia, reaching its northern extent in the south of the Northern Territory. Throughout its distribution it occurs in a wide range of arid and semi-arid habitats; mainly in the low shrubs and undergrowth of mallee scrub, but also in mulga, cypress pine, desert eucalypt woodlands, saltbush, desert-heaths and coastal tea-tree (Pizzey and Knight 2007). This species could possibly occupy vegetation communities such as blue mallee/Spinifex, acacia/Spinifex in association with the rocky outcrops of the mine site. It is possible that the shrub layer in these areas is not sufficiently dense to support this species.
Grey Honeyeater *Conopophila whitei*	-	DD	DLRM, BPB	2009 DLRM	**Possible** – all areas, particularly Mulga woodland	None were recorded during the GHD field surveys, although there are three records within 20 km of the Study area (up to 2009). Species is nomadic. Grey honeyeaters inhabit the mulga woodlands of inland Australia, mainly mature woodland, open mulga with spinifex, tall open scrub dominated by other acacias and eremophilas (Pizzey and Knight 2007). Little is known about this species' life history, although they are known to nest in dense mulga with abundant mistletoe. Habitat exists within the Study area.
Australian spotted crake *Porzana fluminea*	-	DD	BPB	-	**Highly Unlikely** – all areas	None were recorded during the GHD surveys. Habitat for this species includes drying, fresh, brackish or salt swamps with cover of water ribbons, sedges, bulrushes, clumps of rush or tussock, samphire around salt marshes, saltfields, salt lakes (inland and coastal) (Pizzey and Knight 2003). Habitat requirements of this species are not met by any of the habitats present within the Study area.

Species	EPBC	TPWC	Source	Most recent (DLRM or other)	Likelihood of occurrence within the study area	Comments
REPTILES						
Great Desert Skink *Liopholis kintorei*	VU	VU	GHD 2015; DLRM, PMST, BPB	2015 GHD; DLRM - no date	**Present** - Borefield area **Possible** - Processing site **Unlikely** - Mine site	Burrow/latrine system seen in Borefield area during GHD 2015 survey. NT Fauna Atlas indicates one undated record, also in the Borefield area (nr Napperby Road). This species inhabits large complex burrows in a variety of desert habitats on sandy, clay and loamy soils (Cogger, 2000 cited in DoE 2015). It occurs on sand plains and on the flats between low sand dunes, preferring areas vegetated with spinifex clumps and scattered shrubs (Paltridge and McAlpin, 2002 cited in DotE 2015). Habitats for this species within the mine site are limited and this species is considered unlikely to occur there. However, sand plain habitats located in the borefield area and parts of the processing area support the preferred spinifex clumps with scattered shrubs occupied by this species in other areas.
Mulga Snake *Pseudechis australis*	-	NT	DLRM; BPB; Milligan 1980	1980 Milligan 1954 DLRM	**Possible** – all areas	The Mulga Snake is widespread throughout Australia except for humid eastern and southern areas and can be found in all virtually all habitats in its range (Wilson and Swan 2008).
Woma python *Aspidites ramsayi*	-	NT	BPB	-	**Unlikely** – mine site **Possible** – all other areas	None were detected during the GHD surveys of the study area. The woma python is restricted to arid areas including desert sandhills, is nocturnal and shelters during the day in hollow logs, animal burrows or thick herbage (Cogger, 2000). The mine site provides marginal habitat for this species. It is possible that the woma python could occur within sandy areas of the mine site, although it would be relatively rare and not often encountered. This species is highly likely to occur within the sandplain habitats located within the borefield and other areas of the Study area.

Species	EPBC	TPWC	Source	Most recent (DLRM or other)	Likelihood of occurrence within the study area	Comments
Centralian blind snake *Ramphotyphlops centralis*	-	DD	BPB	-	**Possible** – all areas	None were detected during the GHD surveys of the study area. This species is only known from Alice Springs (Wilson and Swan 2008) and little information appears to be available regarding the habitat preferences of this species. Without any additional information regarding this species' habitat preferences, it is difficult to discount the presence of the centralian blind snake, although if it were present, it would likely be quite scarce and restricted.
INVERTEBRATES						
Spencer's land snail *Bothriembryon spenceri*	-	VU	-	-	**Unlikely** – all areas	None were detected during the GHD surveys of the study area. Species appears generally restricted to Krichauff and Chewings Range, where they occur in leaf litter under fig trees and/or rocky areas. This species has a restricted distribution in the Alice Springs area, however, potentially suitable habitat is present within the rocky outcrops within and surrounding the study area.

Appendix E – List of fauna species identified for the Study area by all sources

Common Name	Scientific Name	EPBC	TPWC	GHD 2015	GHD 2010	Green 2010	Low Ecol 2007	Milligan 1980	LRMDLRM records	Burt Plain	PMST
MAMMALS											
Short-beaked Echidna	*Tachyglossus aculeatus*		LC	x	x		x	x	5	x	
Brush-tailed Mulgara	*Dasycercus blythi*		VU	x							
Crest-tailed mulgara	*Dasycercus cristicauda*	VU	VU							x	
Western Quoll	*Dasyurus geoffroii*	VU	RX							x	
Fat-tailed Pseudantechinus	*Pseudantechinus macdonnellensis*		LC	x				x	1	x	
Red-tailed Phascogale	*Phascogale calura*	EN	RX							x	
Long-tailed Planigale	*Planigale ingrami*		LC							x	
Wongai Ningaui	*Ningaui ridei*		LC							x	
Kultarr	*Antechinomys laniger*		NT					x		x	
Fat-tailed Dunnart	*Sminthopsis crassicaudata*		LC	x						x	
Hairy-footed Dunnart	*Sminthopsis hirtipes*		LC							x	
Stripe-faced Dunnart	*Sminthopsis macroura*		LC	x	x		x	x	3	x	
Ooldea Dunnart	*Sminthopsis ooldea*		LC							x	
Lesser Hairy-footed Dunnart	*Sminthopsis youngsoni*		LC	x						x	
Pig-footed Bandicoot	*Chaeropus ecaudatus*	EX	EX						2	x	
Golden Bandicoot	*Isoodon auratus*	VU	EN							x	
Desert Bandicoot	*Perameles eremiana*	EX	EX							x	
Bilby	*Macrotis lagotis*	VU	VU							x	yes
Common Brushtail Possum (Southern NT)	*Trichosurus vulpecula vulpecula*		EN							x	
Burrowing Bettong	*Bettongia lesueur graii*	EX	RX							x	
Brush-tailed Bettong	*Bettongia penicillata*	EN	RX							x	

