Flinders Mines Limited

Flinders Mines: Blacksmith Prospect Infrastructure Investigation

Vegetation, Flora and Fauna Assessment

October 2014

Executive summary

This report is subject to, and must be read in conjunction with, the limitations set out in sections 1.4 and 1.5 and the assumptions and qualifications contained throughout the Report.

Flinders Mines Limited (Flinders) proposes to develop an iron ore mining project on the Blacksmith tenement (M47/1451) in the Hamersley Range, in the West Pilbara Region of Western Australia. The Pilbara Iron Ore Project (PIOP) Project involves two stages:

- Stage 1: PIOP Iron ore mining operations
- Stage 2: PIOP Iron ore processing, transport and associated mining infrastructure (located off tenement).

Stage 1 has been assessed by the Environmental Protection Authority (EPA) at the level of Assessment on Proponent Information (API). Ministerial Statement 924 for PIOP Stage 1 was approved on 11/1/2013.

In order to continue to advance mine related project approvals and design of ancillary infrastructure (Stage 2), Flinders has commissioned GHD Pty Ltd (GHD) to provide a range of environmental and engineering services, including a Level 1 vegetation, flora and fauna assessment. The purpose of this assessment was to identify major ecological constraints associated with the proposed infrastructure sites and to recommend the least constrained sites.

The assessment included two village options, two airstrip options and associated road infrastructure (the Study area). The Study area is located approximately 70 km northwest of Tom Price and 160 km southeast of Dampier on Flinders exploration tenement E47/1306 in the Hamersley Ranges of the West Pilbara.

GHD undertook a desktop assessment of the Study area in July 2014 and a Level 1 flora and fauna field assessment from the 29 July to 1 August 2014. This assessment identified the following ecological features of the site:

- The Study area is located within the Pilbara Interim Biogeographic Regionalisation of Australia (IBRA) bioregion and the Hamersley IBRA subregion and intersects four land systems; Platform, Boolgeeda, Newman and River.
- Broad scale vegetation mapping by Beard (1975) which has been adapted and digitised by Shepherd *et al.* (2002) indicates that two vegetation associations are present within the Study area: Vegetation Association 82 and 565. The extent of Beard's (1975) vegetation associations have been determined by the state-wide vegetation remaining extent calculations maintained by the Department of Parks and Wildlife (DPaW) (latest update 2012 -Government of Western Australia 2013). The extent of vegetation associations 82 and 565 remaining is greater than 99.4% of the pre-European extent at the state, IBRA bioregion, IBRA sub-region and local government authority (LGA) levels. This vegetation is considered of Least Concern.
- A search of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) Protected Matters Search Tool (PMST) (DotE 2014) did not identify any federally listed Threatened Ecological Communities (TECs) within 20 km of the Study area. A search of the DPaW TEC/Priority Ecological Community (PEC) databases identified one DPaW-listed TEC and one PEC occurring within 20 km of the Study area; however no TECs or PECs were recorded within the Study area during the field survey.
- During the field assessment seven vegetation types were identified within the Study area:
  - *Eucalyptus camaldulensis* woodland in major drainage lines (EcW)

- *Eucalyptus victrix* open woodland in drainage lines (EvW)
- *Corymbia hamersleynsis* low open woodland in minor drainage lines (ChLOW)
- *Eucalyptus gamophylla/Eucalyptus leucophloia/Corymbia hamersleyensis* open woodland on sandy-loam plains (EgElChW)
- *Triodia wiseana* hummock grassland on stony hills (TwHG)
- *Triodia wiseana/Triodia epactia* hummock grassland on stony plains (TwTeHG)
- *Triodia melvillei* hummock grassland (TmHG)

- The condition of the vegetation in the Study area was generally very high, with cattle grazing and trampling being the most widespread disturbance. Evidence of cattle disturbance was generally higher in the creeklines and associated floodplains and very low on the hills. The vegetation of the Study area was mapped with the following condition ratings:
  - Condition 1-2 376.9 ha
  - Condition 2 (Excellent) 174.4 ha
  - Condition 2-3 460.2 ha
  - Condition 3 (Very Good) 82.1 ha
  - Condition 3-4 2.2 ha
  - Condition 4 (Good) 1.37 ha
  - Condition 6 (Completely Degraded) 15.05 ha
  - Condition Uninterpretable: Burnt 139 ha
- A total of 172 flora taxa (including subspecies and varieties) representing 41 families and 97 genera were recorded in the Study area during the GHD field surveys. This total comprised 168 (98 %) native taxa and four (2 %) introduced taxa.
- The GHD field survey did not record any EPBC Act or *Wildlife Conservation Act 1950* (*WC* Act)-listed flora taxa within the Study area, however, three DPaW Priority-listed flora taxa were recorded. These were:
  - *Rostellularia adscendens* var. *latifolia* (Priority 3)
  - *Indigofera* sp. Bungaroo Creek (S. van Leeuwen 4301) (Priority 3)
  - *Goodenia nuda* (Priority 4)
- The four fauna habitats types present within the Study area include:
  - *Triodia* hummock grasslands on low hills
  - Open woodlands and hummock grasslands on plains (including woodlands/shrublands regrowing after fire)
  - Breakaway/rocky ridgelines
  - Drainage lines and associated riparian vegetation
- The desktop assessment identified 217 vertebrate fauna species consisting of 97 birds, 89 reptiles, four amphibians and 27 mammals (including four introduced species) that have been previously recorded within 20 km of the Study area.
- A total of 20 conservation significant fauna have been identified as present or likely to occur in the Study area based on a combination of the desktop assessment and previous field assessments for fauna in the area. This includes five species listed as Threatened (EPBC Act and/or WC Act), one species listed as Specially Protected (WC Act), eight species listed as Priority (DPaW) and 6 species listed as Migratory. Of these, one bird species is listed as both Threatened and Migratory.

- A likelihood of occurrence assessment for conservation significant fauna species identified three Specially Protected (EPBC and/or WC Act) and eight Priority (DEC) fauna species as present or likely to occur in the Study area. These species are *Dasyurus hallucatus* (Northern Quoll) – Schedule 1, Endangered, *Liasis olivaceus barroni* (Pilbara Olive Python) – Schedule 1, Vulnerable, *Falco peregrinus* (Peregrine Falcon) – Schedule 4, *Pseudomys chapmani* (Western Pebble-mound Mouse) – Priority 4, *Burhinus grallarius* (Bush Stone-curlew) – Priority 4, *Leggadina lakedownensis* (Lakeland Downs Mouse) – Priority 4, *Ardeotis australis* (Australian Bustard) – Priority 4, *Lagorchestes conspicillatus leichardti* (Spectacled Hair-wallaby) – Priority 3, *Amytornis striatus striatus* (Striated Grasswren) (inland) – Priority 4, *Sminthopsis longicaudata* (Long-tailed Dunnart) – Priority 4 and *Notoscincus butleri* (Lined Soil-crevice Skink), – Priority 4.
- Two Migratory species have been identified as present or likely to occur within the Study area: *Ardea modesta* (Great Egret) and *Merops ornatus* (Rainbow Bee eater).
- No fauna species listed as Threatened under the EPBC Act or WC Act are restricted to the Study area. However, two species, the Northern Quoll and Pilbara Olive Python are considered likely to occur. These species would utilise rock breakaway and gorge areas (Figure 6) as well as the major drainage lines and associated woodlands (Figure 7) that are prevalent immediately around and within the Study area. Impacts on these areas of habitat should be minimised as much as possible.

Conclusions

The vegetation that was recorded within the Study area is generally widespread in the general area and is not likely to constrain the infrastructure site selection process. However, there were a number of locations that contained more restricted and ecologically valuable vegetation. These included the major drainage lines that occur in the west of the Study area, which supported woodlands that occur only along well-defined drainage lines and which act as refugia for a number of flora and fauna species. It also included a small section along the road alignment to the east of the main hill that incorporated a minor gully and drainage line at the base of the range. This drainage line supported a diverse range of grass and shrub species that were distinct from the surrounding vegetation. This area also supported a number of DPaW-listed Priority flora species. Impacts on these areas of vegetation should be minimised, or avoided if possible.

Impacts on vegetation and flora should be minimised during the detailed design stage by minimising the extent of clearing required for each infrastructure site to the minimum possible. Management measures will also be required during construction and operation phases of the infrastructure sites in order to minimise impacts. This should include consideration of appropriate drainage design to prevent changes and impacts on downstream ecosystems.

Significant fauna habitats include a major drainage line and associated riparian woodland (Figure 7), and breakaway area and small gorge (Figure 6) which are both considered significant habitat for the Northern Quoll and Pilbara Olive Python. Impacts on these areas of habitat should be kept to the minimum possible. Additionally Airstrip 1 has nine active mounds of the priority listed Western Pebble-mound Mouse. This population appears good and where possible impacts on the species mounds and immediate area avoided where possible or minimised.

Site selection

Based upon ecological attributes the Village site that can be considered least constrained is Village Site 1 and the airstrip site that can be considered least constrained is Airstrip Site 2. However, the Airstrip Site 2 site had a number of watercourses and floodways associated with it

and management measures will be required to minimise potential environmental impacts for this site. If this site is utilised it is recommended that the infrastructure be situated to avoid the major drainage lines and associated vegetation. In addition, drainage management would be required to minimise potential downstream impacts.

There were no major ecological constraints identified for the majority of the road alignment; however, there were three locations along the road that had ecological value and in these areas impacts should be minimised and appropriate management measures implemented to reduce potential impacts to flora and fauna. These locations are:

- Minor gully/drainage line on the eastern side of the main hill – this vegetation contained priority flora species and impacts on this vegetation should be minimised by minimising the clearing footprint required for the road in this section. Management measures should be implemented during construction to reduce off-site impacts in this area (Figure 6).
- Drainage line crossings in the west of the Study area – impacts on this vegetation should be avoided or minimised wherever possible (Figure 7).
- Section of road that runs north-south at the western end of the alignment. This section of the road was highly constrained as it occurred along the base of a steep slope and a major drainage line. A road through this section is likely to require a high level of earthworks and drainage alterations, potentially with associated ecological impacts. It is recommended that this north-south section of road is avoided (Figure 8).

Site selection should also include consideration of the extent of site works required. Sites that require extensive cut and fill are likely to have a larger impact on ecological values and should be avoided where possible.

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1. Introduction

1.1 Background

Flinders Mines Limited (Flinders) proposes to develop an iron ore mining project on the Blacksmith tenement (M47/1451) in the Hamersley Range, in the West Pilbara Region of Western Australia. The Pilbara Iron Ore Project (PIOP) includes development and operation of seven deposits that would be mined separately. Annual ore production is targeted at 25 million tonnes per annum (Mtpa).

The iron ore processing plant, administration buildings, ore stockpiles, accommodation village and all associated mining infrastructure will be located off-tenement. In addition to this, Flinders has not finalised ore transport or port arrangement and as such an environmental impact assessment of the PIOP is occurring in two stages:

- Stage 1: PIOP Iron ore mining operations
- Stage 2: PIOP Iron ore processing, transport and associated mining infrastructure.

Stage 1 has been assessed by the Environmental Protection Authority (EPA) at the level of Assessment on Proponent Information (API). Ministerial Statement 924 for PIOP Stage 1 was approved on 11/1/2013.

Flinders has commissioned GHD Pty Ltd (GHD) to provide a range of environmental and engineering services, in order to advance mine related project approvals and design of ancillary infrastructure (Stage 2). This includes the following:

- Undertake an options analysis to identify a suitable location for an accommodation village, airstrip and connecting access road from this infrastructure to the Blacksmith tenement.
- Undertake a Level 1 vegetation, flora and fauna survey of the selected sites and recommend locations for the airstrip, village and associated roads based on ecological constraints.

1.2 Purpose of this report

This report details the Level 1 flora and fauna assessment of the selected sites for the ancillary infrastructure for the PIOP. This assessment will assist in identifying ecological constraints associated with the potential infrastructure areas and in identifying any further investigations required.

1.3 Study area

The Study area is located approximately 70 km northwest of Tom Price and 160 km southeast of Dampier on Flinders exploration tenement E47/1306 in the Hamersley Ranges of the West Pilbara. Tenement E47/1306 is located directly south of the Blacksmith mining tenement (M47/1451). The Study area is within the Shire of Ashburton.

The Study area is approximately 1251 ha in size and includes two village options, two airstrip options and associated road infrastructure. These locations are shown in Figure 1, Appendix A. The proposed road corridor runs from the proposed rail connection to north of the mining tenement. The proposed road corridor follows an existing track for much of its length in order to reduce on ground disturbance and cost.

1.4 Scope of Works

GHD's scope of work for the vegetation, flora and fauna assessment was to:

- Undertake a desktop assessment to describe the existing vegetation, flora and fauna associated with the Study area
- Undertake a Level 1 vegetation, flora and fauna field survey of the Study area
- Identify any key flora and fauna constraints and any additional ecological investigations required

1.5 Limitations

This report has been prepared by GHD for Flinders and may only be used and relied on by Flinders for the purpose agreed between GHD and Flinders as set out in section 1.5 of this report.

GHD otherwise disclaims responsibility to any person other than Flinders 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 (refer section(s) 1.4 and 3.3 of 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 Flinders 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 buildings, services and vegetation. 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.

It should be noted that the flora and fauna survey is based upon the Study area shown in Figure 1, Appendix A and further assessment would be required should the Study area significantly change.

2. Relevant Legislation

An outline of key relevant legislation and guidelines relevant to this report is provided in Table 1. Relevant background information and conservation codes are detailed in Appendix B.

Table 1 Relevant environmental legislation and guidelines

Legislation / Guideline	Responsible Agency	Aspect / Application
Commonwealth		
Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)	Department of the Environment	Protection of matters of national environmental significance; assessments on Commonwealth land.
State		
Biosecurity and Agriculture Management Act 2007 (BAM Act)	Department of Agriculture and Food Western Australia	Outlines Declared pests which are nominated by DAFWA as organisms that are, or may become, a problem to the environment.
Conservation and Land Management Act 1984 (CALM Act)	Department of Parks and Wildlife	Provides for the better protection and management of certain public lands and waters, and the flora and fauna thereof.
Wildlife Conservation Act 1950 (WC Act)	Department of Parks and Wildlife	Provides for the conservation and protection of wildlife (flora and fauna). Special provisions and schedules cover protection and management of gazetted rare flora and fauna.
Draft Technical Guide – Flora and Vegetation Surveys for Environmental Impact Assessment (EPA and DEC 2010)	Environmental Protection Authority and Department of Parks and Wildlife	Provides guidance and information on expected standards and protocols for terrestrial flora and vegetation surveys to environmental consultants and proponents.
Guidance Statement No. 51 – Guidance for the Assessment of Environmental Factors: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia. (EPA 2004a)	Environmental Protection Authority	Provides guidance and information on expected standards and protocols for terrestrial flora and vegetation surveys to environmental consultants and proponents.
Guidance Statement No. 56 – Guidance for the Assessment of Environmental Factors: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia. (EPA 2004b)	Environmental Protection Authority	Provides guidance and information on expected standards and protocols for terrestrial fauna surveys to environmental consultants and proponents.
Position Statement No. 3 – Terrestrial Biological Surveys as an Element of Biodiversity Protection. (EPA 2002)	Environmental Protection Authority	Outlines the principles in relation to the provision of information in the assessment of biodiversity.
Technical Guide for Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment (EPA and DEC 2010)	Environmental Protection Authority and Department of Parks and Wildlife	Provides guidance and information on expected standards and protocols for terrestrial fauna surveys to environmental consultants and proponents.

3. Methodology

3.1 Vegetation and flora

GHD undertook a vegetation and flora survey that was based upon the requirements of the Environmental Protection Authority (EPA's) *Guidance for the Assessment of Environmental Factors 51: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia* (EPA 2004a). The survey was a Level 1 survey as defined by the EPA Guidance 51 and included a desktop assessment and a reconnaissance survey.

3.1.1 Desktop assessment

As part of the flora and vegetation desktop assessment, GHD undertook a review of the following information sources:

- Current and relevant literature sources relating to the Study area, including *Pilbara Iron Ore Project – Blacksmith Flora and Vegetation Survey* (Ecoscape 2011a)
- Beard (1975) vegetation mapping
- The Department of Parks and Wildlife (DPaW) and WA Museum NatureMap database (DPaW 2007–) to identify threatened flora and priority listed flora species previously recorded within the Study area (20 km buffer)
- A review of the DPaW Threatened and Priority flora databases (Threatened and Priority Flora database (TPFL) and Western Australian Herbarium specimen database (WAHERB) for the area (20 km buffer)
- A review of DPaW Threatened Ecological Community (TEC) and Priority Ecological Community (PEC) databases to determine the potential for TECs or PECs to be present within the Study area (20 km buffer)
- A review of the Department of the Environment (DotE) Protected Matters Search Tool (PMST) (DotE 2014a) to identify threatened flora species listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) as potentially occurring within the Study area and identify any TECs previously identified as occurring or potentially occurring within the works area (20 km buffer)
- Review of aerial photography and desktop assessment results to identify areas with potential to contain Threatened Flora, Priority Listed Flora and TECs.

3.1.2 Field survey

GHD conducted a four day Level 1 reconnaissance field survey from 29 July to 1 August 2014 in order to verify and ground truth the results of the desktop assessment, identify and describe dominant vegetation units, assess vegetation condition, and identify and record vascular flora taxa. A Level 1 survey includes selective, low intensity sampling of the flora and vegetation (EPA 2004a).

Field survey methodology involved a combination of releve, transect and opportunistic sampling. A total of 13 releves and two transects were established during the field surveys. Releve locations have been mapped at Figure 3, Appendix A.

Releves

Releves[1] were established in areas that are representative of a vegetation assemblage. The releves were approximately 50 m x 50 m in size, with shape and/or size adjusted as necessary to best represent assemblages that are not able to be captured in a 50 m x 50 m releve (e.g. drainage areas, or areas of unique geology).Releves were uniquely numbered starting from R01, R02 and so on. Field data at each releve were recorded on a pro-forma data sheet and include the parameters indicated in Table 2.