Common Name	Scientific Name	EPBC	TPWC	GHD 2015	GHD 2010	Green 2010	Low Ecol 2007	Milligan 1980	LRMDLRM records	Burt Plain	PMST
Central Hare-wallaby	*Lagorchestes asomatus*	EX	EX							x	
Spectacled Hare-wallaby	*Lagorchestes conspicillatus*		NT	x						x	
Mala	*Lagorchestes hirsutus*	EN	EW							x	
Euro	*Macropus robustus*		LC	x	x		x	x	17	x	
Red Kangaroo	*Macropus rufus*		LC	x	x		x	x	20	x	
Crescent Nailtail Wallaby	*Onychogalea lunata*	EX	EX							x	
Northern Nailtail Wallaby	*Onychogalea unguifera*		NT	x							
Black-footed Rock-wallaby	*Petrogale lateralis*	VU	NT		x				2	x	yes
Southern Marsupial Mole	*Notoryctes typhlops*		VU							x	
Little Red Flying-fox	*Pteropus scapulatus*		LC							x	
Ghost Bat	*Macroderma gigas*		NT							x	
Dusky Leaf-nosed Bat	*Hipposideros ater*		LC							x	
Yellow-bellied Sheathtail Bat	*Saccolaimus flaviventris*		LC		x						
Hill's Sheath-tailed Bat	*Taphozous hilli*		LC				x			x	
Beccari's Freetail Bat	*Mormopterus beccarii*		LC							x	
Inland Free-tailed Bat	*Mormopterus sp.3*		LC	*P*			x - as M. planiceps			x	
Hairy-nosed Free-tailed Bat	*Mormopterus eleryi*		LC		x					x	
White-striped Free-tailed Bat	*Tadarida australis*		LC	x	x		x		1	x	
Lesser Long-eared Bat	*Nyctophilus geoffroyi*		LC	x			x	x	5	x	
Gould's Wattled Bat	*Chalinolobus gouldii*		LC	x	x		x	x	5	x	
Chocolate Wattled Bat	*Chalinolobus morio*		LC	x			P			x	
Inland Broad-nosed Bat	*Scotorepens balstoni*		LC	x	x		x		2	x	
Little Broad-nosed Bat	*Scotorepens greyii*		LC	x	x					x	

Common Name	Scientific Name	EPBC	TPWC	GHD 2015	GHD 2010	Green 2010	Low Ecol 2007	Milligan 1980	LRMDLRM records	Burt Plain	PMST
Inland Forest Bat	*Vespadelus baverstocki*		LC	x	x		x			x	
Finlayson's Cave Bat	*Vespadelus finlaysoni*		LC		x		P			x	
Inland Cave Bat / Chocolate Wattled Bat	*Vespadelus finlaysoni / Chalinolobus morio*		LC				x				
Inland Forest Bat/Little Broad-nosed Bat	*Vespadelus baverstocki/Scotorepens greyii*			x	x						
Central Short-tailed Mouse	*Leggadina forresti*		LC							x	
Northern Short-tailed Mouse	*Leggadina lakedownensis*		LC							x	
Lesser Stick-nest Rat	*Leporillus apicalis*	EX	EX							x	
Spinifex Hopping-mouse	*Notomys alexis*		LC	x	x			x		x	
Long-tailed Hopping-mouse	*Notomys longicaudatus*	EX	EX							x	
Desert Mouse	*Pseudomys desertor*		LC							x	
Sandy Inland Mouse	*Pseudomys hermannsburgensis*		LC	x	x			x		x	
Central Rock-rat	*Zyzomys pedunculatus*	EN	EN							x	
Pale Field-rat	*Rattus tunneyi*		VU							x	
Long-haired Rat	*Rattus villosissimus*		NT							x	
Dingo	*Canis lupus*		LC	x	x		x	x	3	x	
Dog	*Canis lupus familiaris*	Invasive	Introduced								yes
House Mouse	*Mus musculus*	Invasive	Introduced	x	x		x		5	x	yes
Red Fox	*Vulpes vulpes*	Invasive	Introduced	x						x	yes
Cat	*Felis catus*	Invasive	Introduced	x			x	x		x	yes
European Rabbit	*Oryctolagus cuniculus*	Invasive	Introduced		x			x	1	x	
Donkey	*Equus asinus*	Invasive	Introduced							x	
Horse	*Equus caballus*	Invasive	Introduced					x	2	x	

Common Name	Scientific Name	EPBC	TPWC	GHD 2015	GHD 2010	Green 2010	Low Ecol 2007	Milligan 1980	LRMDLRM records	Burt Plain	PMST
Camel	*Camelus dromedarius*	Invasive	Introduced	x	x				6	x	yes
Cattle	*Bos taurus*	Invasive	Introduced	x	x		x	x	10	x	yes
Goat	*Capra hircus*	Invasive	Introduced							x	
BIRDS											
Emu	*Dromaius novaehollandiae*		NT	x						x	
Malleefowl	*Leipoa ocellata*	VU	CR						1	x	
Stubble Quail	*Coturnix pectoralis*		LC							x	
Brown Quail	*Coturnix ypsilophora*		LC						2	x	
Plumed Whistling-Duck	*Dendrocygna eytoni*		LC							x	
Black Swan	*Cygnus atratus*		LC							x	
Australian Wood Duck	*Chenonetta jubata*		LC		x			x	5	x	
Pink-eared Duck	*Malacorhynchus membranaceus*		LC		x			x	2	x	
Grey Teal	*Anas gracilis*		LC					x	7	x	
Pacific Black Duck	*Anas superciliosa*		LC						1	x	
Hardhead	*Aythya australis*		LC		x				4	x	
Australasian Grebe	*Tachybaptus novaehollandiae*		LC		x				6	x	
Hoary-headed Grebe	*Poliocephalus poliocephalus*		LC					x	2	x	
Common Bronzewing	*Phaps chalcoptera*		LC	x	x	x		x	5	x	
Flock Bronzewing	*Phaps histrionica*		NT		x					x	
Crested Pigeon	*Ocyphaps lophotes*		LC	x	x	x	x		35	x	
Spinifex Pigeon	*Geophaps plumifera*		LC					x	4	x	
Diamond Dove	*Geopelia cuneata*		LC	x	x	x			16	x	
Peaceful Dove	*Geopelia striata*		LC						1	x	

Common Name	Scientific Name	EPBC	TPWC	GHD 2015	GHD 2010	Green 2010	Low Ecol 2007	Milligan 1980	LRMDLRM records	Burt Plain	PMST
Tawny Frogmouth	*Podargus strigoides*		LC	x	x		x	x	2	x	
Spotted Nightjar	*Eurostopodus argus*		LC	x	x	x		x	2	x	
Australian Owlet-nightjar	*Aegotheles cristatus*		LC	x	x	x			7	x	
Fork-tailed Swift	*Apus pacificus*	Mi / Ma	LC							x	yes
Australasian Darter	*Anhinga novaehollandiae*		LC							x	
Little Pied Cormorant	*Microcarbo melanoleucos*		LC							x	
Great Cormorant	*Phalacrocorax carbo*		LC							x	
Little Black Cormorant	*Phalacrocorax sulcirostris*		LC					x		x	
Pied Cormorant	*Phalacrocorax varius*		LC							x	
Australian Pelican	*Pelecanus conspicillatus*		LC							x	
Black-necked Stork	*Ephippiorhynchus asiaticus*		LC							x	
White-necked Heron	*Ardea pacifica*		LC	x				x	2	x	
Eastern Great Egret	*Ardea modesta*	Mi / Ma	LC								yes
Eastern Great Egret	*Ardea modesta*		LC					x		x	
Intermediate Egret	*Ardea intermedia*		LC							x	
Cattle Egret	*Ardea ibis*	Mi / Ma	LC								yes
White-faced Heron	*Egretta novaehollandiae*		LC						1	x	
Nankeen Night Heron	*Nycticorax caledonicus*		LC					x		x	
Glossy Ibis	*Plegadis falcinellus*		LC						1	x	
Australian White Ibis	*Threskiornis molucca*		LC					x		x	
Straw-necked Ibis	*Threskiornis spinicollis*		LC		x			x	2	x	
Royal Spoonbill	*Platalea regia*		LC					x		x	
Yellow-billed Spoonbill	*Platalea flavipes*		LC					x	3	x	