Data collection for each releve followed the requirements as stipulated by DPaW and with vegetation descriptions being consistent with the National Vegetation Information System (NVIS), Australian Vegetation Attribute Manual (ESCAVI 2003).

Table 2 Data collected during the field survey

Aspect	Measurement
Collection attributes	Personnel/recorder; date, quadrat dimensions, photograph of the quadrat.
Physical features	Aspect, soil attributes. Percentage surface cover by: rocks, logs and branches, leaf litter, bare ground.
Location of important features	Coordinates recorded in GDA94 datum using a hand-held Global Positioning System (GPS) tool to accuracy approximately ± 5 m.
Vegetation condition	Vegetation condition was assessed using the condition rating scale devised by Keighery (1994).
Disturbance	Level and nature of disturbances (e.g. weed presence, fire — and time since last fire, impacts from grazing, exploration activities).
Flora	List of dominant flora from each structural layer. List of all species within the quadrat including average height and cover (using a modified Braun-Blanquet scale)

Vegetation units

Vegetation units were identified and boundaries delineated using a combination of aerial photography and field data including releve and transect data together with field and mapping notes. Similarities in landforms and soil types were taken into account.

Vegetation units were described based on their structure, dominant taxa and cover abundance, as defined by releve and transect data. Vegetation unit descriptions follow the NVIS (ESCAVI 2003. Vegetation unit descriptions were consistent with NVIS Level V (Association), which are grouped within NVIS Level III (Broad Floristic Formation). At Level V up to three strata and a maximum of three taxa per stratum are used to describe the association (ESCAVI 2003). NVIS is the DPaW preferred vegetation classification system (EPA and DEC 2010).

Vegetation condition

The vegetation condition of the Study area was assessed and mapped in accordance with the vegetation condition rating scale developed by Keighery (1994). This scale recognises the intactness of vegetation, which is defined by the following:

- Completeness of structural levels.
- Extent of weed invasion.
- Historical disturbance from tracks and other clearing or dumping.
- The potential for natural or assisted regeneration.

[1] Releves are sampling sites similar to quadrats but which are not marked on the ground and are an approximate defined area.

The scale consists of six rating levels as outlined in Table 3.

Table 3 Vegetation condition rating scale (Keighery 1994)

Condition rating	Vegetation condition	Description
1	Pristine or Nearly So	No obvious signs of disturbance.
2	Excellent	Vegetation structure intact, disturbance affecting individual species, and weeds are non-aggressive species.
3	Very Good	Vegetation structure altered, obvious signs of disturbance.
4	Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances retains basic vegetation structure or ability to regenerate it.
5	Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not in a state approaching good condition without intensive management.
6	Completely Degraded	The structure of the vegetation is no longer intact and the area is completely or almost without native species.

Flora identification and nomenclature

Species that were well known to the survey botanist were identified in the field; all other species were collected and assigned a unique collection number to facilitate tracking. Plant species were identified by the use of local and regional flora keys and by comparison with the named species held at the Western Australian Herbarium. When necessary, plant taxonomists considered to be authorities on particular plant groups were consulted.

The conservation status of all recorded flora was compared against the current lists available on *FloraBase* (WA Herbarium 1998–) and the EPBC Act Threatened species database provided by DotE (2014b).

Nomenclature used in this report follows that used by the Western Australian Herbarium as reported on *FloraBase* (WA Herbarium 1998–).

Targeted surveys for conservation significant flora

Prior to the field survey, information obtained from the desktop assessments (e.g. aerial photography, geology, soils and topography data, DEFL, *NatureMap* and WAHERB database search results) was reviewed to determine potential conservation significant flora taxa and locations. Additionally, ecological information (e.g. habitat, associated flora taxa and phenology) was sourced from *FloraBase* (DPaW 2007–) and other relevant publications where available, to provide further details.

Potential habitat were searched by transect sampling and opportunistic sampling (e.g. on route to sites and incidentally in adjacent areas). Locations within the Study area with differing hydrology, fire or disturbance history to the surrounding areas were also searched where identified.

When conservation significant flora were identified, the location of each individual was recorded by Global Positioning System (GPS), or if the stand was extensive the boundary recorded by GPS.

3.2 Fauna

3.2.1 Desktop assessment

GHD conducted a literature review, including map-based information searches of all current and relevant literature sources and databases relating to the Study area. This included the following information sources:

- Current and relevant literature sources relating to the Study area, including *Pilbara Iron Ore Project – Blacksmith Flora and Vegetation Survey* (Ecoscape 2011b, c)
- The DPaW and WA Museum NatureMap database (DPaW 2007–) to identify Threatened fauna and Priority listed fauna species previously recorded within the Study area
- A review of the DotE PMST (DotE 2014a) to identify fauna species listed under the EPBC Act potentially occurring within the Study area
- Review of all desktop information to identify habitat types within the Study area that have the potential to support listed Threatened fauna species. These areas will be targeted during the field survey to allow for confirmation of key habitat elements (including habitat condition, presence of refuge sites, key food sources, suitable vegetation strata, suitability of soils for digging).

3.2.2 Field survey

GHD undertook a Level 1 fauna survey of the Study area concurrently with the vegetation and flora assessment from the 29 July to 1 August 2014. The main aim of the fauna survey was to verify the findings of the desktop assessment, and to record any additional information from the Study area. The Level 1 fauna survey included:

- Mapping of fauna habitat types within the Study area
- Recording all opportunistic fauna observations
- Representative photographs of fauna habitats
- Evaluation of habitat types in the areas likely to support conservation significant fauna species
- Identifying and mapping critical habitat for conservation significant species identified in the desktop assessment as potentially occurring with the Study area
- Targeted detailed searches of potential habitat for conservation significant fauna species
- A survey for key distinguishing features/descriptions (including diggings, scats, refuge types) of conservation significant fauna
- Recording the GPS locations of any conservation significant fauna species or fauna of interest that were observed

3.3 Desktop and field assessment limitations

Desktop investigations use a variety of online resources such as the Western Australian Museum (WAM) and DPaW NatureMap database (DPaW 2007–), and the EPBC Act PMST. The responsibility for the accuracy of such data remains with the issuing authority, not with GHD. The PMST database is used to identify species listed under the EPBC Act. This database draws on various sources to report on the potential of the species occurrence within the area. The EPBC Act search tool is broad-scale in its reporting and often the specific habitat requirements of the species do not occur within the Study area. For this reason not all species reported by the search tool need to be considered in management decisions. The NatureMap

database reports on actual records of the species within the designated area and can provide more accurate information of the likelihood of species presence.

The limitations and constraints associated with the field survey are discussed in Table 4.

Table 4 Field survey limitations

Aspect	Constraint	Comment
Sources of information and availability of contextual information.	Minor	Broad scale (1:1,000,000) mapping by Beard (1975) and Shepherd et al. (2002) is available. The area to the north of the Study area (tenement M47/1451) has been surveyed as part of a detailed Level 2 by Ecoscape (2011a; b).
Scope (what life forms were sampled etc.)	Nil	Vascular flora and terrestrial vertebrate fauna were sampled during the survey. Non-vascular flora, invertebrate and aquatic fauna were not assessed as part of survey.
Proportion of flora collected and identified (based on sampling, timing and intensity)	Minor	The survey was a Level 1 survey only, and took place during one season in one year. The survey took place at the end of the dry season which is not generally the optimal time of year for surveying the Pilbara. However, the number of taxa found compares favourably with that of other surveys completed in the general area (172 taxa recorded in a 1,251 ha area compared to 269 species in a 10, 870 ha area).
Completeness and further work which might be needed (e.g. was the relevant area fully surveyed)	Nil	This survey was conducted to provide information on potential constraints associated with a number of potential infrastructure areas. The survey was sufficiently detailed and covered enough of the relevant area at this stage of the Project. Once sites have been determined further surveys may be required, depending on the sites chosen. The Study area was sufficiently traversed during this study. The surrounding region has been assessed by Ecoscape for both flora and fauna and Short Range Endemics (SRE). The Level 1 survey is considered adequate for this project.
Mapping reliability	Nil	High resolution ESRI aerial imagery was available and the number and distribution of releves and transects is considered adequate for a Level 1 definition of vegetation within the Study area.
Timing/weather/ season/cycle	Minor	The survey was conducted in July/August 2014 (end of the dry season). Rainfall records from Wittenoom Weather Station (station no. 5026) indicate that the rainfall for the year to date was 337.2 mm (January- July) which is less than the long-term mean for the same period (388.2 mm). However, in the three months prior to the survey (May – July) the area has received 55 mm of rainfall which is higher than the long-term mean for the same period (50.7 mm) (BoM 2014). This period of above average winter rainfall meant that conditions during the flora survey can be considered suitable for a Level 1 survey. The weather conditions during the survey were sunny with daily maximum temperatures ranging from 27.8 to 29.3 °C and daily minimum temperatures of 11.9 to 15.3 °C (at Wittenoom station no. 5026). No rainfall was recorded during the field survey (BoM 2014). The Level 1 survey was undertaken during winter. Some taxa (particularly reptiles) may have been less active and therefore less detectable in winter. Complete fauna surveys can require multiple surveys, at different times of year, and over a period of a number of years to enable observation of all species present. Some degree of variability is likely if subsequent surveys were to occur.

Aspect	Constraint	Comment
Determination of species	Minor	Six flora specimens were not able to be identified to species level due to lack of flowering or fruiting material. Additionally some species, particularly grasses, may have been overlooked due to lack of material; however this is unlikely to affect the results of the survey, as these species are not likely to be conservation significant species. In general it was possible to identify the majority of flora species located in the Study area. The taxonomy and conservation status of Western Australian flora is dynamic. This report was prepared in reliance on taxonomy and conservation status current at the time, but it should be noted this may change.
Disturbances (e.g. fire, flood, accidental human intervention)	Minor	Some sections of the Study area had been burnt less than 5 years ago. However, the vegetation had generally regrown well and this was not likely to affect the survey.
Intensity (in retrospect, was the intensity adequate)	Nil	The vascular flora of the Study area was sampled in accordance with EPA (2004a) and terrestrial fauna sampled in accordance with EPA (2004b). A single Level 1 survey of the Study area was undertaken. This level of survey is considered adequate at this stage of the proposal to determine the major constraints associated with the Study area. Further assessments may be required at later stages of the project, once specific sites have been selected.
Resources	Nil	Adequate resources were employed during the field survey. A total of 8 person days were spent undertaking the survey.
Access restrictions	Minor	The majority of the Study area was accessible. However, it was not possible to survey the section of track in the northeast part of the Study area as it did not occur on Flinders tenement. Information on this area was extrapolated from the accessible areas.
Experience levels	Nil	The survey ecologists are practitioners suitably qualified and experienced in their respective fields. The zoologist that conducted the field survey has more than 10 years and the botanist has more than six years conducting botanical surveys in Western Australia (including the Pilbara region).

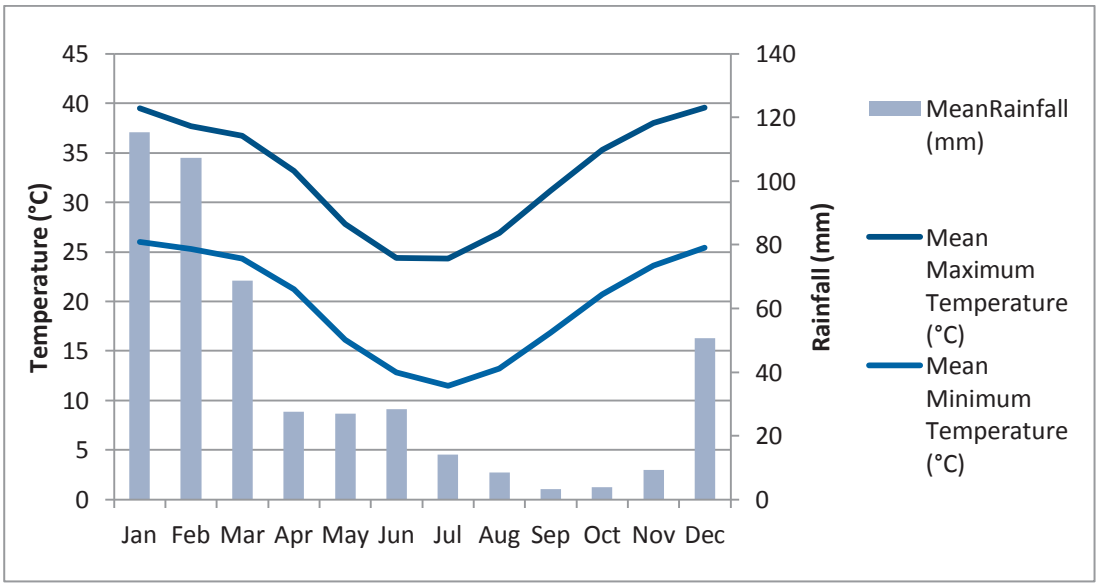
4. Results - Desktop assessment

4.1 Climate

The Study area is located in the Pilbara region of Western Australia. The Pilbara experiences an arid-tropical climate with two distinct seasons, a hot wet summer (October to April) and a mild dry winter (May to September) (BoM 2014).

In summer, maximum daytime temperatures average 37.7-29.6 °C, whilst in winter, minimum night time temperatures average 11.5-13.2 °C (BoM 2013). Rainfall in the Pilbara is often sporadic and may occur during both seasons. Average long term annual rainfall for the central Hamersley area is 465.6 mm (1950 – 2014 (Wittenoom Station)) with an average of 33.8 rain days per year. Summer rainfall is often associated with scattered thunderstorms and the occasional tropical cyclone. A secondary peak in the monthly rainfall occurs in May as a result of rainfall caused by tropical cloud bands which intermittently affect the area mostly in May and June. These events can also produce low maximum temperatures particularly away from the coast. Almost all storms occur in the summer (BoM 2014).

The closest Bureau of Meteorology (BoM) weather recording station with continuously recorded data (since 1950) in the vicinity of the Study area was Wittenoom (Station No. 50265). Monthly mean climatic data for Wittenoom is presented below (BoM 2014).



Graph 1 Wittenoom climatic data (1951 – 2014)

4.2 Geology and landforms

4.2.1 Geology

The Pilbara region is composed of the Pilbara Craton, which consists of two different tectonic components. The two broad geologic sequences are the ancient Archaean granite-greenstone terrain and the younger volcano-sedimentary sequence of the Hamersley Basin, which overlies the Archaean province and is well preserved in the southern two thirds of the Craton (Trendall 1990; Tille 2006).

4.2.2 Landforms

Landforms in the Pilbara region are dominated by hills and ranges with stony plains and some alluvial plains and sandplains on the volcanic, granitic and sedimentary rocks of the Pilbara Craton (Tille 2006).

The Study area traverses several different landform types. At the western end, the Study area includes a number of well-defined ephemeral drainage lines and floodplains that drain from the ranges to the north and east of the creeklines. Adjacent to these drainage lines are a number of small foothills and steeply sloped rocky areas. These creeklines include a number of deeply incised drainage channels. East of these drainage lines the Study area traverses a gently undulating plain which rises to a large hill in the central part of the Study area. East of this hill the Study area passes through a flat sandy-loam plain, which is intersected by a number of ephemeral drainage lines and some low stony hills at the edge of the Study area.

4.3 Land systems

The Pilbara region has been surveyed by the Department of Agriculture and Food WA (DAFWA) and the Department of Land Administration (now Department of Land Information) for the purposes of land classification, mapping and resource evaluation. A total of 102 land systems which are grouped into 20 broad land types have been described for the region, which are distinguished on the basis of topography, geology, soils and vegetation (Van Vreeswyk *et al*. 2004). The Study area intersects four land systems; details of these land systems are presented in Table 5.

Table 5 Land systems within the Study area (Van Vreeswyk *et al*. 2004)

Land System	Description	Geology and soils	Geomorphology	Location in Study area
Platform	Occupies 1,570 km^2 and consists of dissected slopes and raised plains supporting hard spinifex grasslands.	Partly consolidated Tertiary colluvium	Erosional surfaces formed by partial dissection of the old Tertiary surface; very gently inclined upper plains with extensive marginal dissection zones with gently inclined to steep slopes, closely spaced dendritic or sub-parallel drainage patterns with narrow floors in upper parts, floors incised up to 30 m with steep stable marginal slopes and becoming wider downslope.	Occurs in the north - west of the Study area
Boolgeeda	Occupies 7,748 km^2 and consists of stony lower slopes and plains below hill systems supporting hard and soft spinifex grasslands and mulga shrublands.	Quaternary colluvium.	Predominantly depositional surfaces; very gently inclined stony slopes and plains below hill systems becoming almost level further downslope; closely spaced, dendritic and sub-parallel drainage lines.	Occurs in the south-west and the central part of the Study area

Land System	Description	Geology and soils	Geomorphology	Location in Study area
Newman	Occupies 14,580 km^2 and consists of rugged jaspilite plateaux, ridges and mountains supporting hard spinifex grasslands.	Lower Proterozoic jaspilite, chert, siltstone, shale, dolomite and minor acid volcanics.	Erosional surfaces; plateaux and mountains - extensive high plateaux, mountains and strike ridges with vertical escarpments and steep scree slopes and more gently inclined lower slopes; moderately spaced dendritic and rectangular tributary drainage patterns of narrow valleys and gorges with narrow drainage floors and channels.	Occurs across the central part and the eastern section of the Study area
River	Occupies 4,088 km^2 and consists of active flood plains and major rivers supporting grassy eucalypt woodlands, tussock grasslands and soft spinifex grasslands.	Quaternary alluvium.	Flood plains and river terraces subject to fairly regular overbank flooding from major channels and watercourses, sandy banks and poorly defined levees and cobble plains. Banks, levees and slightly higher upper terraces receive less regular flooding than lower terraces and flood plains.	Occurs in the west of the Study area, associated with the major creeklines

4.4 Regional biogeography

The Study area is situated in the Eremaean Botanical Province (Beard 1990), within the Pilbara bioregion as described by the Interim Biogeographic Regionalisation of Australia (IBRA) (DotE 2014c). IBRA divides the Australian continent into 89 biogeographic regions based on similar climate, geology, landform, vegetation and fauna (DotE 2014c). The Study area is located within the Pilbara IBRA bioregion and the Hamersley IBRA subregion (PIL3). The Hamersley subregion is a mountainous area of Proterozoic sedimentary ranges and plateaux, dissected by gorges (basalt, shale and dolerite). The subregion supports Mulga low woodland over bunch grasses on fine textured soils in valley floors and *Eucalyptus leucophloia* over *Triodia brizoides* on skeletal soils of the ranges (Kendrick 2001).

Key special values and areas of refugia in the Hamersley subregion include the gorges of the Hamersley Ranges, particularly the deeply incised gorges, *Themeda* grasslands mountain tops of the Hamersley Range and calcrete deposits (Kendrick 2001).

4.5 Broad vegetation mapping

Broad scale (1:1,000,000) vegetation mapping of the Pilbara region was completed by Beard (1975) at an association level. The Beard mapping, which has been adapted and digitised by Shepherd *et al.* (2002), indicates that two vegetation associations are present within the Study area:

- Vegetation Association 82 'Hummock grasslands, low tree steppe, snappy gum over *Triodia wiseana'* – occurs across the majority of the Study area
- Vegetation association 565 'Hummock grasslands, low tree steppe, bloodwood over soft spinifex' – occurs in the east of the Study area

4.5.1 Broad vegetation extent and status

The extent of Beard's (1975) vegetation associations have been determined by the state-wide vegetation remaining extent calculations maintained by the DPaW (latest update 2012 -

Government of Western Australia 2013). As shown in Table 6, the extent of vegetation associations 82 and 565 remaining is greater than 99.4% of the pre-European extent at the state, IBRA bioregion, IBRA subregion and local government authority (LGA) levels. This vegetation is considered of Least Concern.

Table 6 Vegetation associations (Beard 1975) extent and status

Vegetation association	Scale	Pre-European Extent (ha)	Current Extent (ha)	Remaining (%)	% Pre-European Extent in IUCN Class I-IV Reserves	% Current Extent in All DPaW managed lands
IBRA bioregion Pilbara		17,808,657	17,733,584	99.58	6.36	8.43
IBRA subregion Hamersley		5,634,727	5,610,205	99.56	12.88	14.33
82	State	2,565,901	2,553,217	99.51	10.25	10.56
	Bioregion - Pilbara	2,563,583	2,550,899	99.51	10.26	10.57
	Sub-region – Hamersley	2,177,574	2,165,235	99.43	12.04	12.4
	LGA – Shire of Ashburton	1,537,077	1,533,325	99.76	17.11	17.58
565	State	143,439	143,427	99.99	0	0
	Bioregion - Pilbara	108,957	108,945	99.99	0	0
	Sub-region – Hamersley	108,957	108,945	99.99	0	0
	LGA – Shire of Ashburton	108,957	108,945	99.99	0	0

4.5.1 Conservation Significant Vegetation Communities

A search of the EPBC Act PMST (DotE 2014a) did not identify any federally listed TECs within 20 km of the Study area. A search of the DPaW TEC/PEC databases identified one DPaW-listed TEC and one PEC occurring within 20 km of the Study area (Figure 2, Appendix A). Details on each TEC and PEC and the locations relative to the Study area are presented below.

Table 7 Threatened and Priority Ecological Communities occurring within 20 km of the Study area

Name	Status	Description	Location
Themeda grasslands on cracking clays (Hamersley Station, Pilbara)	TEC – Vulnerable (DPaW)	*Themeda* grasslands on cracking clays (Hamersley Station, Pilbara). Grassland plains dominated by the perennial *Themeda* (kangaroo grass) and many annual herbs and grasses.	One occurrence approximately 18 km to the south-west of the Study area
Brockman Iron cracking clay communities of the Hamersley Range	PEC - Priority 1 (DPaW)	Rare tussock grassland dominated by *Astrebla lappacea* (not every site has presence of Astrebla) in the Hamersley Range, on the Brockman land system. Tussock grassland on cracking clays-derived in valley floors, depositional floors. This is a rare community and the landform is rare. Known from near West Angeles, Newman, Tom Price and boundary of Hamersley and Brockman Stations.	Four occurrences approximately 12-15 km south of the Study area Ten occurrences approximately 13-20 km south-west of the Study area

4.6 Flora

4.6.1 Flora diversity

A search of the *NatureMap* database (DPaW 2007–) identified 707 plant taxa, representing 62 families and 223 genera that have previously been recorded within 20 km of the Study area. This total comprised 683 native flora taxa and 24 naturalised (non-native) flora taxa. Dominant families within this search result included Fabaceae, Asteraceae and Scrophulariaceae.

The Ecoscape survey of the tenement to the north of the Study area (Ecoscape 2011a) identified 269 plant taxa within the tenement, representing 41 families and 44 genera, during three survey periods over two years. Dominant families recorded within the tenement included Fabaceae, Poaceae, Malvaceae and Amaranthaceae.

4.6.2 Conservation significant flora

Desktop searches of the EPBC Act PMST database (DotE 2014a), NatureMap database (DPaW 2007–), DPaW Threatened and Priority Flora database (TPFL) and Western Australian Herbarium database (WAHERB) identified the presence/potential presence of 35 conservation significant flora taxa within the Study area including one species listed under the EPBC Act and *Wildlife Conservation Act 1950* (WC Act) and 33 species listed as Priority species by DPaW (six Priority 1; three Priority 2, twenty Priority 3 and five Priority 4) (Table D.1, Appendix D).

The Ecoscape (2011a) surveys of the tenement to the north of the Study area identified five of the priority species that were recorded in the desktop assessments:

- *Goodenia nuda* - Priority 4 (3 locations)
- *Indigofera* sp. Bungaroo Creek (S. van Leeuwen 4301)- Priority 3 (six locations)
- *Rhynchosia bungarensis* - Priority 4 (eight locations)
- *Rostelluaria adscendens* var. *latifolia* – Priority 3 (two locations)
- *Sida* sp. Barlee Range – Priority 3 (one location)

4.7 Fauna

4.7.1 Fauna diversity

The NatureMap search identified 217 vertebrate fauna species previously recorded within 20 km of the Study area. This comprised 97 birds, 89 reptiles, four amphibians and 27 mammals (including four introduced species) (DPaW 2007–).

4.7.2 Conservation significant fauna

Desktop searches of the EPBC Act PMST database (DotE 2014a) and NatureMap database (DPaW 2007–) identified the presence/potential presence of 20 conservation significant fauna taxa. A summary of the fauna species of conservation significance recorded for the Study area from the desktop review is provided Table 8.

Six of the species identified by the PMST (DotE 2014a) for the search area are listed as Migratory (i.e. migratory marine, migratory terrestrial or migratory wetland) under the EPBC Act. Species solely listed as migratory marine or migratory wetlands (e.g. marine birds (i.e. Plover), migratory wetlands (Egrets) and migratory terrestrial (White-bellied Sea-Eagle)), with the exception of the Fork-tailed Swift and Rainbow Bee-eater were excluded from this assessment as no marine or wetland habitats was present within the Study area. The Fork-tailed Swift and Rainbow Bee-eater were included as they are not solely listed in the above categories.

Table 8 Conservation significant fauna species identified in the desktop assessment as potentially occurring within the Study area

Species	Common Name	Status		Source	
		Federal (EPBC Act)	State	EPBC Act PMST (DotE 2014a)	Nature Map (DPaW 2007-)
Birds					
Rostratula australis	Australian Painted Snipe	Vulnerable, Migratory	Schedule 1, Schedule 3	x	
Amytornis striatus striatus	Striated Grass-wren		Priority 4		x
Ardeotis australis	Australian Bustard		Priority 4		x
Burhinus grallarius	Bush Stone-curlew		Priority 4		x
Falco peregrinus	Peregrine Falcon		Schedule 4		x
Mammals					
Dasyurus hallucatus	Northern Quoll	Endangered	Schedule 1	x	
Rhinonicteris aurantia	Pilbara Leaf-nosed Bat	Vulnerable	Schedule 1	x	
Macrotis lagotis	Greater Bilby	Vulnerable	Schedule 1	x	
Sminthopsis longicaudata	Long-tailed Dunnart		Priority 4		x
Macroderma gigas	Ghost Bat		Priority 4		x
Leggadina lakedownensis	Lakeland Downs Mouse		Priority 4		x
Pseudomys chapmani	Western Pebble-mound Mouse	-	Priority 4		x
Reptiles					
Liasis olivaceus barroni	Pilbara Olive Python	Vulnerable	Schedule 1	x	x
Notoscincus butleri	Lined Soil-crevice Skink	-	Priority 4		x
Migratory Birds					
Charadrius veredus	Oriental Plover	Migratory marine	Schedule 3	x	
Haliaeetus leucogaster	White-bellied Sea-Eagle	Migratory terrestrial	Schedule 3	x	-
Apus pacificus	Fork-tailed Swift	Migratory marine	Schedule 3	x	x
Merops ornatus	Rainbow Bee-eater	Migratory terrestrial	Schedule 3	x	x
Ardea modesta	Great Egret	Migratory wetland	Schedule 3	x	
Ardea ibis	Cattle Egret	Migratory wetland	Schedule 3	x	

5. Results - Field Surveys

5.1 Vegetation and flora

5.1.1 Vegetation associations

The vegetation of the Study area included woodlands and hummock grasslands, with varying densities of *Eucalyptus* and *Corymbia* species over predominantly *Triodia* hummock grasslands. The sandy-loam plains in the east of the Study area contained mixed woodland of *Eucalyptus gamophylla, E. leucophloia* and *Corymbia hamersleynsis* over *Triodia epactia* hummock grassland that have recovered after a fire.

A number of small stony hills occurred across the Study area and in these areas the coverage of Eucalypt species was reduced and the hills were dominated by *Triodia wiseana* hummock grassland with scattered *Acacia, Senna* and other shrub species. In the northwest of the Study area the vegetation structure was similar to the stony hills; however also included the spinifex species, *Triodia melvillei.*

The stony plains in the centre of the Study area were dominated by hummock grassland of *Triodia wiseana* and *T. epactia* with an overstorey that included *Eucalyptus gamophylla, E. leucophloia, Corymbia hamerslensis* and occasional scattered *C. deserticola.*

The main drainage lines in the west of the Study area supported woodland of *Eucalyptus camaldulensis* with occasional *E. victrix* and *E. xerothermica* over mixed grass and shrub species. The minor drainage lines in this area supported *Corymbia hamersleyensis* woodland over mixed *Acacia* shrubland.

During the field assessment seven vegetation associations were identified within the Study area and described based on field observations:

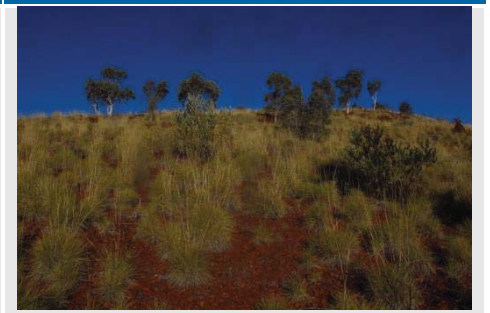
- *Eucalyptus camaldulensis* woodland in major drainage lines (EcW)
- *Eucalyptus victrix* open woodland in drainage lines (EvW)
- *Corymbia hamersleynsis* low open woodland in minor drainage lines (ChLOW)
- *Eucalyptus gamophylla/Eucalyptus leucophloia/Corymbia hamersleyensis* open woodland on sandy-loam plains (EgElChW)
- *Triodia wiseana* hummock grassland on stony hills (TwHG)
- *Triodia wiseana/Triodia epactia* hummock grassland on stony plains (TwTeHG)
- *Triodia melvillei* hummock grassland (TmHG)

In addition, 15.05 ha of the Study area was mapped as ‘cleared’, this included the existing tracks and laydown areas. The vegetation associations have been mapped in Figure 3, Appendix A and are detailed in Table 9.

Table 9 Vegetation associations within the Study area

Vegetation association (NVIS V vegetation description and NVIS map-unit)	General vegetation description	Landform and/or substrate	Representative sample locations and mapped extents (ha)	Notes	Indicative photograph
Eucalyptus camaldulensis woodland (EcW) U+ ^*Eucalyptus camaldulensis*\^tree\7\i; M ^*Acacia elachantha, Acacia pyrifolia, Tephrosia rosea* var. Fortescue Creeks\^shrub\5\r; G ^*Cymbopogon obtectus, Themeda triandra, Phyllanthus maderspatensis*\^grass,forb\2\bi	*Eucalyptus camaldulensis* woodland over sparse shrubland of *Acacia elachantha, A. pyrifolia* and *Tephrosia rosea* var. Fortescue Creeks over sparse tussock grassland of *Cymbopogon obtectus, Themeda triandra*	Major drainage lines	R01 12.8 ha		
Eucalyptus victrix open woodland (EvW)	not sampled by releve	Minor drainage lines	Not sampled – not in Flinders tenement 2.2 ha	very isolated occurrence – not able to be sampled	-

Vegetation association (NVIS V vegetation description and NVIS map-unit)	General vegetation description	Landform and/or substrate	Representative sample locations and mapped extents (ha)	Notes	Indicative photograph
Corymbia hamersleyensis low open woodland (ChLOW) U+ ^*Corymbia hamersleyana, Eucalyptus gamophylla, Eucalyptus xerothermica*\^tree, tree mallee\6\i; M ^*Keraudrenia velutina* subsp. *elliptica, Scaevola parvifolia* subsp. *pilbarae, Acacia elachantha*\^shrub\4\i; G ^^*Themeda triandra, Triodia epactia, Ptilotus nobilis* subsp. *nobilis*\^grass,forb\2\i	*Corymbia hamersleynsis* low open woodland with occasional *Eucalyptus gamophylla* and *E. xerothermica* over shrubland of *Keraudrenia velutina* subsp. *elliptica, Scaevola parvifolia* subsp. *pilbarae, Acacia elachantha* over mixed hummock grassland and herbland of *Themeda triandra, Triodia epactia* and *Ptilotus nobilis* subsp. *nobilis*	Minor drainage lines and floodplains	R09, R13 345.7 ha	Equivalent to Ecoscape (2011a) – ChEgLOW	
Eucalyptus gamophylla/ Eucalyptus leucophloia/Corymbia hamersleyensis open woodland (EgElChW) U+ ^^*Eucalyptus gamophylla, Corymbia hamersleyana, Eucalyptus leucophloia*\^tree, tree mallee\6\i; M ^^*Isotropis atropurpurea, Scaevola parvifolia* subsp. *pilbarae, Acacia spp.*\^shrub\3\r; G ^*Triodia epactia, Themeda triandra, Paraneurachne muelleri*\^grass\2\i	*Eucalyptus gamophylla, Eucalyptus leucophloia* and *Corymbia hamersleyensis* open woodland over mixed shrubland of *Isotropis atropurpurea, Scaevola parvifolia* subsp. *pilbarae, Acacia* spp. over hummock grassland of *Triodia epactia* and tussock grassland of *Themeda triandra* and *Paraneurachne muelleri*	Sandy-loam plains	R02, R04 143.1 ha	Equivalent to Ecoscape (2011a) – EgChElLW	

Vegetation association (NVIS V vegetation description and NVIS map-unit)	General vegetation description	Landform and/or substrate	Representative sample locations and mapped extents (ha)	Notes	Indicative photograph
Triodia wiseana hummock grassland (TwHG) U ^*Eucalyptus leucophloia, Corymbia hamersleyana*\^tree\6\r; M ^^*Senna glutinosa* subsp. *glutinosa, Acacia hilliana, A. adoxa* var *adoxa*\^shrub\4\r; G+ ^*Triodia wiseana, Enneapogon lindleyanus, Eriachne mucronata*\^hummock grass, tussock grass\2\c	*Triodia wiseana* hummock grassland with open woodland of *Eucalyptus leucophloia* and *Corymbia hamersleyana* over sparse mixed shrubland of *Senna* spp., *Acacia hilliana, A. adoxa* var *adoxa*	Stony hills	R03, R05, R06 78.9 ha	Equivalent to Ecoscape (2011a) – TwHg	
Triodia wiseana/Triodia epactia hummock grassland (TwTeHG) U ^*Eucalyptus leucophloia, Corymbia hamersleyana, C. deserticola*\^tree\6\r; M ^^*Acacia elachantha, Keraudrenia velutina* subsp. *elliptica, Ptilotus astrolasius*\^shrub\3\r; G+ ^^*Triodia wiseana, Triodia epactia, Themeda triandra*\^hummock grass, tussock grass\2\c	*Triodia wiseana* and *Triodia epactia* hummock grassland with open woodland of *Eucalyptus leucophloia* and isolated *Corymbia hamersleyana* and *C. deserticola* over mixed shrubland of hummock grassland of *Triodia wiseana* and *Triodia epactia* with isolated tussock grasses, including *Themeda triandra*	Stony plains	R07, R08, R11, R12 352.8 ha	Equivalent to Ecoscape (2011a) – EgChEILW	

Vegetation association (NVIS V vegetation description and NVIS map-unit)	General vegetation description	Landform and/or substrate	Representative sample locations and mapped extents (ha)	Notes	Indicative photograph
Triodia melvillei hummock grassland (TmHG) U^^*Eucalyptus leucophloia, Corymbia hamersleyana, C* \^tree\6\r; M ^^*Acacia adoxa* var. *adoxa, Keraudrenia velutina* subsp. *elliptica, Ptilotus calostachyus*\^shrub\3\r; G+ ^*Triodia melvillei, Triodia wiseana, Heliotropium* sp.\^hummock grass, forb\2\c	*Triodia melvillei* hummock grassland with isolated trees of *Eucalyptus leucophloia* and *Corymbia hamersleyana* over mixed shrubland of *Acacia adoxa* var. *adoxa, Keraudrenia velutina* subsp. *elliptica* and *Ptilotus calostachyus*	Stony plains and low hills	R10 300.7 ha352.8+78.9+	Equivalent to Ecoscape (2011a) – TmHG	

5.1.2 Conservation significant vegetation

The field survey did not identify any TECs or PECs within the Study area and the Study area did not contain the landforms on which the TECs or PECs that are found in the region occur.