Common Name	Scientific Name	EPBC	TPWC	GHD 2015	GHD 2010	Green 2010	Low Ecol 2007	Milligan 1980	LRMDLRM records	Burt Plain	PMST
Black-shouldered Kite	*Elanus axillaris*		LC	x						x	
Letter-winged Kite	*Elanus scriptus*		NT							x	
Square-tailed Kite	*Lophoictinia isura*		NT							x	
Black-breasted Buzzard	*Hamirostra melanosternon*		LC	x	x		x		10	x	
Whistling Kite	*Haliastur sphenurus*		LC	x	x				17	x	
Black Kite	*Milvus migrans*		LC	x	x	x			21	x	
Brown Goshawk	*Accipiter fasciatus*		LC		x			x	6	x	
Collared Sparrowhawk	*Accipiter cirrocephalus*		LC		x			x	2	x	
Spotted Harrier	*Circus assimilis*		LC	x	x				4	x	
Swamp Harrier	*Circus approximans*		LC							x	
Red Goshawk	*Erythrotriorchis radiatus*	VU	VU							x	yes
Wedge-tailed Eagle	*Aquila audax*		LC	x	x	x		x	20	x	
Little Eagle	*Hieraaetus morphnoides*		LC		x			x	3	x	
Nankeen Kestrel	*Falco cenchroides*		LC	x	x		x		26	x	
Brown Falcon	*Falco berigora*		LC	x	x	x	x		40	x	
Australian Hobby	*Falco longipennis*		LC	x	x	x	x	x	5	x	
Grey Falcon	*Falco hypoleucos*		VU					x		x	
Black Falcon	*Falco subniger*		LC					x	2	x	
Peregrine Falcon	*Falco peregrinus*		LC					x		x	
Brolga	*Grus rubicunda*		LC							x	
Buff-banded Rail	*Gallirallus philippensis*		LC							x	
Australian Spotted Crake	*Porzana fluminea*		DD							x	
Black-tailed Native-hen	*Tribonyx ventralis*		LC						2	x	

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Eurasian Coot	*Fulica atra*		LC							x	
Australian Bustard	*Ardeotis australis*		NT	x	x			x	1	x	
Bush Stone-curlew	*Burhinus grallarius*		NT	x			x		1	x	
Black-winged Stilt	*Himantopus himantopus*		LC					x	2	x	
Red-necked Avocet	*Recurvirostra novaehollandiae*		LC					x		x	
Oriental Plover	*Charadrius veredus*	Mi / Ma	LC							x	yes
Inland Dotterel	*Charadrius australis*		LC							x	
Black-fronted Dotterel	*Elseyornis melanops*		LC		x				4	x	
Red-kneed Dotterel	*Erythrogonys cinctus*		LC					x	2	x	
Banded Lapwing	*Vanellus tricolor*		LC	x		x		x	2	x	
Masked Lapwing	*Vanellus miles*		LC	x					2	x	
Australian Painted Snipe	*Rostratula australis*	EN / Mi / Ma	VU							x	yes
Common Sandpiper	*Actitis hypoleucos*		LC		x					x	
Common Greenshank	*Tringa nebularia*		LC							x	
Marsh Sandpiper	*Tringa stagnatilis*		LC							x	
Wood Sandpiper	*Tringa glareola*		Not evaluated							x	
Sharp-tailed Sandpiper	*Calidris acuminata*		LC							x	
Little Button-quail	*Turnix velox*		LC	x	x	x			3	x	
Oriental Pratincole	*Glareola maldivarum*	Mi / Ma	LC								yes
Australian Pratincole	*Stiltia isabella*		LC							x	
Gull-billed Tern	*Gelochelidon nilotica*		LC							x	
Whiskered Tern	*Chlidonias hybrida*		LC							x	

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Silver Gull	*Chroicocephalus novaehollandiae*		LC							x	
Red-tailed Black-cockatoo (central Australia)	*Calyptorhynchus banksii samueli*		NT					x		x	
Major Mitchell's Cockatoo	*Lophochroa leadbeateri*		LC	x	x	x	x		12	x	
Galah	*Eolophus roseicapilla*		LC	x	x	x	x		15	x	
Little Corella	*Cacatua sanguinea*		LC							x	
Cockatiel	*Nymphicus hollandicus*		LC	x	x	x			4	x	
Princess Parrot	*Polytelis alexandrae*	VU	VU							x	yes
Australian Ringneck	*Barnardius zonarius*		LC	x	x	x	x		36	x	
Mulga Parrot	*Psephotus varius*		LC	x	x	x	x	x	10	x	
Budgerigar	*Melopsittacus undulatus*		LC	x	x	x	x		29	x	
Bourke's Parrot	*Neopsephotus bourkii*		LC	x				x	2	x	
Scarlet-chested Parrot	*Neophema splendida*		NT							x	
Night Parrot	*Pezoporus occidentalis*	EN	CR							x	
Channel-billed Cuckoo	*Scythrops novaehollandiae*		LC							x	
Horsfield's Bronze-Cuckoo	*Chalcites basalis*		LC	x	x	x			7	x	
Black-eared Cuckoo	*Chalcites osculans*		LC				x	x	1	x	
Little Bronze-cuckoo	*Chalcites minutillus*		LC							x	
Pallid Cuckoo	*Cacomantis pallidus*		LC		x	x		x	10	x	
Southern Boobook	*Ninox novaeseelandiae*		LC	x	x	x		x	3	x	
Eastern Barn Owl	*Tyto javanica*		LC					x		x	
Red-backed Kingfisher	*Todiramphus pyrrhopygius*		LC	x	x	x	x		7	x	
Sacred Kingfisher	*Todiramphus sanctus*		LC	x				x		x	

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Rainbow Bee-eater	*Merops ornatus*	Mi / Ma	LC		x		x		14	x	yes
Western Bowerbird	*Ptilonorhynchus guttatus*		LC			x		x	13	x	
Splendid Fairy-wren	*Malurus splendens*		LC	x	x	x	x		8	x	
White-winged Fairy-wren	*Malurus leucopterus*		LC	x		x	x		5	x	
Variegated Fairy-wren	*Malurus lamberti*		LC	x	x	x	x		2	x	
Rufous-crowned Emu-wren	*Stipiturus ruficeps*		LC					x		x	
Striated Grasswren	*Amytornis striatus*		NT							x	
Dusky Grasswren	*Amytornis purnelli*		LC		x	x			7	x	
Redthroat	*Pyrrholaemus brunneus*		NT				x		1	x	
Weebill	*Smicrornis brevirostris*		LC				x	x	7	x	
Western Gerygone	*Gerygone fusca*		LC	x	x	x		x	10	x	
Slaty-backed Thornbill	*Acanthiza robustirostris*		LC	x					3	x	
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*		LC	x	x	x	x		19	x	
Chestnut-rumped Thornbill	*Acanthiza uropygialis*		LC	x	x	x	x		10	x	
Inland Thornbill	*Acanthiza apicalis*		LC	x		x			6	x	
Southern Whiteface	*Aphelocephala leucopsis*		LC	x		x	x		5	x	
Banded Whiteface	*Aphelocephala nigricincta*		LC	x						x	
Red-browed Pardalote	*Pardalotus rubricatus*		LC	x				x	18	x	
Striated Pardalote	*Pardalotus striatus*		LC			x		x	2	x	
Pied Honeyeater	*Certhionyx variegatus*		LC		x	x		x	4	x	
Singing Honeyeater	*Lichenostomus virescens*		LC	x		x	x		48	x	
Grey-headed Honeyeater	*Lichenostomus keartlandi*		LC	x	x	x	x		28	x	
Grey-fronted Honeyeater	*Lichenostomus plumulus*		LC		x	x		x	7	x	