5.1.3 Other significant vegetation

No vegetation that is considered to be a rare feature, centres of endemism or area of refugia as defined by Kendrick (2001) within the Hamersley subregion were recorded within the Study area. However, the creekline vegetation that occurs within the Study area can be considered as an ecosystem at risk due to the high level of cattle disturbance (Kendrick 2001).

In addition, there was one small gorge/drainage line at the base of the main hill in the centre of the Study area that contained a diverse range of flora species, including a number of priority species and a number of species that weren't recorded in other locations throughout the Study area (Figure 6). This area contains unusual species and is also likely to be a refuge, and as such can be considered as 'other significant vegetation' as defined by the EPA (2004a).

5.1.4 Vegetation condition

The vegetation condition of the Study area ranged from *Excellent* (2) to *Completely Degraded* (6). Most of the Study area was in relatively good condition with few disturbances and was rated as *Excellent* to *Very Good* (3). Areas of best vegetation condition were generally recorded from outcrops and stony hills.

Grazing by livestock, native mammals and feral animals has altered vegetation composition across some sections of the Study area, with palatable taxa being far more heavily grazed. Grazing and trampling impacts were generally more prevalent within drainage lines and adjacent floodplain areas.

An existing track runs through the Study area which was completely cleared and was rated as *Completely Degraded* (Condition 6). The north-eastern section of the track alignment had been recently burnt and as such the condition of the vegetation could not be determined. This section was mapped as 'Condition Uninterpretable'.

The extents of the vegetation condition ratings mapped within the Study area are detailed in Table 10.

Table 10 Extents of vegetation condition ratings mapped within the Study area

Vegetation Condition	Extent (ha)
Condition 1-2	376.9
Condition 2 (Excellent)	174.4
Condition 2-3	460.2
Condition 3 (Very Good)	82.1
Condition 3-4	2.2
Condition 4 (Good)	1.37
Condition 6 (Completely Degraded)	15.05
Condition Uninterpretable: Burnt	139

5.2 Flora

5.2.1 Flora diversity

A total of 172 flora taxa (including subspecies and varieties) representing 41 families and 97 genera were recorded in the Study area during the GHD field survey. This total comprised 168 (98 %) native taxa and four (2 %) introduced taxa.

Dominant families recorded from the Study area included:

- Fabaceae 37 taxa
- Poaceae 24 taxa
- Malvaceae 16 taxa
- Amaranthaceae 11 taxa

Dominant genera recorded from the Study area included:

- *Acacia* 16 taxa
- *Senna* 8 taxa
- *Ptilotus* 7 taxa
- *Eucalyptus* 6 taxa

A flora list for the Study area is provided in Table D.2, Appendix D.

5.2.2 Conservation significant flora

Field survey

The GHD field survey did not record any EPBC Act or WC Act-listed flora taxa within the Study area; however, three DPaW Priority-listed flora taxa were recorded. These were:

- *Rostellularia adscendens* var. *latifolia* (Priority 3)
- *Indigofera* sp. Bungaroo Creek (S. van Leeuwen 4301) (Priority 3)
- *Goodenia nuda* (Priority 4)

A brief description of each of these taxa is provided below (Source: WA Herbarium 1998–). The conservation significant flora species recorded during the field survey have been mapped at Figure 3, Appendix A. All of these species were also recorded by Ecoscape (2011a) within tenement M47/1451.

Rostellularia adscendens var. *latifolia* (Priority 3)

Rostellularia adscendens var. *latifolia* is a herb or shrub to 0.3 m high. It has blue-purple-violet flowers in April and May (Plate 1). This species occurs on ironstone soils near creeks and on rocky hills.

Rostellularia adscendens var. *latifolia* was recorded in two locations within the Study area in drainage lines. One plant was located within the main drainage line in the west of the Study area and one was within the minor gully/drainageline at the base of the main hill in the centre of the Study area (Figure 3, Appendix A).

Plate 1 *Rostellularia adscendens* var. *latifolia within the Study area*

Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301) (Priority 3)

Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301) is an upright shrub that is restricted to the Hamersley region. It was recorded within the road alignment section of the Study area in a minor gully/drainage line (Plate 2). Sixteen plants were counted in this area, on both sides of the track.

Plate 2 *Indigofera* sp. Bungaroo Creek (S. van Leeuwen 4301) within the Study area

Goodenia nuda (Priority 4)

Goodenia nuda is an erect to ascending herb up to 0.5 m high. This species has yellow flowers between April and August (Plate 3). Three plants of this species were recorded within the Airport Site 1 at one location within a floodplain area (Figure 3, Appendix A). This species is likely to be widespread through the general area.

Plate 3 *Goodenia nuda* within the Study area

5.2.3 Other significant flora

The flora species recorded during the field surveys were assessed to determine whether any were regarded as other 'significant flora' as defined by the EPA (2004a). No new or potentially new species were recorded within the Study area during the field assessments.

One grass species that was recorded in the field assessment, *Mnesithea formosa* has been previously recorded in the Kimberley region with only two records from the Pilbara. However, recent surveys (including Ecoscape 2011a) have recorded this species in the Pilbara and lack of historical records in this area is likely due to lack of survey effort.

5.2.4 Introduced flora (weeds)

The GHD field assessment recorded four introduced taxa during the field survey, these included:

- **Bidens bipinnata (*Bipinnate Begger's Tick)
- **Cenchrus ciliaris* (Buffel Grass)
- **Malvastrum americanum* (Spiked Malvastrum)
- **Sonchus oleraceus* (Common Sowthistle)

All introduced taxa were recorded in small densities in isolated occurrences along the main creeklines. The creeklines contained evidence of high use and disturbance by cattle.

None of the introduced flora species recorded in the Study area are listed federally as Weeds of National Significance or at the state level as Declared Pests. The recorded introduced species are generally widespread in the Pilbara region, particularly within disturbed riparian areas.

5.3 Fauna

5.3.1 Fauna habitat

Four fauna habitat types were identified within the Study area. Fauna habitat is based on vegetation structure and composition or features in the environment that fauna can utilise. Each of these habitat types are well represented in the immediate vicinity of the Study area and in the broader Hamersley Ranges. The area and habitat value of each habitat type is detailed in Table 11. A small amount of modified habitat was present in the Study area and consisted of established roads and drill pads; this has been excluded from the habitat types.

The four fauna habitats types present within the Study area include:

- *Triodia* hummock grasslands on low hills
- Open woodlands on plains (including shrublands which are regrowth woodlands after fire)

- Breakaway/rocky ridgelines
- Drainage lines and associated riparian vegetation.

Table 11 Fauna habitat types identified within the Study area.

Habitat types and area (ha)	Habitat Connectivity	Habitat value for fauna species of conservation significance	Photograph
Triodia hummock grasslands on low hills Area 379.3 ha	Excellent, continuous to surrounding habitats. Some minor roads and drill areas present but would not cause an obstacle for most species.	Habitat value – medium value Lakeland Downs Mouse Western Pebble-mound Mouse Striated Grass-wren Australian Bustard	
Open woodlands and hummock grasslands with scattered trees on plains, including low woodlands/shrublands which are regrowing after fire Area 495.24 ha	Excellent, continuous to surrounding habitats. Some minor roads and drill areas present but would not cause an obstacle for most species.	Habitat value – medium value Lakeland Downs Mouse Australian Bustard Bush Stone-curlew Lined Soil-crevice Skink Rainbow Bee-eater	
Breakaway/rocky ridgelines Area 0.95 ha	Excellent, continuous to surrounding habitats. Some minor roads and drill areas present but would not cause an obstacle for most species.	Habitat value – high value Peregrine Falcon Long-tailed Dunnart Ghost Bat Northern Quoll Pilbara Leaf-nosed Bat Pilbara Olive Python	

Habitat types and area (ha)	Habitat Connectivity	Habitat value for fauna species of conservation significance	Photograph
Drainage lines and associated riparian vegetation Area 360.73 ha	Good, continuous to surrounding habitats. Some disturbance from cattle and other feral pests, minor roads and drill areas present but would not cause an obstacle for most species.	Habitat value – high value Pilbara Olive Python Peregrine Falcon Ghost Bat Northern Quoll Pilbara Leaf-nosed Bat Lined Soil-crevice Skink Rainbow Bee-eater Great Egret	 

5.3.2 Habitat linkages and connectivity

Habitats are important to allow animals to move between areas of resource availability. They are important for ground and aerial fauna, providing cover, resources, and linking area suitable for rest and reproduction. Fragmentation of habitat limits the resources available to species, particularly sedentary species, which means fauna maybe more vulnerable to natural disasters or habitat changes over time. Fragmentation of habitat can lead to edge effects, leading to degradation of habitat. Where the distance between habitat fragments in small, species may still be able to move between these habitat areas, but maybe more exposed to predation pressures in the cleared zones.

Overall, the habitats within the Study area are well connected both locally and regionally to other areas of habitat. The majority of the Study area is pastoral and continues to be grazed, therefore some of the habitats have experienced various levels of disturbance resulting in some areas being degraded. Patches of degraded habitat form a mosaic with other areas that have retained habitat structure, which may reduce the ability of some fauna species to move through the landscape at a local scale. Evidence of degraded habitat was present within the drainage lines and plain where feeding resources are more desirable to cattle. Additionally the drainage lines appeared to be key rest locations for the cattle and numerous areas showed evidence of surface erosion and vegetation damage.

5.3.3 Fauna diversity

In total 74 vertebrate fauna species were recorded within the Study area during the field assessment, these included:

- 51 birds
- 8 mammals (including 4 introduced)
- 15 reptiles.

The complete list of species observed is presented in Appendix E. Of the 74 fauna species recorded, five were fauna species of conservation significance and included:

- Bush Stone-curlew (*Burhinus grallarius*), Priority 4 - DPaW listing.
- Rainbow Bee-eater (*Merops ornatus*), Migratory - EPBC Act, Schedule 3 - WC Act 1950.
- Australian Bustard (*Ardeotis australis*), Priority 4 - DPaW listing.
- Spectacled Hair-wallaby (*Lagorchestes conspicillatus leichardti*), Priority 3 - DPaW listing.
- Western Pebble-mound Mouse (*Pseudomys chapmani*), Priority 4 - DPaW listing.

Each species is further discussed in Section 5.3.5.

5.3.4 Introduced fauna species

Seven introduced mammals were identified in the field and from desktop assessment from the Study area and surrounding region. These include the House Mouse, Donkey, Rabbit, Cat, Dog/Dingo, Horse and Red Fox. All of these species are well known to be in the region.

5.3.5 Conservation significant species

Likelihood of occurrence assessment for significant fauna

A number of conservation significant fauna species were identified as potentially occurring within the Study area during the desktop investigation and then habitats or presence verified during the field investigation. An assessment on the likelihood of these species occurring in the

Study area was undertaken. This assessment is based on species biology, habitat requirements, the quality and availability of suitable habitat as determined during the field survey and records of the species in the Study area and locality. Additional to the species identified via desktop assessment any conservation significant fauna identified in the field not in the list are also included. In this case the Spectacled Hair Wallaby was recorded within the Study area and subsequently included in the likelihood of occurrence assessment.

The search areas for the desktop investigations included a 20 km buffer around the Study area. Species specific searches of the DPaW NatureMap database with a buffer of 20 km were also conducted in order to gather information about the broader regional occurrence of species to further inform the likelihood of occurrence assessment (Appendix E). The assessment concluded that:

- Five conservation significant fauna species are present within the Study area
- Eight conservation significant fauna species are likely to occur within the Study area
- Eight conservation significant species are unlikely to occur within the Study area
- One conservation significant species is highly unlikely to occur within the Study area.

The parameters of assessment outcome for this likelihood of occurrence assessment are described in Table 12. The occurrence assessment is summarised in Table 13.

Table 12 Parameters of assessment outcomes

Assessment outcome	Description
Present	Species recorded during the field survey or from recent, reliable records from within the Study area.
Likely	Species are likely to occur in the Study area where there is suitable habitat present and there are recent records of occurrence of the species in close proximity to the Study area OR Species known distribution overlaps with the Study area and there is suitable habitat within the Study area.
Unlikely	Species assessed as unlikely include: those species previously recorded within the search area (10 km desktop buffer) however: there is limited (i.e. the type, quality and quantity of the habitat is generally poor or restricted) habitat in the Study area the suitable habitat within the Study area is isolated from other areas of suitable habitat and the species has no capacity to migrate into the Study area OR those species that have a known distribution overlapping with the Study area however: there is limited (i.e. the type, quality and quantity of the habitat is generally poor or restricted) habitat in the Study area the suitable habitat within the Study area is isolated from other areas of suitable habitat and the species has no capacity to migrate into the Study area
Highly unlikely	Species that are considered highly unlikely to occur in the Study area include those species: that have no suitable habitat within the Study area that have become locally extinct, or are not known to have ever been present in the region of the Study area.

Table 13 Likelihood of occurrence for conservation-significant fauna species deemed known or likely to occur within the Study area

Species	Common Name	Listing under WC Act or DPaW Priority List	Listing under EPBC Act	LOO Assessment
Birds				
Falco peregrinus	Peregrine Falcon	Schedule 4		Likely
Ardeotis australis	Australian Bustard	Priority 4		Present
Amytornis striatus striatus	Striated Grasswren (inland)	Priority 4		Likely
Burhinus grallarius	Bush Stone-curlew	Priority 4		Present
Mammals				
Dasyurus hallucatus	Northern Quoll	Threatened	Endangered	Likely
Lagorchestes conspicillatus leichardti	Spectacled Hair-wallaby	Priority 3		Present
Pseudomys chapmani	Western Pebble-mound Mouse	Priority 4	-	Present
Sminthopsis longicaudata	Long-tailed Dunnart	Priority 4		Likely
Leggadina lakedownensis	Lakeland Downs Mouse	Priority 4		Likely
Reptiles				
Liasis olivaceus barroni	Pilbara Olive Python	Threatened	Vulnerable	Likely
Notoscincus butleri	Lined Soil-crevice Skink	Priority 4		Likely
Migratory Birds				
Merops ornatus	Rainbow Bee-eater	Schedule 3	Migratory	Present

Conservation fauna species that are 'Present'

Bush Stone-curlew (*Burhinus grallarius*), Priority 4 - DPaW listing

One Bush Stone-curlew set of prints was recorded in a drainage line in the western portion of the Study area during the field survey (see Table 14 and Figure 5, Appendix A). It is likely that Bush Stone-curlew in the area utilise the drainage lines and associated accumulated debris as diurnal refuges, and is likely to utilise the surrounding habitats, mainly woodlands for foraging and dispersal. Given the availability of suitable habitat in the local area and surrounding region, and that the Bush Stone-curlew are a wide ranging and highly mobile species, the proposed infrastructure is unlikely to have a significant impact on any individual Bush Stone-curlew.

Table 14 Bush Stone Curlew record

Species	Easting	Northing	Comment
Bush-stone Curlew	539026	7546363	prints

Rainbow Bee-eater (*Merops ornatus*) Migratory - EPBC Act, Schedule 3 - WC Act

Several Rainbow Bee-eaters were observed in a drainage line in the western portion of the Study area during the field survey (see Table 15 and Figure 5, Appendix A). This species occurs in a variety of habitats throughout Australia and it is likely that this species is a seasonal migrant to the Study area. No breeding of the species was recorded, however, suitable breeding habitat is present throughout the area in sandy soils. It should be noted that Rainbow Bee-eaters often take advantage of windrows of soil pushed up by graders and earth moving equipment along tracks, and may potentially use these areas within the proposed village and airstrip for breeding.

Given the availability of suitable habitat in the local area and surrounding region, and that the Rainbow Bee-eater is wide ranging and highly mobile species, the proposed project is unlikely to have a significant impact on any individual Rainbow Bee-eater.

Table 15 Rainbow Bee eater record

Species	Easting	Northing	Comment
Rainbow Bee eater	539026	7546363	Recorded specimens

Australian Bustard (*Ardeotis australis*), Priority 4 - DPaW listing

Australian Bustard tracks were recorded within hummock grassland habitats alongside a drainage line in the Study area during the field survey (see Table 16 and Figure 5, Appendix A). The Australian Bustard occurs across much of Australia, including across most of Western Australian, except in heavily wooded areas in the south. It occurs mainly in open country, such as grasslands, low heath or lightly wooded grassland (Morcombe 2004). The Bustard is a nomadic bird which is known to migrate to suitable feeding areas dependent upon conditions. It is likely that the Australian Bustard is a nomadic visitor to the Study area, and is likely to utilise all of the habitat types for foraging.

Given the availability of suitable habitat in the local area and surrounding region, and that the Australian Bustard wide ranging and highly mobile species, the proposed project is unlikely to have a significant impact on any individual Australian Bustard.

Table 16 Australian Bustard record

Species	Easting	Northing	Comment
Australian Bustard	540848	7547338	prints

Spectacled Hair-wallaby (*Lagorchestes conspicillatus leichardti*), Priority 3 - DPaW listing

The Spectacled hare-wallaby inhabits *Triodia* hummock grasslands and *Acacia* Shrublands in northern Australia. The species is often cryptic within their habitat and often over looked during assessment. In this study good evidence of Spectacle Hair Wallaby was recorded in the eastern portion of the Study area along the proposed road upgrade alignment (see Table 17 and Figure 5, Appendix A). Observations consisted of feeding and foraging evidence on *Eremophila* fruits, prints and droppings as seen in Plate 4, Plate 5 and Plate 6. Droppings were not typical of normal Spectacle Hair Wallaby (i.e. shape and composition), however, this individual appeared to be only feeding on *Eremophila* fruits and nothing else, altering its typical appearance. Vegetation in the Study area and immediate surrounds is consistent with habitat required for Spectacle Hair Wallaby. This species has been recorded historically in the area and surrounding region. This record is significant for this species in this region.