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White-plumed Honeyeater	*Lichenostomus penicillatus*		LC		x	x	x		34	x	
White-fronted Honeyeater	*Purnella albifrons*		LC		x	x		x	1	x	
Yellow-throated Miner	*Manorina flavigula*		LC	x	x	x	x		56	x	
Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*		LC	x	x	x	x		56	x	
Grey Honeyeater	*Conopophila whitei*		DD						3	x	
Crimson Chat	*Epthianura tricolor*		LC	x	x	x			5	x	
Orange Chat	*Epthianura aurifrons*		LC	x						x	
Black Honeyeater	*Sugomel niger*		LC		x	x		x	5	x	
Brown Honeyeater	*Lichmera indistincta*		LC	x	x	x			22	x	
Black-chinned Honeyeater	*Melithreptus gularis*		LC	x					2	x	
White-throated Honeyeater	*Melithreptus albogularis*		LC							x	
Grey-crowned Babbler	*Pomatostomus temporalis*		LC	x	x	x	x		26	x	
White-browed Babbler	*Pomatostomus superciliosus*		LC	x	x		x	x	2	x	
Chestnut Quail-thrush	*Cinclosoma castanotum*		NT						1	x	
Cinnamon Quail-thrush	*Cinclosoma cinnamomeum*		LC							x	
Chiming Wedgebill	*Psophodes occidentalis*		LC					x	4	x	
Varied Sittella	*Daphoenositta chrysoptera*		LC			x			3	x	
Ground Cuckoo-shrike	*Coracina maxima*		LC	x		x	x	x	13	x	
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*		LC	x	x	x	x		29	x	
White-winged Triller	*Lalage sueurii*		LC	x	x	x		x	7	x	
Rufous Whistler	*Pachycephala rufiventris*		LC	x	x	x	x		22	x	
Grey Shrike-thrush	*Colluricincla harmonica*		LC	x	x	x	x		18	x	
Crested Bellbird	*Oreoica gutturalis*		LC	x	x	x	x		34	x	

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White-breasted Woodswallow	*Artamus leucorynchus*		LC					x		x	
Masked Woodswallow	*Artamus personatus*		LC		x	x	x	x	8	x	
White-browed Woodswallow	*Artamus superciliosus*		LC		x				2	x	
Black-faced Woodswallow	*Artamus cinereus*		LC	x	x	x	x	x	34	x	
Little Woodswallow	*Artamus minor*		LC	x	x				7	x	
Grey Butcherbird	*Cracticus torquatus*		LC	x	x	x			7	x	
Pied Butcherbird	*Cracticus nigrogularis*		LC	x	x	x	x		40	x	
Australian Magpie	*Cracticus tibicen*		LC	x	x	x	x	x	32	x	
Grey Fantail	*Rhipidura albiscapa*		LC	x		x	x	x	4	x	
Willie Wagtail	*Rhipidura leucophrys*		LC	x	x	x	x		48	x	
Australian Raven	*Corvus coronoides*		LC	x						x	
Little Crow	*Corvus bennetti*		LC		x		x		21	x	
Torresian Crow	*Corvus orru*		LC	x		x	x		19	x	
Magpie-lark	*Grallina cyanoleuca*		LC	x	x	x	x		34	x	
Jacky Winter	*Microeca fascinans*		LC				x		2	x	
Red-capped Robin	*Petroica goodenovii*		LC	x	x	x	x	x	17	x	
Hooded Robin (Mainland)	*Melanodryas cucullata picata/westralensis*		LC	x	x	x	x		20	x	
Golden-headed Cisticola	*Cisticola exilis*		LC							x	
Australian Reed-warbler	*Acrocephalus australis*		NT							x	
Rufous Songlark	*Cincloramphus mathewsi*		LC		x				5	x	
Brown Songlark	*Cincloramphus cruralis*		LC	x	x	x			8	x	
Spinifexbird	*Eremiornis carteri*		LC		x	x			4	x	

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White-backed Swallow	*Cheramoeca leucosterna*		LC	x	x	x	x	x	9	x	
Welcome Swallow	*Hirundo neoxena*		LC						1	x	
Fairy Martin	*Petrochelidon ariel*		LC		x			x	5	x	
Tree Martin	*Petrochelidon nigricans*		LC					x	2	x	
Mistletoebird	*Dicaeum hirundinaceum*		LC	x	x		x		34	x	
Zebra Finch	*Taeniopygia guttata*		LC	x	x	x	x		53	x	
Painted Finch	*Emblema pictum*		LC	x	x	x			5	x	
Australasian Pipit	*Anthus novaeseelandiae*		LC	x	x	x	x	x	13	x	
Rock Dove	*Columba livia*	Invasive	Introduced							x	yes
REPTILES											
Clawless Gecko	*Crenadactylus ocellatus*		LC							x	
Fat-tailed Gecko	*Diplodactylus conspicillatus*		LC		x			x		x	
Centralian Dtella	*Gehyra montium*		LC	x	x				1	x	
Northern Spotted Rock Dtella	*Gehyra nana*		LC						1	x	
Purplish Dtella	*Gehyra purpurascens*		LC						4	x	
Tree Dtella	*Gehyra variegata*		LC		x			x	18	x	
Bynoe's Gecko	*Heteronotia binoei*		LC					x	10	x	
Desert Cave Gecko	*Heteronotia spelea*		Not evaluated							x	
Beaded Gecko	*Lucasium damaeum*		LC					x		x	
Crowned Gecko	*Lucasium stenodactylum*		LC				x		1	x	
Centralian Knob-tailed Gecko	*Nephrurus amyae*		LC							x	
Three-lined Knob-tailed Gecko	*Nephrurus levis*		LC					x		x	
Marbled Velvet Gecko	*Oedura marmorata*		LC	x				x		x	

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Beaked Gecko	*Rhynchoedura ornata*		LC		x			x	2	x	
Northern Spiny-tailed Gecko	*Strophurus ciliaris*		LC	x	x			x	12	x	
Jewelled Gecko	*Strophurus elderi*		LC							x	
Eastern Spiny-tailed Gecko	*Strophurus intermedius*		LC							x	
Southern Phasmid Gecko	*Strophurus jeanae*		LC							x	
White-striped Gecko	*Strophurus taeniatus*		LC							x	
Thick-tailed Gecko	*Underwoodisaurus milii*		LC							x	
Marble-faced Delma	*Delma australis*		LC							x	
Rusty-topped Delma	*Delma borea*		LC	x				x		x	
Neck-barred Delma	*Delma haroldi*		LC							x	
Sharp-snouted Delma	*Delma nasuta*		LC							x	
Black-necked Snake-lizard	*Delma tincta*		LC					x	1	x	
Burton's Legless Lizard	*Lialis burtonis*		LC		x					x	
Western Hooded Scaly-foot	*Pygopus nigriceps*		LC						1	x	
Striped Rainbow Skink	*Carlia munda*		LC		x				1	x	
Three-Spined Rainbow Skink	*Carlia triacantha*		LC	x	x			x	1	x	
Inland Snake-Eyed Skink	*Cryptoblepharus australis*		LC						8		
Carnaby's Snake-Eyed Skink	*Cryptoblepharus carnabyi*		Not evaluated							x	
Aboreal Snake-Eyed Skink	*Cryptoblepharus plagiocephalus*		Not evaluated		x					x	
Lively Ctenotus	*Ctenotus alacer*		LC		x			x		x	
Blue-tailed Ctenotus	*Ctenotus calurus*		LC	x							
Grand Ctenotus	*Ctenotus grandis*		LC	x						x	

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Greer's Ctenotus	*Ctenotus greeri*		LC	x	x					x	
Hanlon's Ctenotus	*Ctenotus hanloni*		LC						1	x	
Helen's Ctenotus	*Ctenotus helenae*		LC						1	x	
Gravelly-soil Ctenotus	*Ctenotus lateralis*		LC							x	
Leonhard's Ctenotus	*Ctenotus leonhardii*		LC	x	x		x	x	5	x	
Leopard Ctenotus	*Ctenotus pantherinus*		LC	x						x	
Pianka's Ctenotus	*Ctenotus piankai*		LC	x						x	
Fourteen-lined Ctenotus	*Ctenotus quattuordecimlineatus*		LC							x	
Robust Ctenotus	*Ctenotus robustus*		LC		x					x	
Royal Ctenotus	*Ctenotus regius*		LC	x							
Rock Ctenotus	*Ctenotus saxatilis*		LC	x				x	3	x	
Schomburgk's Ctenotus	*Ctenotus schomburgkii*		LC	x	x				2	x	
Strauch's Ctenotus	*Ctenotus strauchii*		LC							x	
Tanami Ctenotus	*Ctenotus tanamiensis*		LC						1	x	
Rich Ctenotus	*Ctenotus uber*		Not evaluated							x	
Slender Blue-tongued Lizard	*Cyclodomorphus melanops*		LC					x	1	x	
Desert Skink	*Liopholis inornata*		LC							x	
Great Desert Skink	*Liopholis kintorei*	VU	VU	x					1	x	yes
Rock Skink	*Liopholis margaretae*		LC	x					3	x	
Stoke's Egernia	*Egernia stokesii*		LC							x	
Night Skink / Striated Egernia	*Liopholis striata*		LC	x					9	x	
Narrow-Banded Sand Swimmer	*Eremiascincus fasciolatus*		LC							x	
Broad-Banded Sand Swimmer	*Eremiascincus richardsonii*		LC				x			x	

Common Name	Scientific Name	EPBC	TPWC	GHD 2015	GHD 2010	Green 2010	Low Ecol 2007	Milligan 1980	LRMDLRM records	Burt Plain	PMST
Two-toed Lerista	*Lerista bipes*		LC				x	x		x	
Desert Lerista	*Lerista desertorum*		LC							x	
Frost's Lerista	*Lerista frosti*		LC							x	
Sand Lerista	*Lerista labialis*		LC						4	x	
Yellow-Tailed Lerista	*Lerista xanthura*		LC							x	
Grey's Menetia	*Menetia greyii*		LC	x	x			x	7	x	
Boulenger's Snake-eyed Skink	*Morethia boulengeri*		LC							x	
Red-tailed Snake-Eyed Skink	*Morethia ruficauda*		LC					x		x	
Spinifex Snake-Eyed Skink	*Proablepharus reginae*		LC		x						
Centralian Blue-Tongued Lizard	*Tiliqua multifasciata*		LC		x				2	x	
Ring-tailed Dragon	*Ctenophorus caudicinctus*		LC	x	x			x	2	x	
Military Dragon	*Ctenophorus isolepis*		LC	x	x				4	x	
Central Netted Dragon	*Ctenophorus nuchalis*		LC	x	x		x		9	x	
Round-headed Dragon	*Diporiphora lalliae*		LC	x							
Gilbert's Dragon	*Lophognathus gilberti*		LC						1	x	
Long-nosed Water Dragon	*Lophognathus longirostris*		LC		x		x	x	3	x	
Thorny Devil	*Moloch horridus*		LC	x					1	x	
Dwarf Bearded Dragon	*Pogona minor*		LC		x				2	x	
Central Bearded Dragon	*Pogona vitticeps*		LC					x		x	
Pebble Dragon	*Tympanocryptis cephalus*		LC					x		x	
Lined Earless Dragon	*Tympanocryptis lineata*		LC							x	
Ridge-tailed Monitor	*Varanus acanthurus*		LC	x	x			x		x	
Short-tailed Pygmy Monitor	*Varanus brevicauda*		LC							x	

Common Name	Scientific Name	EPBC	TPWC	GHD 2015	GHD 2010	Green 2010	Low Ecol 2007	Milligan 1980	LRMDLRM records	Burt Plain	PMST
Rusty Desert Monitor	*Varanus eremius*		LC	x	x				1	x	
Perentie	*Varanus giganteus*		LC				x			x	
Pygmy Mulga Monitor	*Varanus gilleni*		LC		x				1		
Sand Goanna	*Varanus gouldii*		LC	x	x				2	x	
Black-tailed Monitor	*Varanus tristis*		LC	?				x		x	
Prong-snouted Blind Snake	*Ramphotyphlops bituberculatus*		LC							x	
Centralian Blind Snake	*Ramphotyphlops centralis*		DD							x	
Northern Blind Snake	*Ramphotyphlops diversus*		LC						1	x	
Interior Blind Snake	*Ramphotyphlops endoterus*		LC							x	
Long-beaked Blind Snake	*Ramphotyphlops grypus*		LC							x	
Blind Snake	*Ramphotyphlops sp.*							x			
Children's Python	*Antaresia childreni*		LC					x			
Stimson's Python	*Antaresia stimsoni*		LC	x	x					x	
Black-headed Python	*Aspidites melanocephalus*		LC						1	x	
Woma Python	*Aspidites ramsayi*		NT							x	
Centralian Carpet Python	*Morelia spilota bredli*		LC							x	
Desert Death Adder	*Acanthophis pyrrhus*		LC						1	x	
Unbanded Shovel-nosed Snake	*Simoselaps incinctus*		Not evaluated						1	x	
Half-girdled Snake	*Brachyurophis semifasciatus*		LC					x		x	
Yellow-faced Whip Snake	*Demansia psammophis*		LC					x	2	x	
Collared Whip Snake	*Demansia torquata*		Not evaluated							x	
Orange-naped Snake	*Furina ornata*		LC					x		x	

Common Name	Scientific Name	EPBC	TPWC	GHD 2015	GHD 2010	Green 2010	Low Ecol 2007	Milligan 1980	LRMDLRM records	Burt Plain	PMST
Mulga Snake	*Pseudechis australis*		NT					x	1	x	
Ringed Brown Snake	*Pseudonaja modesta*		LC							x	
Western Brown Snake	*Pseudonaja nuchalis*		LC					x	1	x	
Eastern Brown Snake	*Pseudonaja textilis*		LC							x	
Northern Desert Banded Snake	*Simoselaps anomalus*		LC							x	
Little Spotted Snake	*Suta punctata*		LC		x				11	x	
Curl Snake	*Suta suta*		LC					x		x	
Bandy Bandy	*Vermicella annulata*		LC					x		x	
Asian House Gecko	*Hemidactylus frenatus*	Invasive	Introduced							x	yes
FROGS											
Northern Burrowing Frog	*Neobatrachus aquilonius*		LC		x					x	
Shoemaker Frog	*Neobatrachus sutor*		LC							x	
Desert Spadefoot Toad	*Notaden nichollsi*		LC							x	
Spencer's Frog	*Platyplectrum spenceri*		LC	x	x				2	x	
Giant Frog	*Cyclorana australis*		LC							x	
Knife-footed Frog	*Cyclorana cultripes*		LC							x	
Main's Frog	*Cyclorana maini*		LC							x	
Water-holding Frog	*Cyclorana platycephala*		LC						1	x	
Red Tree-frog	*Litoria rubella*		LC	x					1	x	
INVERTEBRATES											
Snail	*Sinumelon expositum*		Not evaluated	x			x				

Appendix F – Fauna species recorded within the Study area during the 2010 and 2015 fauna surveys

Sites are grouped by habitat and then by year
Values represent counts of observations, rather than counts of individuals.