Table 17 Spectacle Hair Wallaby

Species	Easting	Northing	Comment
Spectacle Hair Wallaby	550842	7546704	prints, droppings and feeding evidence

Plate 4 Eremophila plants showing fruits (arrow) and prints at base

Plate 5 Prints recorded of Spectacle Hair Wallaby

Plate 6 Droppings around the Eremophila

Western Pebble-mound Mouse (*Pseudomys chapmani*), Priority 4 - DPaW listing

Evidence of Western Pebble-mound Mouse was recorded in the western section of the Study area in the northern most potential airstrip site (as shown in Figure 5, Appendix A). In total nine active and one abandoned Western Pebble-mound Mouse mounds were recorded on low stony hills in the middle of the Study area surrounded by drainage areas. The locations of mounds recorded during the survey are listed in Table 18 and mapped in Figure 5,Appendix A. NatureMap records (DPaW 2007–) indicate that this species is wide spread in the Hamersley Ranges and greater Pilbara region. However this species is known to be sensitive to local disturbances and populations have been recorded decreasing in areas to which it has occurred. Where possible these areas (where mounds are located) should not be impacted by disturbance.

Table 18 Western Pebble-mound Mice Mounds recorded in the Study area.

Species	Easting	Northing	Comment
Pebble mound Mouse	536766	7549562	Active Mound
Pebble mound Mouse	536674	7549458	Active Mound
Pebble mound Mouse	536857	7549546	Active Mound
Pebble mound Mouse	536909	7549497	Active Mound
Pebble mound Mouse	536988	7549542	Active Mound
Pebble mound Mouse	536966	7549572	Active Mound
Pebble mound Mouse	536816	7549742	Old Mound
Pebble mound Mouse	536761	7549718	Active Mound
Pebble mound Mouse	536800	7549680	Active Mound
Pebble mound Mouse	538125	7548217	Active Mound

Plate 7 Active Western Pebble-mound Mouse mound.

Conservation significant fauna species that are 'likely' to occur

Northern Quoll (*Dasyurus hallucatus*), Endangered - EPBC Act, Threatened - WC Act

The Northern Quoll is both arboreal and terrestrial and occupies a variety of habitats across its current range including rocky areas, eucalypt forest and woodlands, rainforests, sandy lowlands and beaches, shrublands, grasslands and deserts (DotE 2014c). Habitat usually requires some form of rocky area or structurally diverse woodland or forest for denning/shelter purposes with surrounding vegetated habitats used for foraging and dispersal.

Northern Quoll has been recorded in the general region by Ecoscape (2011b) via droppings in suitable habitat just north of the Study area. During the field assessment no quolls or evidence of Quolls were recorded in the Study area. However habitat is available for the species on outcropping and breakaways (Figure 6) and along the drainage line and within riparian vegetation (Figure 7). A large amount of habitat is also available along the rocky ridgelines and mesas immediately surrounding (but outside of) the Study area.

Pilbara Olive Python (*Liasis olivaceus barroni*), Vulnerable - EPBC Act, Threatened - WC Act

The Pilbara Olive Python's range is restricted to the Pilbara region, north Western Australia, and the Dampier Archipelago. Habitat consists of rocky escarpments, gorges and waterholes. The preferred microhabitats for this species are under rock piles, on top of rocks, and under spinifex as well as in man-made features such as overburden heaps, railway embankments and sewerage treatment ponds. The species breeding season occurs from June to August, with males moving long distances in search of breeding females (Wilson and Swan 2010).

The rocky ridgeline habitats and drainage lines (and associated riparian vegetation) in the area around and within the Study area are core habitat for this species.

Peregrine Falcon (*Falco peregrinus*), Schedule 4 - WC Act

The Peregrine Falcon has been previously recorded in the Hamersley Ranges, preferring deep gorges or areas of large cliff faces. This species diet predominantly consists of other birds, and

to a lesser extent, small mammals, which it hunts from the air. The Peregrine Falcon nests primarily on ledges of cliffs, shallow tree hollows, and ledges of buildings in cities (Morcombe 2004).

No large rocky cliff faces are present within the Study area, however habitat is available to the species in the rocky ridgelines and mesa immediately adjacent to the Study area. There are no suitable nesting areas for this species present within the Study area.

The Peregrine Falcon is wide ranging, mobile and aerial in nature, and therefore is likely to utilise all of the habitats within the Study area.

Given the availability of suitable habitat in the local area and surrounding region, and that the Peregrine Falcon is a wide ranging and highly mobile species, the proposed project is unlikely to have a significant impact on Peregrine Falcon habitat at either the local or regional levels.

Striated Grasswren (inland) (*Amytornis striatus striatus*), Priority 4 - DPaW listing

The inland sub-species of the Striated Grasswren occurs in spinifex, preferring big old clumps on sand dunes, rocky ranges and in the eastern part of the range large spinifex clumps under mallee. This sub-species has a wide range from the sandy deserts of interior Western Australian through to mallee areas of north-western Victoria (Morcombe 2004). There are numerous records of this species within the Hamersley Ranges and the species is known to occur in the region.

It is possible that this species utilises the habitats within the Study area for foraging, dispersal and potentially for nesting.

Given the availability of suitable habitat in the local area and surrounding region, and that the Striated Grasswren is a highly mobile species, the proposed project is unlikely to have a significant impact on any individual of this species.

Long-tailed Dunnart (*Sminthopsis longicaudata*), Priority 4 - DPaW listing

The Long-tailed Dunnart utilises rocky outcrops and breakaways habitat types within the Pilbara, Gascoyne, Murchison and northern Goldfields. Sparse records exist for this species which are rare and scattered, however it may be locally common at times and numerous records are represented from the Hamersley Ranges. In winter the Long-tailed Dunnart feeds on arthropods, including mainly beetles and ants, but also spiders, cockroaches, centipedes, grasshoppers, flies and various larvae. The records of the Long-tailed Dunnart come from widely scattered localities in the arid zone where it inhabits rugged, rocky areas including scree slopes, boulder and stony plateaus, and adjacent stony plains with shrubs over spinifex grasslands (Van Dyck et al. 2013)

Given that most of the Study area excludes rocky habitat the proposed project is unlikely to have a significant impact on any individual Long-tailed Dunnart.

Lakeland Downs Mouse (*Leggadina lakedownensis*), Priority 4 - DPaW listing

The Lakeland Downs Mouse occupies a diverse range of habitats from the monsoon tropical coast to semiarid climates, including spinifex and tussock grasslands, samphire and sedgelands, *Acacia* shrublands, tropical *Eucalyptus* and *Melaleuca* woodlands and stony ranges. Most habitats, however, are seasonally inundated on red or white sandy-clay soils. This species has previously been recorded in the region close to the Study area. This species is likely to occur within this precinct, in particular the areas around drainage lines and on plains. Once detailed designs and proposed location of infrastructure is known, further surveys would be required to confirm is any individuals of this species are likely to be impacted.

Lined Soil-crevice Skink (*Notoscincus butleri*), Priority 4 - DPaW listing

The Priority 4 listed *Notoscincus butleri* an endemic reptile to the Pilbara and is known only from the Dampier district, Harding River Dam to the western portion of the Hamersley Range (Storr et al., 1999, DPaW 2007–). The preferred habitat of this species includes areas near creeks and river margins dominated by spinifex and cracking clays. This species has previously been recorded in the region close to the Study area. This species is likely to occur within this precinct, in particular the areas around drainage lines and on plains. Once detailed designs and proposed location of infrastructure is known, further surveys would be required to confirm is any individuals of this species are likely to be impacted.

Great Egret (*Ardea modesta*), Migratory - EPBC Act, Schedule 3 - WC Act

Greater Egret is a very common species throughout Western Australia. Preferred habitat includes wetlands (for example inland and coastal, freshwater and saline, permanent and ephemeral, open and vegetated, large and small, natural and artificial). These include swamps and marshes, margins of rivers and lakes, damp or flooded grasslands, pastures or agricultural lands; reservoirs, sewage treatment ponds, drainage channels, salt pans and salt lakes, salt marshes, estuarine mudflats, tidal streams, mangrove swamps, coastal lagoons and offshore reefs. The species is migratory following favourable conditions and feeding areas during periods of seasonal inundation. The species has numerous records from within the Hamersley Ranges and the greater Pilbara area whereever habitat is present.

Within the Study area the drainage lines (and associated riparian vegetation) are core habitat for this species.

6. Conclusions and Site Selection

6.1 Vegetation and flora

A majority of the vegetation types present within the Study area are widespread in the general area and are not likely to constrain the infrastructure site selection process. However, there were a number of locations that contained more restricted and ecologically valuable vegetation. These included the major drainage lines that occur in the west of the Study area, which supported woodlands that occur only along well-defined drainage lines and which act as refugia for a number of flora and fauna species. It also included a small section along the road alignment to the east of the main hill that incorporated a minor gully and drainage line at the base of the range (labelled 'minor gully' on Figure 3, Appendix A). This drainage line supported a diverse range of grass and shrub species that were distinct from the surrounding vegetation. This area also supported a number of DPaW-listed Priority flora species. Impacts on this area should be kept to the minimum practical.

Impacts on vegetation and flora should be minimised during the site detailed design phase to minimise the extent of clearing required for each infrastructure site. Management measures will also be required during construction and operation phases of the infrastructure sites in order to minimise impacts. This should include consideration of appropriate drainage design to prevent changes and impacts on downstream ecosystems.

6.2 Fauna

A majority of the fauna habitat types present within the Study area are widespread in the general area and are not likely to constrain the infrastructure site selection process. However, like the vegetation and flora assessment further disturbance at a number of localised areas should be kept to the minimum possible.The major drainage line and supportive woodlands (Figure 7) provide habitat for threatened species such as the Northern Quoll and Pilbara Olive Python. Breakaway areas or small gorges are also denning locations for Northern Quoll and wintering refuge for Pilbara Olive Python (Figure 6). Impacts on these areas should be kept to the minimum possible.

Within the northern section of Airstrip Site 1 a small hill has a number of mounds of the priority listed Western Pebble-mound Mouse. Ten mounds were located over a small area and nine of these were active. This appears to be a good population of the species and where possible should be avoided.

6.3 Site selection

Based upon ecological attributes the Village site that can be considered least constrained is Village Site 1 and the airstrip site that can be considered least constrained is Airstrip Site 2. However, the Airstrip Site 2 site had a number of watercourses and floodways associated with it and management measures will be required to minimise potential environmental impacts for this site. If this site is utilised it is recommended that the infrastructure be situated to avoid the major drainage lines and associated vegetation. In addition, drainage management would be required to minimise potential downstream impacts.

There were no major ecological constraints identified for the majority of the road alignment; however, there were three locations along the road that had ecological value and in these areas impacts should be minimised where possible and appropriate management measures implemented to reduce potential impacts to flora and fauna. These locations are:

- Minor gully/drainage line on the eastern side of the main hill – this vegetation contained priority flora species and impacts on this vegetation should be minimised by minimising the clearing footprint required for the road in this section. Management measures should be implemented during construction to reduce off-site impacts in this area. It is noted that the corridor identified for the access road is approximately 200 metres wide, the existing exploration track in this location is approximately 3-4 metres wide and the ultimate road is anticipated to be approximately 10 metres wide. GHD considers that with appropriate detail design, the majority of habitat and significant flora shown in Figure 6 will not be disturbed by the expanded road.
- Drainage line crossings in the west of the Study area – impacts on this vegetation should be avoided or minimised wherever possible. It is noted that it will be necessary for an access road to be constructed through this drainage line to access the preferred airstrip (Site 2) shown in Figure 2. The existing exploration access track already crosses this drainage line. GHD considers that with appropriate detail design, the majority of habitat and significant flora shown in Figure 7 will not be disturbed by the expanded road.
- Section of road that runs north-south at the western end of the alignment - This section of the road was highly constrained as it occurred along the base of a steep slope and a major drainage line. A road through this section is likely to require a high level of earthworks and drainage alterations, potentially with associated ecological impacts. It is recommended that this north-south section of road is avoided. It is noted that this section of the access road is for access to the Site1 airstrip option, which has not been selected as the preferred airstrip location.

Site selection should also include consideration of the extent of site works required. Sites that require extensive cut and fill are likely to have a larger impact on ecological values and should be avoided where possible.

The ecological constraints and recommendations associated with each site are detailed in Table 19.

Table 19 Ecological constraints and recommendations associated with each infrastructure site

Option	Constraints	Outcome
Village Site 1 (east)	Land Features: Several large termite mounds[2] present, which could be included into village aesthetics. Drainage features: Drainage line present adjacent to the Study area. Flora: No known constraints Fauna: No known constraints Vegetation: The majority of the site contains widespread vegetation type; however, impacts on the vegetation of the drainage line should be avoided	Least constrained village site
Village Site 2 (west)	Land Features: No known constraints Drainage features: Constrained by the presence of drainage line and associated flood zone between the site and access track. Flora: No known constraints Fauna: No known constraints Vegetation: The majority of the site contains widespread vegetation type; however, impacts	Not the recommended village site in terms of ecological considerations.

[2] Locations of termite mounds in Village Site 1 are included in Table E.3 Appendix E

Option	Constraints	Outcome
	on the vegetation of the drainage line should be avoided	
Airstrip Site 1 (north)	Land Features: Two low hills are present on the eastern side of the Study area that may increase construction costs. Drainage features: Constrained by the presence of large and minor drainage lines and associated flood zones in the middle on the Study area. Flora: No known constraints Fauna: Nine active Western Pebble-mound Mouse mounds were recorded active in the north eastern portion of the Study area. Vegetation: Contains large areas of creekline vegetation considered as 'other significant vegetation' as it can be considered as refugia for flora and fauna species	Not recommended – contains a number of ecological constraints, including drainage lines and Western Pebble-mound Mouse mounds
Airstrip Site 2 (south)	Land Features: No known constraints Drainage features: Constrained by the presence of large and minor drainage lines and associated flood zones along the eastern edge of the Study area. Flora: No known constraints Fauna: No known constraints Vegetation: The majority of the site contains widespread vegetation type; however, impacts on the vegetation of the drainage lines should be avoided or minimised	Least constrained of the airstrip sites in terms of ecological issues; however does include riparian habitat along an edge of the site – it is recommended that impacts on the riparian habitat be avoided or minimised
Road	Land Features: No known constraints Drainage features: Constrained by the presence of minor drainage lines and associated flood zones along the track. Flora: Conservation significant species (DPaW listed Priority species) occur within the low gorge/drainage line at the base of the hill Fauna: No constraints Vegetation: The majority of the site contains widespread vegetation type; however, impacts at the major drainage line and gully should be kept to the minimum possible	Avoid using section of road that runs north-south at western end of the alignment. Minimise clearing of vegetation where possible. Minimise impacts on vegetation and flora at the eastern side of the low gorge/drainage line at the base of the main hill. Implement drainage management measures to reduce off-site impacts on vegetation and flora from potential changes to drainage.

6.4 Further investigations required

Once the final location for the infrastructure has been confirmed the sites should be assessed be required to determine whether further ecological investigations are required. In particular, if any major drainage lines, breakaways and gorges will be impacted by the sites targeted conservation significant flora and fauna surveys may be required.

Once the final sites have been determined, further assessment will be required to determine the environmental approvals required, including the requirement to refer the Project to the federal

Department of the Environment or the state Environmental Protection Authority and whether a clearing permit under Part V of the *Environmental Protection Act 1986* will be required.