Habitat			Mulga woodland								Sandplain spinifex								Rocky habitat				Shrubland/Woodland			Ripar	Grass	Incidental	Total
Year			2010				2015				2010			2015					2010		2015		2010	2015		2010	2010		
Common Name	Scientific Name	Site	M1	M6	T08	T10	N01	N02	N07	N08	T09	T11	T12	N09	N10	N11	N12	N13	M2	M3	N03	N05	M4	N04	N06	M5	T07		
Mammals			**4**	**5**	**4**	**5**	**4**	**12**	**5**	**28**	**2**	**2**	**5**	**5**	**6**	**11**	**8**	**0**	**3**	**4**	**3**	**24**	**2**	**11**	**5**	**1**	**2**	**59**	**220**
Short-beaked Echidna	*Tachyglossus aculeatus*																			1				2				1	4
Brush-tailed Mulgara	*Dasycercus blythi*																											36	36
Fat-tailed Pseudantechinus	*Pseudantechinus macdonnellensis*																					6						1	7
Fat-tailed Dunnart	*Sminthopsis crassicaudata*							1	1	1					1		1								1			0	6
Stripe-faced Dunnart	*Sminthopsis macroura*	1	1	1			1	2						2	1				1		1	1	1	1	3		1	1	19
Lesser Hairy-footed Dunnart	*Sminthopsis youngsoni*													1	1													0	2
Spectacled Hare-wallaby	*Lagorchestes conspicillatus*																											1	1
Euro	*Macropus robustus*																		1	1		2						3	7
Red Kangaroo	*Macropus rufus*									1						2												1	4
Northern Nailtail Wallaby	*Onychogalea unguifera*							2																				0	2
Black-footed Rock-wallaby	*Petrogale lateralis*																			1								0	1
Yellow-bellied Sheathtail Bat	*Saccolaimus flaviventris*		1										1														1	0	3
Inland Free-tailed Bat	*Mormopterus sp.3*							1								1						1		1				1	5
Hairy-nosed Free-tailed Bat	*Mormopterus eleryi*		1							1														1				0	3

Habitat			Mulga woodland								Sandplain spinifex								Rocky habitat				Shrubland/Woodland			Ripar	Grass	Incidental	Total
Year			2010				2015				2010			2015					2010		2015		2010	2015		2010	2010		
Common Name	Scientific Name	Site	M1	M6	T08	T10	N01	N02	N07	N08	T09	T11	T12	N09	N10	N11	N12	N13	M2	M3	N03	N05	M4	N04	N06	M5	T07		
White-striped Free-tailed Bat	*Tadarida australis*		1			1				1												1		1		1		1	7
Lesser Long-eared Bat	*Nyctophilus geoffroyi*							1		1																		0	2
Gould's Wattled Bat	*Chalinolobus gouldii*				1			1		1						1			1			1		1				1	8
Chocolate Wattled Bat	*Chalinolobus morio*							1		1														1				0	3
Inland Broad-nosed Bat	*Scotorepens balstoni*							1		1			1			1						1						0	5
Little Broad-nosed Bat	*Scotorepens greyii*							1		1														1				1	4
Inland Forest Bat	*Vespadelus baverstocki*			1						1														1				0	3
Finlayson's Cave Bat	*Vespadelus finlaysoni*				1	1																						0	2
Inland Forest Bat/Little Broad-nosed Bat	*Vespadelus baverstocki/Scotorepens greyii*		1			1						1	1							1								0	5
Spinifex Hopping-mouse	*Notomys alexis*									1	1																	1	3
Sandy Inland Mouse	*Pseudomys hermannsburgensis*				1	1				1	1	1	1				1							1	1			1	10
Dingo	*Canis lupus*									9						2					2	11						5	29
House Mouse*	*Mus musculus*		1	1		1									1								1					0	5
Red Fox*	*Vulpes vulpes*																2											0	2
Cat*	*Felis catus*						4	2	2	6				2	2	3	2											0	23
European Rabbit*	*Oryctolagus cuniculus*																											1	1
Camel*	*Camelus dromedarius*									1			1			1	2											3	8
Birds			**16**	**17**	**31**	**25**	**20**	**37**	**29**	**25**	**10**	**17**	**14**	**27**	**26**	**39**	**29**	**22**	**27**	**19**	**27**	**37**	**19**	**38**	**30**	**29**	**20**	**275**	**905**
Emu	*Dromaius novaehollandiae*														2													0	2

Habitat			Mulga woodland								Sandplain spinifex								Rocky habitat				Shrubland/Woodland			Ripar	Grass	Incidental	Total
Year			2010				2015				2010			2015					2010		2015		2010			2010	2010		
Common Name	Scientific Name	Site	M1	M6	T08	T10	N01	N02	N07	N08	T09	T11	T12	N09	N10	N11	N12	N13	M2	M3	N03	N05	M4	N04	N06	M5	T07		
Australian Wood Duck	*Chenonetta jubata*																											1	1
Pink-eared Duck	*Malacorhynchus membranaceus*																											1	1
Hardhead	*Aythya australis*																											1	1
Australasian Grebe	*Tachybaptus novaehollandiae*																											1	1
Common Bronzewing	*Phaps chalcoptera*						1												1		1	1			1			3	8
Flock Bronzewing	*Phaps histrionica*																											1	1
Crested Pigeon	*Ocyphaps lophotes*				1	1	1								1				1			1	1		3	1	1	3	15
Diamond Dove	*Geopelia cuneata*	1	1	1	1		1					1	1						1	1			1			1		7	18
Tawny Frogmouth	*Podargus strigoides*															2												5	7
Spotted Nightjar	*Eurostopodus argus*														2	2			1									2	7
Australian Owlet-nightjar	*Aegotheles cristatus*																		1								1	2	4
White-necked Heron	*Ardea pacifica*																								1			0	1
Straw-necked Ibis	*Threskiornis spinicollis*																											1	1
Black-shouldered Kite	*Elanus axillaris*													1														1	2
Black-breasted Buzzard	*Hamirostra melanosternon*														1				1									2	4
Whistling kite	*Haliastur sphenurus*				1																							2	3
Black Kite	*Milvus migrans*				1															1								2	4
Brown Goshawk	*Accipiter fasciatus*				1																							0	1
Collared Sparrowhawk	*Accipiter cirrocephalus*																											1	1
Spotted Harrier	*Circus assimilis*							1			1	1																2	5

Habitat			Mulga woodland								Sandplain spinifex								Rocky habitat				Shrubland/Woodland			Ripar	Grass	Incidental	Total
Year			2010				2015				2010			2015					2010		2015		2010	2015		2010	2010		
Common Name	Scientific Name	Site	M1	M6	T08	T10	N01	N02	N07	N08	T09	T11	T12	N09	N10	N11	N12	N13	M2	M3	N03	N05	M4	N04	N06	M5	T07		
Wedge-tailed Eagle	*Aquila audax*																			1								2	3
Little Eagle	*Hieraaetus morphnoides*																											1	1
Nankeen kestrel	*Falco cenchroides*																											3	3
Brown Falcon	*Falco berigora*							1	1			1						1				1					1	5	11
Australian Hobby	*Falco longipennis*																									1		1	2
Australian Bustard	*Ardeotis australis*															2		2										2	6
Bush Stone-curlew	*Burhinus grallarius*																				1							3	4
Black-fronted Dotterel	*Elseyornis melanops*																											1	1
Banded Lapwing	*Vanellus tricolor*																								2			0	2
Masked Lapwing	*Vanellus miles*																											1	1
Common Sandpiper	*Actitis hypoleucos*																											1	1
Little Button-quail	*Turnix velox*		1		1	1					1	1	1	1	2	2			1			1				1	1	13	28
Major Mitchell's Cockatoo	*Lophochroa leadbeateri*																											3	3
Galah	*Eolophus roseicapilla*																								4	1		3	8
Cockatiel	*Nymphicus hollandicus*					1		1							1			1		1		3	1		4	1	1	3	18
Australian Ringneck	*Barnardius zonarius*							1								1			1			1	1	4	1	1	1	2	14
Mulga Parrot	*Psephotus varius*																							3		1	1	4	9
Budgerigar	*Melopsittacus undulatus*				1	1	2	1	3	1	1	1	1	4	3	6	4	4	1	1	2	3	1	4	2	1	1	6	55
Bourke's Parrot	*Neopsephotus bourkii*								1																			1	2
Horsfield's Bronze-Cuckoo	*Chalcites basalis*				1																			1				1	3