7. References

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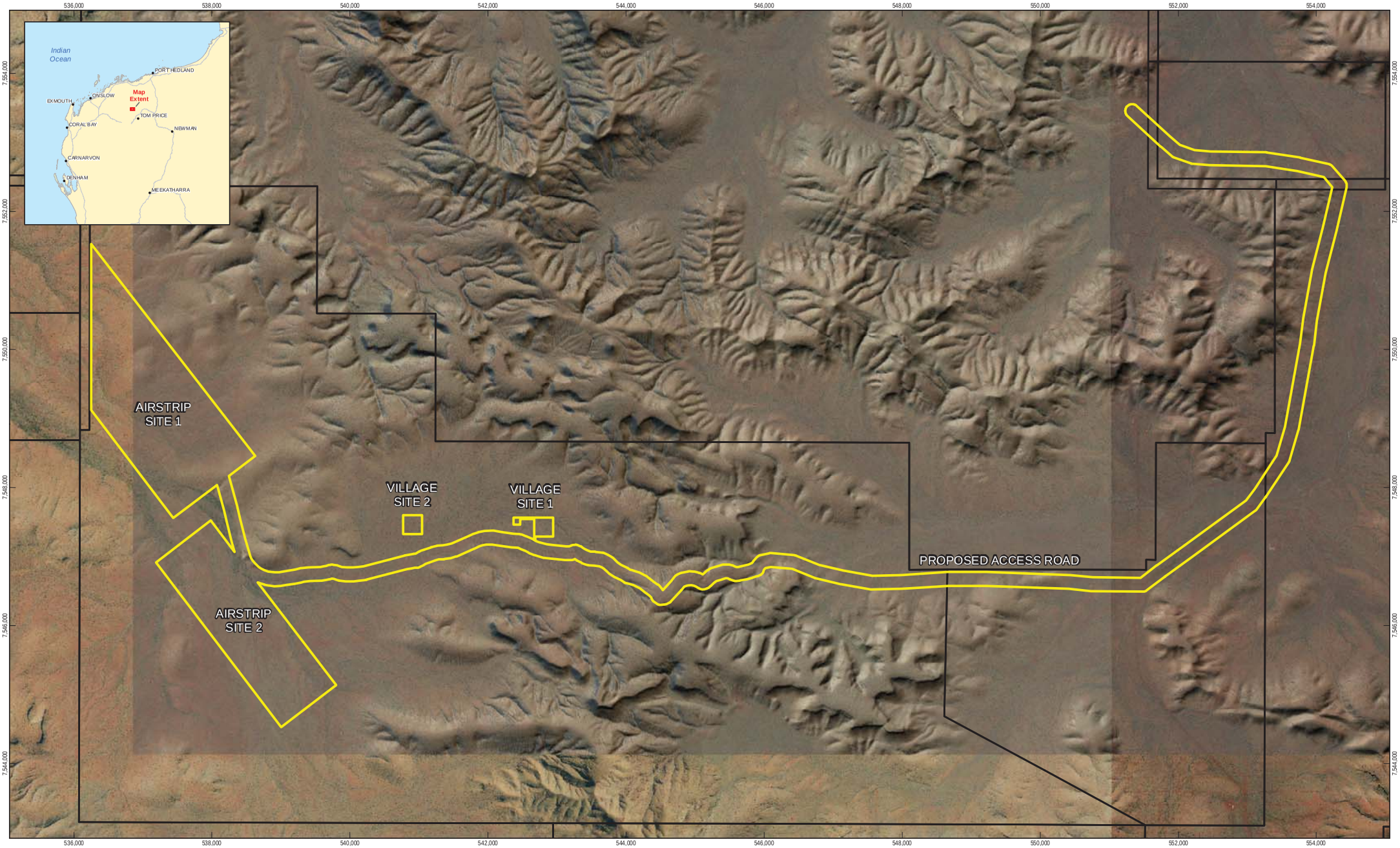
Appendices

Appendix A – Figures



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Kilometres

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N

LEGEND

- Study Area
- Mining Tenement

Flinders Mines
Blacksmith Prospect
Environmental and Engineering Services

Job Number	61-3114700
Revision	0
Date	23 Sep 2014

Study Area Location

Figure 1

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Data source: GHD: Study Area - 20140822; Landgate: Virtual Mosaic Imagery - 20140707; DMP: Mining Tenements - 20140721. Created by: AF

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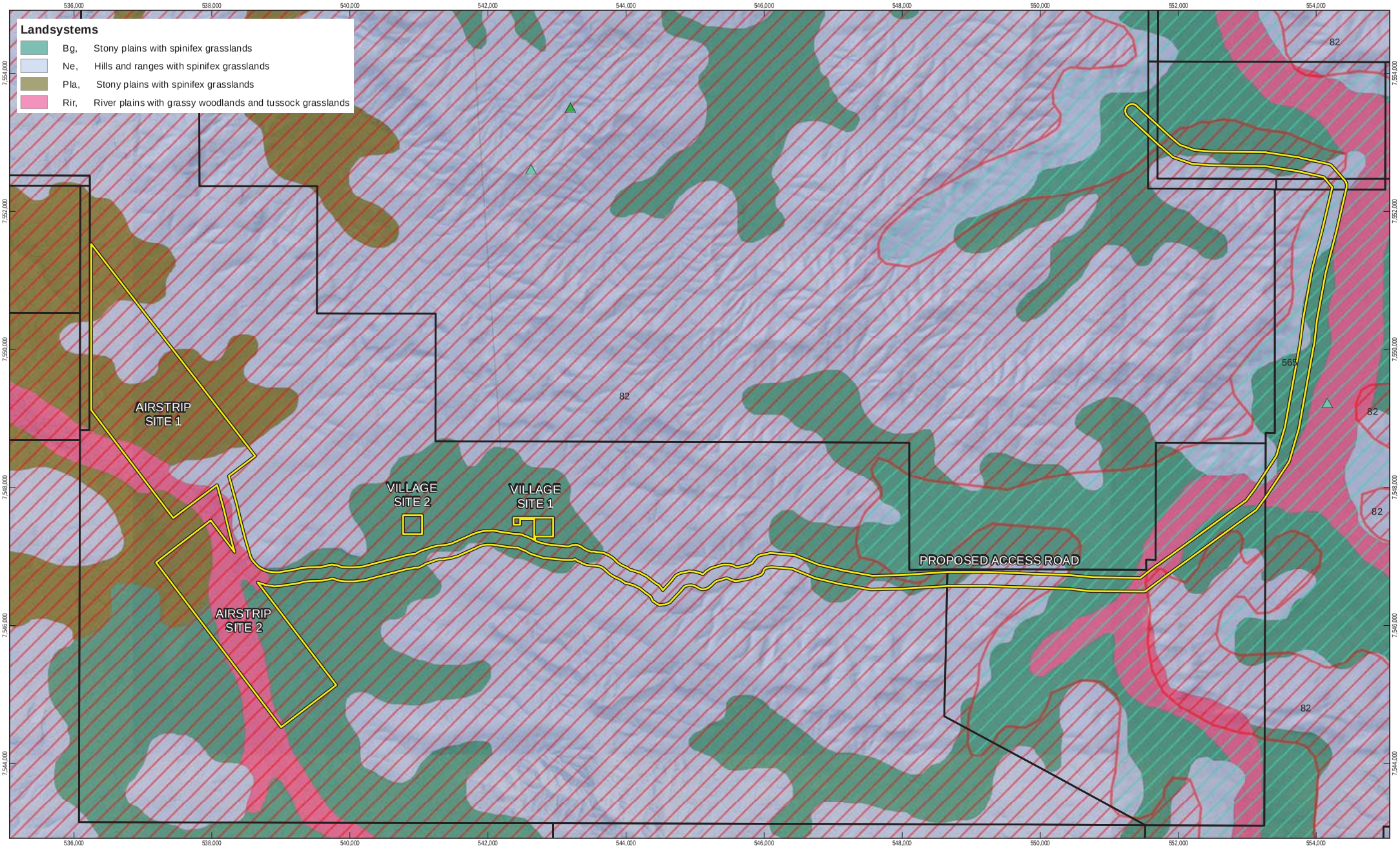

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Kilometres

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Grid: Map Grid of Australia 1994, Zone 50

N

LEGEND

DPaW conservation significant flora

- Priority 3 - Poorly Known Taxa
- Priority 4 - Rare Taxa

- Study Area
- Mining Tenement

Vegetation Association

- 82
- 565

Flinders Mines
Blacksmith Prospect
Environmental and Engineering Services

Job Number	61-31147
Revision	0
Date	23 Sep 2014

Ecological context

Figure 2

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Data source: GHD: Study Area - 20140822; Landgate: Virtual Mosaic Imagery - 20140707; DAFWA: Landsystems, PreEuropean Vegetation - 20140822; DPaW: Conservation Significant Flora - 20140822; DMP: Mining Tenements - 20140721. Created by: AF

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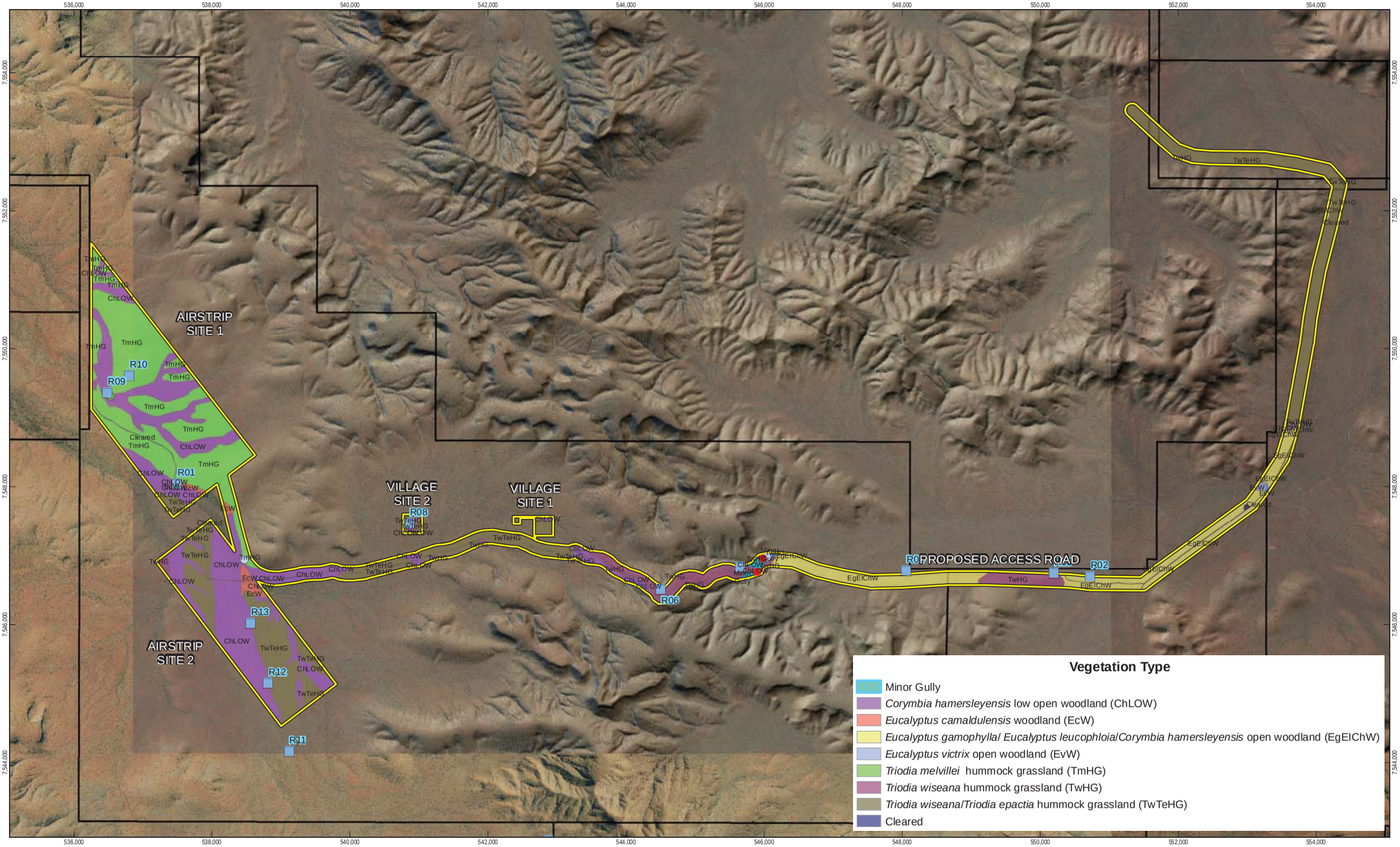

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Grid: Map Grid of Australia 1994, Zone 50

N

LEGEND

Releves

Priority Flora Species

Goodenia nuda (Priority 4)

Indigofera sp Bungaroo Creek (M E Trudgen 11601) (Priority 3)

Rostellularia adscendens var latifolia (Priority 3)

Study Area

Mining Tenement

Flinders Mines

GHD

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Flinders Mines
Blacksmith Prospect
Environmental and Engineering Services

Job Number	61-31147
Revision	0
Date	23 Sep 2014

Vegetation types and conservation significant flora species

Figure 3

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Data source: GHD: Study Area - 20140822, Releves, Priority Flora, Vegetation Type - 20140827; Landgate: Virtual Mosaic Imagery - 20140707; DMP: Mining Tenements - 20140721. Created by: AF

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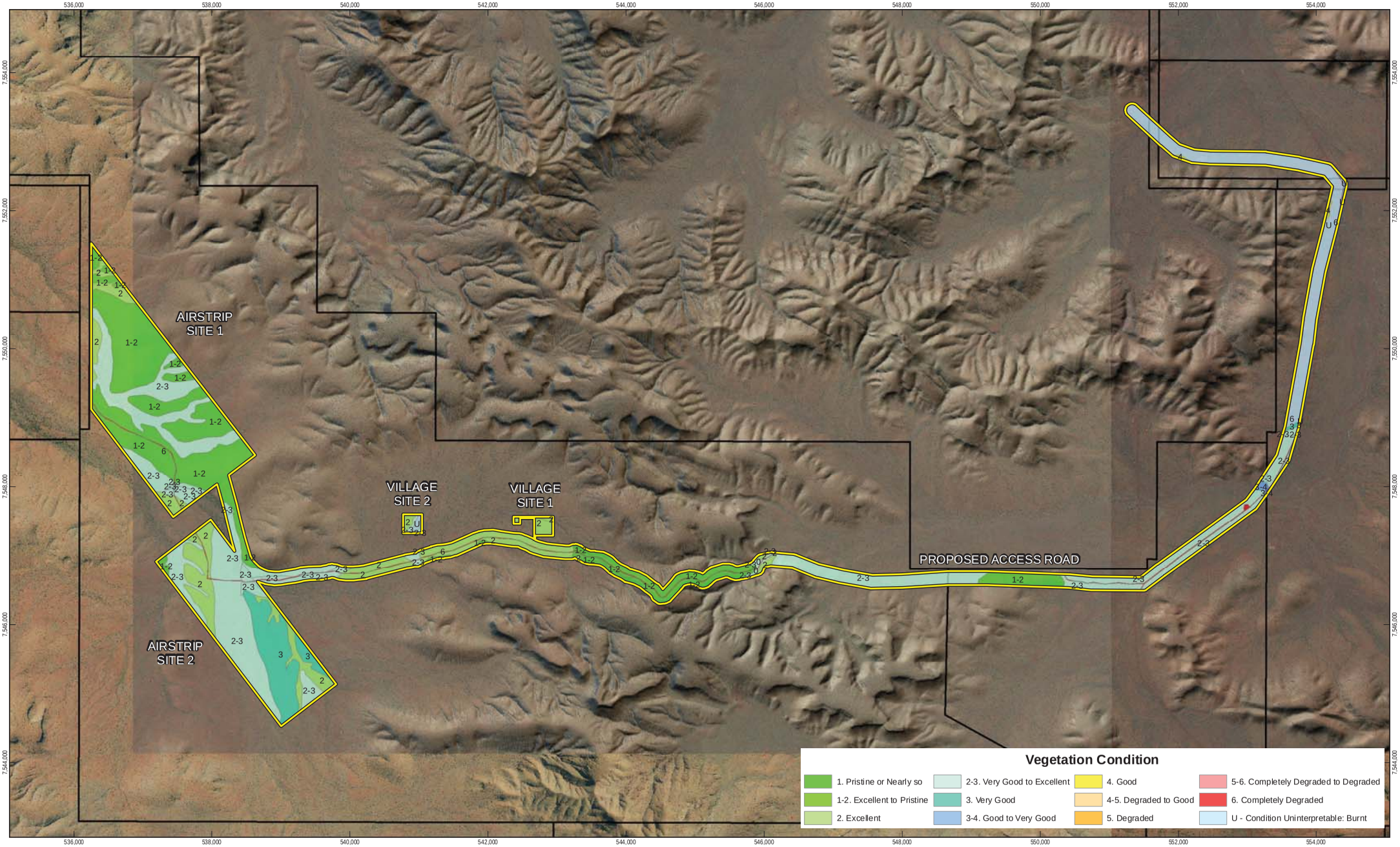

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N

LEGEND

Study Area

Mining Tenement

Flinders Mines
Blacksmith Prospect
Environmental and Engineering Services

Job Number	61-31147
Revision	0
Date	23 Sep 2014

Vegetation condition

Figure 4

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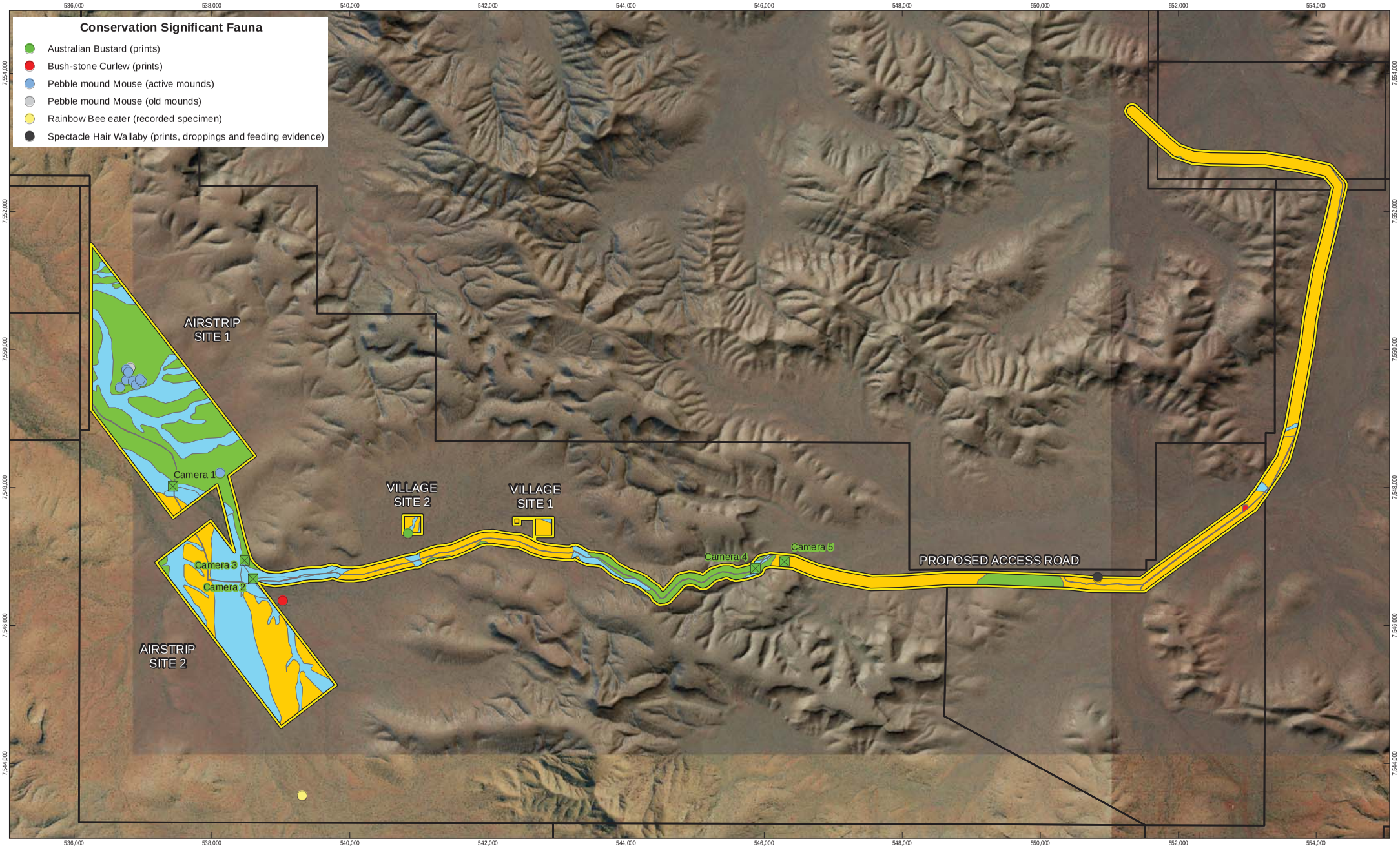

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Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

LEGEND

- Camera Trap Location
- Cleared
- Study Area
- Drainage lines
- Mining Tenement
- Plain

Fauna Habitat

- *Triodia hummock* grassland on low hills
- Breakaways/rocky ridges

Flinders Mines
Blacksmith Prospect
Environmental and Engineering Services

Job Number 61-31147
Revision 0
Date 23 Sep 2014

Fauna habitat and significant fauna locations

Figure 5

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Data source: GHD: Study Area - 20140822, Fauna Habitat, Conservation Significant Fauna Locations, Camera Trap Locations - 20140827; Landgate: Virtual Mosaic Imagery - 20140707; DMP: Mining Tenements - 20140721. Created by: AF

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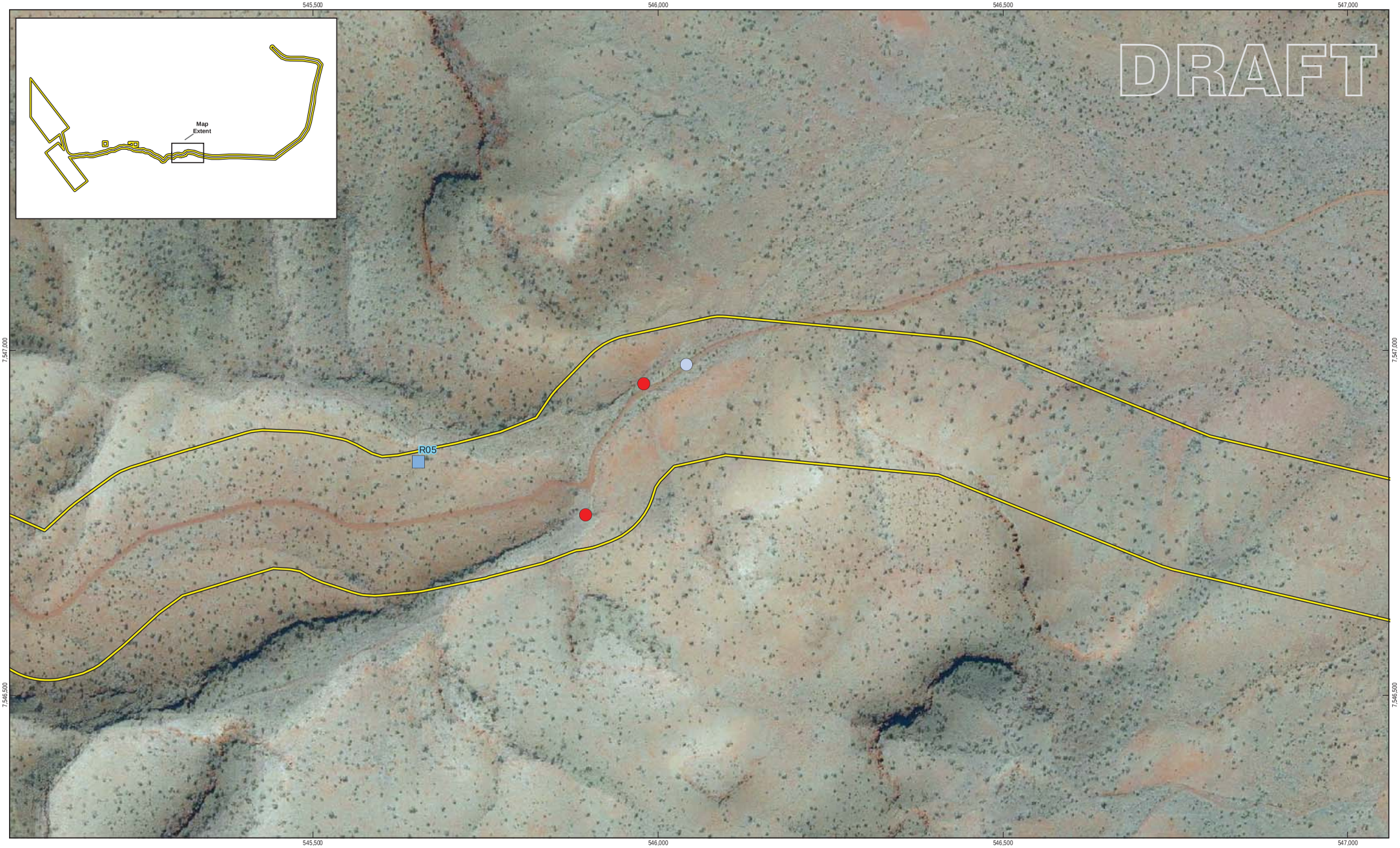

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Map Projection: Transverse Mercator
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Grid: Map Grid of Australia 1994, Zone 50

N

LEGEND

- Releves
- Study Area

Priority Flora Species

- *Goodenia nuda* (Priority 4)
- *Indigofera sp* Bungaroo Creek (M E Trudgen 11601) (Priority 3)
- *Rostellularia adscendens var latifolia* (Priority 3)

Flinders Mines
Blacksmith Prospect
Environmental and Engineering Services

Job Number 61-31147
Revision A
Date 08 Oct 2014

Conservation significant flora species

Figure 6

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Data source: GHD: Study Area - 20140822, Releves, Priority Flora - 20140827; Landgate: Virtual Mosaic Imagery - 20141007; DMP: Mining Tenements - 20140721. Created by: AF

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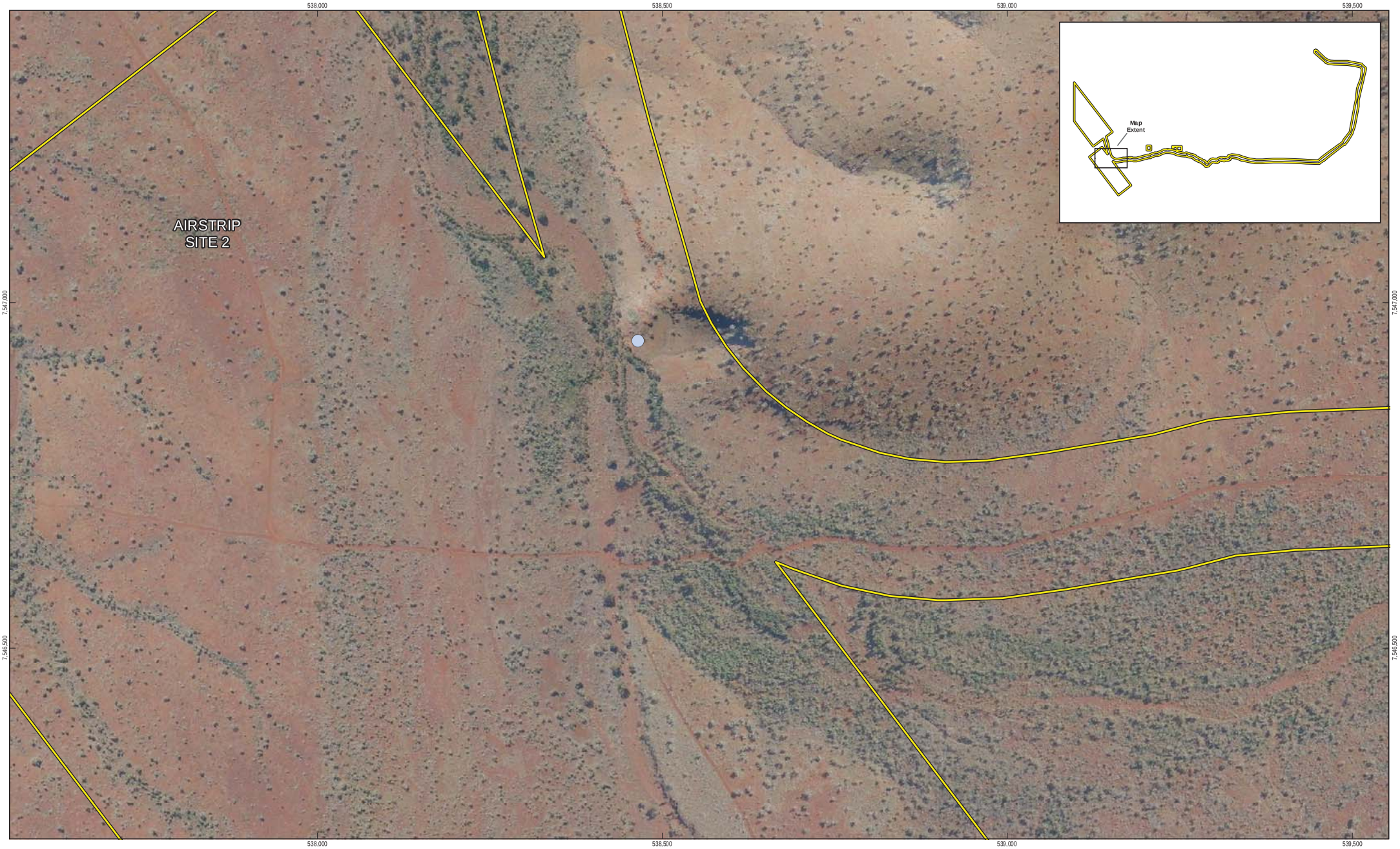

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N

LEGEND

- Releves
- Study Area

Priority Flora Species

- *Goodenia nuda* (Priority 4)
- *Indigofera sp* Bungaroo Creek (M E Trudgen 11601) (Priority 3)
- *Rostellularia adscendens var latifolia* (Priority 3)

Flinders Mines
Blacksmith Prospect
Environmental and Engineering Services

Job Number	61-31147
Revision	A
Date	08 Oct 2014

Conservation significant flora species

Figure 7

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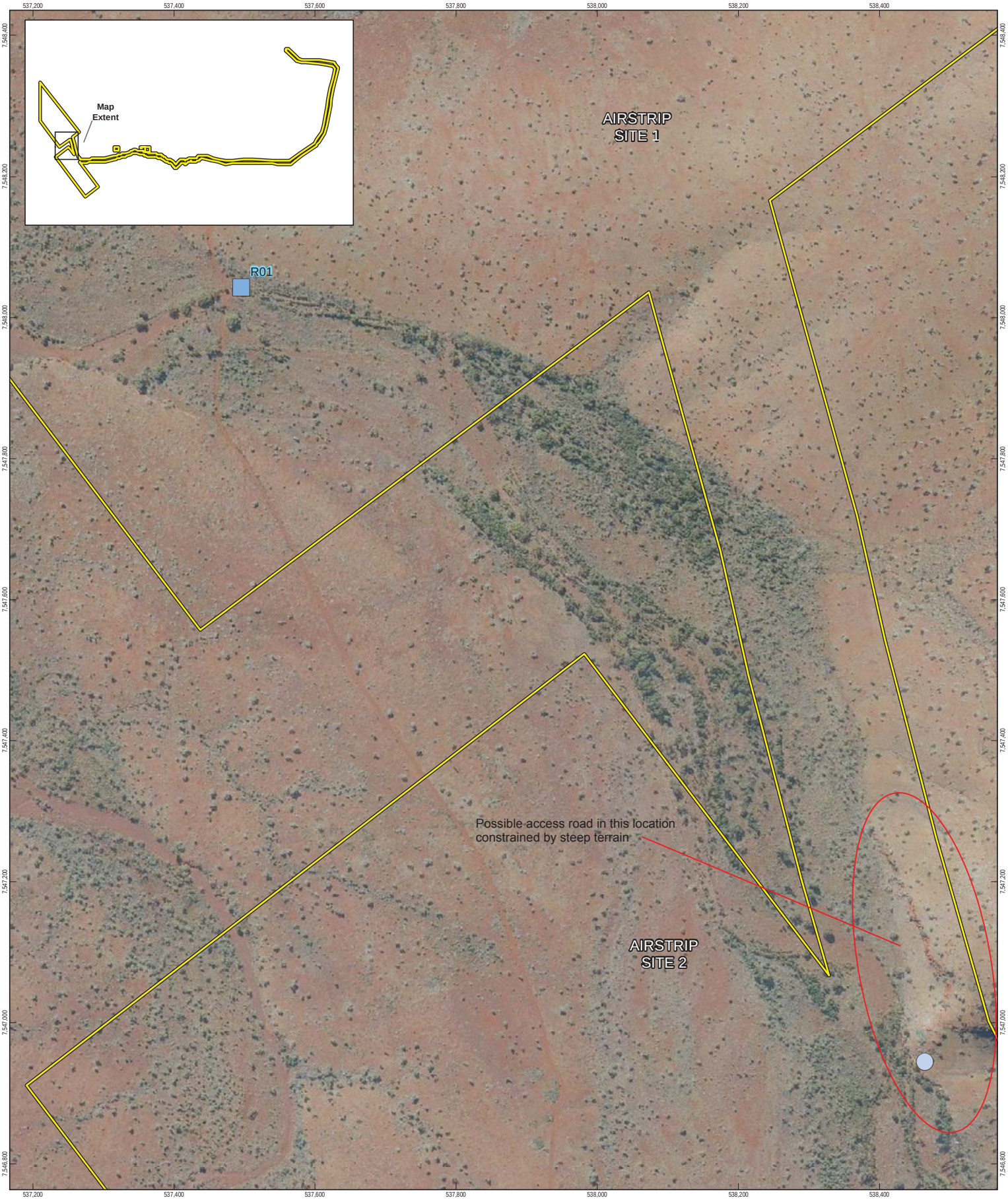

LEGEND

- Releves
- Priority Flora Species
- *Goodenia nuda* (Priority 4)
- *Indigofera sp* Bungaroo Creek (M E Trudgen 11601) (Priority 3)
- *Rostellularia adscendens var latifolia* (Priority 3)
- Study Area
- Mining Tenement

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Grid: Map Grid of Australia 1994, Zone 50

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Flinders Mines
Blacksmith Prospect
Environmental and Engineering Services

Vegetation types and conservation significant flora species

Job Number 61-28910
Revision A
Date 08 Oct 2014

Figure 8

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Data source: GHD: Study Area - 20140822, Releves, Priority Flora, Vegetation Type - 20140827; Landgate: Virtual Mosaic Imagery - 20141007; DMP: Mining Tenements - 20140721. Created by: AF

Appendix B – Background Information and Conservation Codes

Vegetation and Flora

Species of significant flora, fauna and communities are protected under both Federal and State Acts. The Federal EPBC Act provides a legal framework to protect and manage nationally important flora and communities. The State WC Act is the primary wildlife conservation legislation in Western Australia.

Vegetation extent and status

The National Objectives and Targets for Biodiversity Conservation 2001–2005 (Commonwealth of Australia, 2001) recognise that the retention of 30 percent or more of the pre-clearing extent of each ecological community is necessary if Australia's biological diversity is to be protected. This is the threshold level below which species loss appears to accelerate exponentially and loss below this level should not be permitted. This level of recognition is in keeping with the targets recommended in the review of the National Strategy for the Conservation of Australia's Biological Diversity (ANZECC, 2000) and in EPA Position Statement No. 2 on environmental protection of native vegetation in Western Australia (EPA, 2000).

From a purely biodiversity perspective and taking no account of any other land degradation issues, there are a number of key criteria now being applied to the clearing of native vegetation in Western Australia (EPA, 2000).

- The "threshold level" below which species loss appears to accelerate exponentially at an ecosystem level is regarded as being at a level of 30 percent of the pre-European extent of the vegetation type.
- A level of 10 percent of the original extent is regarded as being a level representing Endangered.
- Clearing which would put the threat level into the class below should be avoided.
- From a biodiversity perspective, stream reserves should generally be in the order of at least 200 metres (m) wide.

The extent of remnant native vegetation has been assessed by Shepherd et al. (2002) and the Government of Western Australia (2013), based on broadscale vegetation association mapping by Beard (1974).

Conservation significant communities

Ecological communities are defined as naturally occurring biological assemblages that occur in a particular type of habitat (English and Blyth, 1997). Federally listed Threatened Ecological Communities (TEC) are protected under the EPBC Act administered by the Department of the Environment (DotE) (formerly the Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC)). The DPaW also maintains a list of TECs for Western Australia; some of which are also protected under the EPBC Act. TECs are ecological communities that have been assessed and assigned to one of four categories related to the status of the threat to the community, i.e. Presumed Totally Destroyed, Critically Endangered, Endangered and Vulnerable (Table B.1).

Possible TECs that do not meet survey criteria are added to the DPaW Priority Ecological Community (PEC) List under Priorities 1, 2 and 3 (Table B.2). These are ecological communities that are adequately known; are rare but not threatened, or meet criteria for Near Threatened. PEC that have been recently removed from the threatened list are placed in Priority 4. These ecological communities require regular monitoring. Conservation dependent ecological communities are placed in Priority 5. PEC are not listed under any formal Federal or State legislation.

Table B.1 Conservation codes and definitions for Threatened Ecological Communities endorsed by the Western Australian Minister for the Environment and listed under the *Environment Protection and Biodiversity Conservation Act 1999*

Status	Description
Federal Government Conservation Categories (EPBC Act)	
Critically Endangered (CR)	If, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future
Endangered (EN)	If, at that time, it is not critically endangered and is facing a very high risk of extinction in the wild in the near future
Vulnerable (VU)	If, at that time, it is not critically endangered or endangered, and is facing a high risk of extinction in the wild in the medium-term future
Western Australia conservation categories	
Presumed Totally Destroyed (PD)	The community has been found to be totally destroyed or so extensively modified throughout its range that no occurrence of it is likely to recover its species composition and/or structure in the foreseeable future.
Critically Endangered (CR)	An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or that was originally of limited distribution and is facing severe modification or destruction throughout its range in the immediate future, or is already severely degraded throughout its range but capable of being substantially restored or rehabilitated
Endangered (EN)	An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or was originally of limited distribution and is in danger of significant modification throughout its range or severe modification or destruction over most of its range in the near future.
Vulnerable (VU)	An ecological community that has been adequately surveyed and is found to be declining and/or has declined in distribution and/or condition and whose ultimate security has not yet been assured and/or a community that is still widespread but is believed likely to move into a category of higher threat in the near future if threatening processes continue or begin operating throughout its range.