Habitat			Mulga woodland								Sandplain spinifex								Rocky habitat				Shrubland/Woodland			Ripar	Grass	Incidental	Total
Year			2010				2015				2010			2015					2010		2015		2010			2010	2010		
Common Name	Scientific Name	Site	M1	M6	T08	T10	N01	N02	N07	N08	T09	T11	T12	N09	N10	N11	N12	N13	M2	M3	N03	N05	M4	N04	N06	M5	T07		
Pallid Cuckoo	*Cacomantis pallidus*		1	1	1	1						1	1										1			1	1	5	14
Southern Boobook	*Ninox novaeseelandiae*																									1		3	4
Red-backed Kingfisher	*Todiramphus pyrrhopygius*																									1	1	2	4
Sacred Kingfisher	*Todiramphus sanctus*																											1	1
Rainbow Bee-eater	*Merops ornatus*			1	1	1														1			1					3	8
Splendid Fairy-wren	*Malurus splendens*		1	1		1																						4	7
White-winged Fairy-wren	*Malurus leucopterus*																											1	1
Variegated Fairy-wren	*Malurus lamberti*													2														2	4
Dusky Grasswren	*Amytornis purnelli*																											1	1
Western Gerygone	*Gerygone fusca*		1	1	1			3											1							1		4	12
Slaty-backed Thornbill	*Acanthiza robustirostris*																											2	2
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*						1	1		1														2				2	7
Chestnut-rumped Thornbill	*Acanthiza uropygialis*		1	1		1																						2	5
Inland Thornbill	*Acanthiza apicalis*						1		3	4														1				0	9
Southern Whiteface	*Aphelocephala leucopsis*																				1							1	2
Banded Whiteface	*Aphelocephala nigricincta*																											2	2
Red-browed Pardalote	*Pardalotus rubricatus*																				1							0	1
Pied Honeyeater	*Certhionyx variegatus*																		1	1						1		4	7
Singing Honeyeater	*Lichenostomus virescens*						1	3	1					2	3	4	3	2			1	4		4	2			4	34
Grey-headed	*Lichenostomus keartlandi*												1	3		1	1	2	1	1	1			1				4	16

Habitat			Mulga woodland								Sandplain spinifex								Rocky habitat				Shrubland/Woodland			Ripar	Grass	Incidental	Total
Year			2010				2015				2010			2015					2010		2015		2010	2015		2010	2010		
Common Name	Scientific Name	Site	M1	M6	T08	T10	N01	N02	N07	N08	T09	T11	T12	N09	N10	N11	N12	N13	M2	M3	N03	N05	M4	N04	N06	M5	T07		
Honeyeater																													
Grey-fronted honeyeater	*Lichenostomus plumulus*					1																						0	1
White-plumed Honeyeater	*Lichenostomus penicillatus*																		1							1	1	1	4
White-fronted Honeyeater	*Purnella albifrons*																		1									0	1
Yellow-throated Miner	*Manorina flavigula*				1					1					1		1	1				4	1	1	3	1	1	5	21
Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*		1	1	1		1	1	2	1	1			1		2		1	1	2					1		7	24
Crimson Chat	*Epthianura tricolor*			1	1					1	1	1		3	2	3		1	1	2			2				7	26
Orange Chat	*Epthianura aurifrons*																											1	1
Black Honeyeater	*Sugomel niger*																											1	1
Brown Honeyeater	*Lichmera indistincta*			1	1								1						1	1								3	8
Black-chinned Honeyeater	*Melithreptus gularis*																	1										1	2
Grey-crowned Babbler	*Pomatostomus temporalis*		1	1		1	3												1		1	2	1	1	2	1	1	5	21
White-browed Babbler	*Pomatostomus superciliosus*														1		1				1							2	5
Ground Cuckoo-shrike	*Coracina maxima*						2																					1	3
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	1	1	1		1	1					1											1			1	1	6	15
White-winged Triller	*Lalage sueurii*	1	1	1	1		1		1										1	1			1			1	1	2	13
Rufous Whistler	*Pachycephala rufiventris*	1	1	1	1		3	3	3					1		2	1	1			1	1		2				8	30

Habitat			Mulga woodland								Sandplain spinifex								Rocky habitat				Shrubland/Woodland			Ripar	Grass	Incidental	Total
Year			2010				2015				2010			2015					2010		2015		2010	2015		2010	2010		
Common Name	Scientific Name	Site	M1	M6	T08	T10	N01	N02	N07	N08	T09	T11	T12	N09	N10	N11	N12	N13	M2	M3	N03	N05	M4	N04	N06	M5	T07		
Grey Shrike-thrush	*Colluricincla harmonica*			1	1	1	1	1	3	1						1			1		1					1		3	16
Crested Bellbird	*Oreoica gutturalis*		1	1	1	1	2	3	4	2	1	1	1	4		4	3		1	1	2	2	1	3	1	1		10	51
Masked Woodswallow	*Artamus personatus*		1	1	1	1					1	1	1						1	1						1		3	13
White-browed Woodswallow	*Artamus superciliosus*																			1								1	2
Black-faced Woodswallow	*Artamus cinereus*		1		1	1					1	1	1	2	2	3	1	2	1	1	2			2		1		8	31
Little Woodswallow	*Artamus minor*																											3	3
Grey Butcherbird	*Cracticus torquatus*		1		1				2	2												2		1				4	13
Pied Butcherbird	*Cracticus nigrogularis*						3	3													3	3		3	2			4	21
Australian Magpie	*Cracticus tibicen*						1	3							1								1		1			4	11
Grey Fantail	*Rhipidura albiscapa*							1	2	1																		0	4
Willie Wagtail	*Rhipidura leucophrys*				1	1							1	1		2	1		1	1		2				1	1	6	19
Australian Raven	*Corvus coronoides*																					2						0	2
Little Crow	*Corvus bennetti*		1		1	1						1											1					2	7
Torresian Crow	*Corvus orru*							3		2						1	1	1			1			2				0	11
Magpie-lark	*Grallina cyanoleuca*				1																		1			1		5	8
Red-capped Robin	*Petroica goodenovii*		1	1		1	1			1																		4	9
Hooded Robin (Mainland)	*Melanodryas cucullata picata/westralensis*			1	1	1			2			1					2						1					3	12
Rufous Songlark	*Cincloramphus mathewsi*				1	1						1							1	1			1			1	1	4	12
Brown Songlark	*Cincloramphus cruralis*				1						1	1	1				1						1			1	1	3	11

Habitat			Mulga woodland								Sandplain spinifex								Rocky habitat				Shrubland/Woodland			Ripar	Grass	Incidental	Total
Year			2010				2015				2010			2015					2010		2015		2010	2015		2010	2010		
Common Name	Scientific Name	Site	M1	M6	T08	T10	N01	N02	N07	N08	T09	T11	T12	N09	N10	N11	N12	N13	M2	M3	N03	N05	M4	N04	N06	M5	T07		
Spinifexbird	*Eremiornis carteri*																											1	1
White-backed Swallow	*Cheramoeca leucosterna*																2											3	5
Fairy Martin	*Petrochelidon ariel*												1															0	1
Mistletoebird	*Dicaeum hirundinaceum*													2	1													2	5
Zebra Finch	*Taeniopygia guttata*		1	1	1	1	1	1	3	3	1	1	1	4	1	4	2	4	1	1	3	2	1	1		1	1	8	49
Painted Finch	*Emblema pictum*																		1			2						2	5
Australasian Pipit	*Anthus novaeseelandiae*																								1		1	1	3
Reptiles			**1**	**7**	**6**	**1**	**7**	**5**	**10**	**5**	**1**	**2**	**4**	**8**	**13**	**15**	**4**	**5**	**8**	**4**	**3**	**7**	**2**	**2**	**1**	**2**	**2**	**37**	**162**
Fat-tailed Gecko	*Diplodactylus conspicillatus*																										1	0	1
Centralian Dtella	*Gehyra montium*																		1									2	3
Tree Dtella	*Gehyra variegata*			1																								0	1
Marbled Velvet Gecko	*Oedura marmorata*																											1	1
Beaked Gecko	*Rhynchoedura ornata*																		1									0	1
Northern Spiny-tailed Gecko	*Strophurus ciliaris*				1					2					2	2												0	7
Rusty-topped Delma	*Delma borea*															1												0	1
Burton's Legless Lizard	*Lialis burtonis*																		1									0	1
Striped Rainbow Skink	*Carlia munda*			1																								0	1
Three-Spined Rainbow Skink	*Carlia triacantha*																		1	1		2						0	4
Lively Ctenotus	*Ctenotus alacer*				1														1									0	2
Blue-tailed Ctenotus	*Ctenotus calurus*														2													1	3

Habitat			Mulga woodland								Sandplain spinifex								Rocky habitat				Shrubland/Woodland			Ripar	Grass	Incidental	Total
Year			2010				2015				2010			2015					2010		2015		2010	2015		2010	2010		
Common Name	Scientific Name	Site	M1	M6	T08	T10	N01	N02	N07	N08	T09	T11	T12	N09	N10	N11	N12	N13	M2	M3	N03	N05	M4	N04	N06	M5	T07		
Grand Ctenotus	*Ctenotus grandis*														1	3	2	2										0	8
Greer's Ctenotus	*Ctenotus greeri*				1						1	1			1													0	4
Leonhard's Ctenotus	*Ctenotus leonhardii*			1				1															1	1				0	4
Leopard Ctenotus	*Ctenotus pantherinus*													4	2	4		2										12	24
Pianka's Ctenotus	*Ctenotus piankai*															1												0	1
Robust Ctenotus	*Ctenotus robustus*																		1	1						1		0	3
Royal Ctenotus	*Ctenotus regius*													2														0	2
Rock Ctenotus	*Ctenotus saxatilis*																					4						0	4
Schomburgk's Ctenotus	*Ctenotus schomburgkii*			1	1	1	4	2	8	2														1				0	20
Great Desert Skink	*Liopholis kintorei*																											1	1
Rock Skink	*Liopholis margaretae*																											1	1
Night Skink / Striated Egernia	*Liopholis striata*														3	2												0	5
Grey's Menetia	*Menetia greyii*				1		2						1		1	1		1	1		2					1		0	11
Spinifex Snake-Eyed Skink	*Proablepharus reginae*																		1	1								0	2
Centralian Blue-tongued Lizard	*Tiliqua multifasciata*												1															1	2
Ring-tailed Dragon	*Ctenophorus caudicinctus*																											2	2
Military Dragon	*Ctenophorus isolepis*													2		1												4	7
Central Netted Dragon	*Ctenophorus nuchalis*			1				1		1		1			1					1	1	1						3	11
Round-headed Dragon	*Diporiphora lalliae*						1	1	2																			0	4

Habitat			Mulga woodland								Sandplain spinifex								Rocky habitat				Shrubland/Woodland			Ripar	Grass	Incidental	Total
Year			2010				2015				2010			2015					2010		2015		2010	2015		2010	2010		
Common Name	Scientific Name	Site	M1	M6	T08	T10	N01	N02	N07	N08	T09	T11	T12	N09	N10	N11	N12	N13	M2	M3	N03	N05	M4	N04	N06	M5	T07		
Long-nosed Water Dragon	*Lophognathus longirostris*																											1	1
Thorny Devil	*Moloch horridus*																											1	1
Dwarf Bearded Dragon	*Pogona minor*			1																							1	0	2
Ridge-tailed Monitor	*Varanus acanthurus*																								1			1	2
Rusty Desert Monitor	*Varanus eremius*												1				2											1	4
Pygmy Mulga Monitor	*Varanus gilleni*		1																									1	2
Sand Goanna	*Varanus gouldii*												1															1	2
Black-tailed Monitor	*Varanus tristis*																											1	1
Stimson's Python	*Antaresia stimsoni*																											2	2
Little Spotted Snake	*Suta punctata*			1	1																		1					0	3
Frogs			**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**2**	**4**
Northern burrowing frog	*Neobatrachus aquilonius*				1																							0	1
Spencer's Frog	*Platyplectrum spenceri*																									1		1	2
Red Tree-frog	*Litoria rubella*																											1	1
Invertebrates			**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**3**
Camaenid land snail	*Sinumelon expositum*																											1	1
Unidentified snail sp.	*(unknown)*																											2	2
Total			**21**	**29**	**42**	**31**	**31**	**54**	**44**	**58**	**13**	**21**	**23**	**40**	**45**	**65**	**41**	**27**	**38**	**27**	**33**	**68**	**23**	**51**	**36**	**33**	**24**	**376**	**1294**

Appendix G – Example results from motion-sensing cameras

2010: Few species were detected by cameras at the mine site locations, but more animals were detected along the haul route. In many cases, identification of mammals and reptiles was impossible, due to the small size of the animals and/or the poor light conditions. It is probable, but not certain, that some or all of the small unidentified mammals photographed along the haul route were Sandy Inland Mouse (*Pseudomys hermmansburgensis*), given the relatively large numbers captured in the Elliot traps concurrently.

2015: Deployment of 11 cameras in 2015 over the course of 30 days resulted in 16 species being photographed including

- Mammals: Fat-tailed False Antechinus, Brush-tailed Mulgara, Red Kangaroo, Spinifex Hopping-mouse, Camel, Cat and Cow
- Birds: Australian Magpie, Black-faced Woodswallow, Budgerigar, Crimson Chat, Grey-crowned Babbler, Little Button-quail, and Torresian Crow
- Reptiles: Leopard Ctenotus and Rusty Desert Monitor.

For some species, camera results were the only confirmed record of that species during the 2015 survey (Brush-tailed Mulgara, Spinifex Hopping-mouse, Cat).

Example photographs from each year are provided below.

2010

Nocturnal image of a hopping mouse (probably ***Notomys alexis***) from the haul route.

Diurnal image of an unidentified skink sp. from the mine site.

Diurnal image of a little button quail (***Turnix velox***) from the haul route.

Nocturnal image of two mice, probably sandy inland mouse (***Pseudomys hermannsburgensis***) from the haul route.

2015

Diurnal image of a Brush-tailed Mulgara (***Dasycercus blythi***) at latrine site near N13.

Nocturnal image of a Fat-tailed Pseudantechinus (***Pseudantechinus macdonnellensis***) at site N05.

Nocturnal image of a cat (***Felis catus***) at site N11.

Diurnal image of a Dingo (***Canis lupus dingo***) at Site N05.

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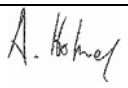
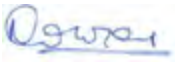
0	R. Retallick C. Whitehead	A. Holmes		Nicole Conroy		29/03/16
1	R. Retallick C. Whitehead	A. Holmes		Nicole Conroy		13/05/16

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