Table B.2 Conservation categories and definitions for Priority Ecological Communities as listed by the Department of Parks and Wildlife

Category	Description
Priority 1	Poorly known ecological communities. Ecological communities that are known from very few occurrences with a very restricted distribution (generally ≤5 occurrences or a total area of ≤100 ha). Occurrences are believed to be under threat either due to limited extent, or being on lands under immediate threat (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) or for which current threats exist. May include communities with occurrences on protected lands. Communities may be included if they are comparatively well-known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range.
Priority 2	Poorly known ecological communities. Communities that are known from few occurrences with a restricted distribution (generally ≤10 occurrences or a total area of ≤200 ha). At least some occurrences are not believed to be under immediate threat of destruction or degradation. Communities may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under threat from known threatening processes.
Priority 3	Poorly known ecological communities. (i) Communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation or: (ii) communities known from a few widespread occurrences, which are either large or with significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat, or; (iii) communities made up of large, and/or widespread occurrences, that may or may not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, and inappropriate fire regimes. Communities may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and/or are not well defined, and known threatening processes exist that could affect them.
Priority 4	Ecological communities that are adequately known, rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list. These communities require regular monitoring. (i) Rare. Ecological communities known from few occurrences that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These communities are usually represented on conservation lands. (ii) Near Threatened. Ecological communities that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. (iii) Ecological communities that have been removed from the list of threatened communities during the past five years.
Priority 5	Conservation Dependent ecological communities. Ecological communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years.

Other significant vegetation

Vegetation may be significant for a range of reasons, other than a statutory listing as a TEC or because the extent is below a threshold level. The EPA (2004a) states that significant vegetation may include vegetation that includes the following:

- Scarcity
- Unusual species
- Novel combinations of species
- A role as a refuge
- A role as a key habitat for Threatened species or large population representing a significant proportion of the local to regional total population of a species
- Being representative of the range of a unit (particularly, a good local and/or regional example of a unit in 'prime' habitat, at the extremes of range, recently discovered range extensions, or isolated outliers of the main range)
- A restricted distribution

This may apply at a number of levels, so the unit may be significant when considered at the fine-scale (intra-locality), intermediate-scale (locality or inter-locality) or broad-scale (local to region).

Conservation significant flora and fauna

Species of significant flora are protected under both Federal and State legislation. Any activities that are deemed to have a significant impact on species that are recognised by the EPBC Act, and/or the WC Act can warrant referral to the DotE and/or the EPA. According to the DPaW (WA Herbarium, 1998–): "Threatened flora are plants which have been assessed as being at risk of extinction. In Western Australia the term Declared Rare Flora (DRF) is applied to Threatened flora due to the laws regarding threatened flora conservation. The WC Act is the primary wildlife conservation legislation in the State and the Minster for the Environment can declare taxa (species, subspecies or variety) as "Rare Flora" if they are considered to be in danger of extinction, rare or otherwise in need of special protection." For the purposes of this report, flora listed by the WC Act as DRF is described as Threatened.

The Federal conservation level of flora and fauna species and their significance status is assessed under the EPBC Act (Table B.3). The significance levels for fauna used in the EPBC Act are those recommended by the International Union for the Conservation of Nature and Natural Resources (IUCN).

The State conservation level of fauna species and their significance status is assessed under the State WC Act (*Wildlife Conservation (Specially Protected Fauna) Notice 2010(2)*). This Act uses a set of Schedules (Table B.4) but also classifies species using some of the IUCN categories. Schedule 3 fauna species are those which are "subject to an agreement between the Government of Australia and the Governments of Japan, China and the Republic of Korea relating to the protection of migratory birds, are declared to be fauna that is in need of special protection".

In Western Australia, the DPaW also maintains a list of Priority listed flora species. Conservation codes for Priority species are assigned by the DPaW to define the level of conservation significance (Table B.4). Priority species are not currently protected under the WC Act.

For the purposes of this assessment, all species listed under the EPBC Act, WC Act and DPaW Priority species are considered conservation significant.

Table B.3 Conservation categories and definitions for *Environment Protection and Biodiversity Conservation Act 1999* listed flora and fauna species

Conservation category	Definition
Extinct	Taxa not definitely located in the wild during the past 50 years
Extinct in the Wild	Taxa known to survive only in captivity
Critically Endangered	Taxa facing an extremely high risk of extinction in the wild in the immediate future
Endangered	Taxa facing a very high risk of extinction in the wild in the near future
Vulnerable	Taxa facing a high risk of extinction in the wild in the medium-term
Near Threatened	Taxa that risk becoming Vulnerable in the wild
Conservation Dependent	Taxa whose survival depends upon ongoing conservation measures. Without these measures, a conservation dependent taxon would be classified as Vulnerable or more severely threatened.
Data Deficient (Insufficiently Known)	Taxa suspected of being Rare, Vulnerable or Endangered, but whose true status cannot be determined without more information.
Least Concern	Taxa that are not considered Threatened

Table B.4 Conservation codes and descriptions for Western Australian flora and fauna

Code	Conservation category	Description
Wildlife Conservation Act 1950		
T	Schedule 1 under the WC Act	Threatened Fauna (Fauna that is rare or is likely to become extinct) Threatened Flora (Declared Rare Flora – Extant) Taxa that have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection, and have been gazetted as such. CR: Critically Endangered – considered to be facing an extremely high risk of extinction in the wild. EN: Endangered – considered to be facing a very high risk of extinction in the wild. VU: Vulnerable – considered to be facing a high risk of extinction in the wild.
X	Schedule 2 under the WC Act	Presumed Extinct Fauna Presumed Extinct Flora (Declared Rare Flora – Extinct) Taxa which have been adequately searched for and there is no reasonable doubt that the last individual has died, and have been gazetted as such.
IA	Schedule 3 under the WC Act	Birds protected under an international agreement. Birds that are subject to an agreement between governments of Australia and Japan relating to the protection of migratory birds and birds in danger of extinction.

Code	Conservation category	Description
S	Schedule 4 under the WC Act	Other specially protected fauna. Fauna that is in need of special protection, otherwise than for the reasons mentioned in the above schedules.
DPaW Priority Listed		
1	Priority One: Poorly-known taxa	Taxa that are known from one or a few collections or sight records (generally less than five), all on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, Shire, Westrail and Main Roads WA road, gravel and soil reserves, and active mineral leases and under threat of habitat destruction or degradation. Taxa may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes.
2	Priority Two: Poorly-known taxa	Taxa that are known from one or a few collections or sight records, some of which are on lands not under imminent threat of habitat destruction or degradation, e.g. national parks, conservation parks, nature reserves, State forest, vacant Crown land, water reserves, etc. Taxa may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes.
3	Priority Three: Poorly-known taxa	Taxa that are known from collections or sight records from several localities not under imminent threat, or from few but widespread localities with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Taxa may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and known threatening processes exist that could affect them.
4	Priority Four: Rare, Near Threatened and other taxa in need of monitoring	(a) Rare. Taxa that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These taxa are usually represented on conservation lands. (b) Near Threatened. Taxa that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. (c) Taxa that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.
5	Priority 5: Conservation Dependent taxa	Taxa that are not threatened but are subject to a specific conservation program, the cessation of which would result in the taxon becoming threatened within five years.

Migratory species listed under the EPBC Act

The EPBC Act also protects land and migratory species that are listed under International Agreements. The list of migratory species established under section 209 of the EPBC Act comprises:

- Migratory species which are native to Australia and are included in the appendices to the Bonn Convention (Convention on the Conservation of Migratory Species of Wild Animals Appendices I and II)
- Migratory species included in annexes established under the Japan-Australia Migratory Bird Agreement (JAMBA) and the China–Australia Migratory Bird Agreement (CAMBA)

- Native, migratory species identified in a list established under, or an instrument made under, an international agreement approved by the Minister, such as the republic of Korea–Australia Migratory Bird Agreement (ROKAMBA)

Other significant flora and fauna

Flora species, subspecies, varieties, hybrids and ecotypes may be significant for a range of reasons, other than as Threatened (Declared Rare) Flora or Priority Flora. The EPA (2004a) states that significant flora may include taxa that have:

- A keystone role in a particular habitat for threatened species or supporting large populations representing a significant proportion of the local regional population of a species
- Relic status
- Anomalous features that indicate a potential new discovery
- Being representative of the range of a species (particularly, at the extremes of range, recently discovered range extensions, or isolated outliers of the main range)
- The presence of restricted subspecies, varieties, or naturally occurring hybrids
- Local endemism/a restricted distribution
- Being poorly reserved

The application of the degree of significance may apply at a range of scales.

Introduced plants (weeds)

Declared Pests

The Department of Agriculture and Food Western Australia (DAFWA) maintains a list of Declared Pests for Western Australia that have been declared under the BAM Act. If a Pest is declared for the whole of the State or for particular Local Government Areas, all landholders are obliged to comply with the specific category of control. Declared Pests are gazetted under categories, which define the action required. The category may apply to the whole of the State, districts, individual properties or even paddocks. Categories of control are defined in Table B.5. Among the factors considered in categorising Declared Pests are:

- The impact of the plant on individuals, agricultural production and the community in general
- Whether it is already established in the area
- The feasibility and cost of possible control measures

Table B.5 Department of Agriculture and Food (Western Australia) Categories for Declared Pests under the *Biosecurity and Agriculture Management Act 2007*

Control class code	Description
C1 (Exclusion)	Pests will be assigned to this category if they are not established in Western Australia and control measures are to be taken, including border checks, in order to prevent them entering and establishing in the State.
C2 (Eradication)	Pests will be assigned to this category if they are present in Western Australia in low enough numbers or in sufficiently limited areas that their eradication is still a possibility.

Control class code	Description
C3 (Management)	Pests will be assigned to this category if they are established in Western Australia but it is feasible, or desirable, to manage them in order to limit their damage. Control measures can prevent a C3 pest from increasing in population size or density or moving from an area in which it is established into an area which currently is free of that pest.

Weeds of National Significance

The spread of weeds across a range of land uses or ecosystems is important in the context of socio-economic and environmental values. The assessment of Weeds of National Significance (WoNS) is based on four major criteria:

- Invasiveness
- Impacts
- Potential for spread
- Socio-economic and environmental values

Australian state and territory governments have identified thirty two Weeds of National Significance (WoNS); a list of 20 WoNS was endorsed in 1999 and a further 12 were added in 2012 (Australian Government, 2012).

Environmental weeds

“Environmental weeds are plants that establish themselves in natural ecosystems (marine, aquatic and terrestrial) and proceed to modify natural processes, usually adversely, resulting in the decline of the communities they invade” (CALM, 1999). The Environmental Weed Strategy for Western Australia (EWSWA) was published in 1999. This document provides direction and an approach to tackling environmental weeds in WA (CALM, 1999). Following on from this strategy (in 2008), in an effort to address invasive weeds and implement an integrated approach to weed management on DPaW-managed lands in WA, the Weed Prioritisation Process was developed (DPaW, 2013). A series of workshops were held in each of the nine DPaW regions with the purpose of scoring all weeds which occurred in each of the DPaW regions according to the following key attributes (DPaW, 2013):

- Potential distribution and impact
- Invasiveness
- Current distribution
- Feasibility of control
- Weed management ability
- Weed risk

This process resulted in the following five ratings for each weed species (DPaW, 2013):

- Very high (VH)
- High (H)
- Medium (M)
- Low (L)
- Negligible (N)

The suggested management actions for each species range from no action required (the weed species ranking is as low as to not warrant any investment in regional strategic management actions), through targeted control to reduce infestation or spread, to species requiring state-wide

eradication (DPaW, 2013). A total of 1350 weeds were rated through this process as high, moderate, mild or low, with 34 weed species being rated as high (DPaW, 2013).

The prioritisation for individual weeds within a DPaW region should be treated as a guide and does not diminish any other requirements of land managers or developers e.g. Declared Plants requirements of the BAM Act or Ministerial requirements under Part IV of the EP Act (DPaW, 2013).

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Appendix C – Desktop Searches

Naturemap (DPaW 2007-)

Environment Protection and Biodiversity Conservation Act 1999 Protected Matters Search Tool (DotE 2014a)

Appendix D – Flora data

Conservation species identified in the desktop assessment as potentially occurring within the Study area

Flora species recorded in the Study area during the July-August field assessment

Releve Data Sheets

Table D.1 Conservation species identified in the desktop assessment as potentially occurring within the Study area

Family	Taxon	Status	Description	Habitat	Source
Acanthaceae	*Rostellularia adscendens var. latifolia*	P3	Herb or shrub, 0.1-0.3 m high. Flowers blue-purple-violet, Apr to May.	Ironstone soils. Near creeks, rocky hills.	DPaW databases, Naturemap (DPaW 2007-), Ecoscape 2011
Amaranthaceae	*Ptilotus mollis*	P4	Compact, perennial shrub, to 0.5 m high, soft grey foliage. Flowers white/pink, May or Sep.	Stony hills and screes.	DPaW databases
Amaranthaceae	*Ptilotus subspinescens*	P3	Compact shrub, to 0.8 m high	Gentle rocky slopes, screes and the bases of screes.	DPaW databases
Apocynaceae	*Gymnanthera cunninghamii*	P3	Erect shrub, 1-2 m high. Flowers cream-yellow-green, Jan to Dec.	Sandy soils	DPaW databases
Asteraceae	*Brachyscome* sp. Wanna Munna Flats (S. van Leeuwen 4662)	P1			DPaW databases
Asteraceae	*Calotis latiuscula*	P3	Erect herb, to 0.5 m high. Flowers yellow, Jun to Oct.	Sand, loam. Rocky hillsides, floodplains, rocky creeks or river beds.	DPaW databases
Asteraceae	*Helichrysum oligochaetum*	P1	Erect annual, herb, to ca 0.25 m high. Flowers yellow, Aug to Nov.	Red clay. Alluvial plains.	DPaW databases, Naturemap (DPaW 2007-)
Asteraceae	*Iotasperma sessilifolium*	P3	Erect herb. Flowers pink	Cracking clay, black loam. Edges of waterholes, plains.	DPaW databases

Family	Taxon	Status	Description	Habitat	Source
Brassicaceae	*Lepidium catapycnon*	Threatened (WC Act) Vulnerable (EPBC Act)	Open, woody perennial, herb or shrub, 0.2-0.3 m high, stems zigzag. Flowers white, Oct.	Skeletal soils. Hillsides.	PMST (DotE 2014)
Chenopodiaceae	*Rhagodia* sp. Hamersley (M. Trudgen 17794)	P3			DPaW databases, Naturemap (DPaW 2007-)
Celastraceae	*Stackhousia clementii*	P3	Dense broom-like perennial, herb, to 0.45 m high. Flowers green/yellow/brown	. Skeletal soils. Sandstone hills.	DPaW databases
Convolvulaceae	*Polymeria distigma*	P3	Prostrate trailing herb. Flowers pink, Apr to Jul	Sandy soils.	DPaW databases
Euphorbiaceae	*Euphorbia inappendiculata* var. *inappendiculata*	P2			DPaW databases
Euphorbiaceae	*Euphorbia inappendiculata* var. *queenslandica*	P1			DPaW databases
Fabaceae	*Acacia bromilowiana*	P4	Tree or shrub, to 12 m high, bark dark grey, fibrous; phyllodes more or less glaucous and slightly pruinose; inflorescence in spikes. Flowers yellow/pink, Jul to Aug.	Red skeletal stony loam, orange-brown pebbly,gravel loam, laterite, banded ironstone, basalt. Rocky hills, breakaways, scree slopes, gorges, creek beds.	DPaW databases
Fabaceae	*Acacia daweana*	P3	Spreading shrub, 0.3-1.5(-2) m high. Flowers yellow, Jul to Sep.	Stony red loamy soils. Low rocky rises, along drainage lines	DPaW databases

Family	Taxon	Status	Description	Habitat	Source
Fabaceae	*Glycine falcata*	P3	Mat-forming perennial, herb, to 0.2 m high. Flowers blue-purple, May or Jul	Black clayey sand. Along drainage depressions in crabhole plains on river floodplains.	DPaW databases
Fabaceae	*Indigofera* sp. Bungaroo Creek (S. van Leeuwen 4301)	P3			DPaW databases, Naturemap (DPaW 2007-), Ecoscape 2011
Fabaceae	*Rhynchosia bungarensis*	P4	Compact, prostrate shrub, to 0.5 m high. Flowers yellow.	Pebbly, shingly coarse sand amongst boulders. Banks of flow line in the mouth of a gully in a valley wall.	DPaW databases, Naturemap (DPaW 2007-), Ecoscape 2011
Fabaceae	*Swainsona thompsoniana*	P3			DPaW databases
Fabaceae	*Vigna* sp. central (M.E. Trudgen 1626)	P2			DPaW databases, Naturemap (DPaW 2007-)
Goodeniaceae	*Dampiera anonyma*	P3	Multistemmed perennial, herb, to 0.5(-1) m high. Flowers blue-purple, Jun to Sep.	Skeletal red-brown to brown gravelly soil over banded ironstone, basalt, shale and jaspilite. Hill summits, upper slopes (above 1000m).	DPaW databases, Naturemap (DPaW 2007-)
Goodeniaceae	*Goodenia nuda*	P4	Erect to ascending herb, to 0.5 m high. Flowers yellow, Apr to Aug.		DPaW databases, Naturemap (DPaW 2007-), Ecoscape 2011
Goodeniaceae	*Goodenia* sp. East Pilbara (A.A. Mitchell PRP 727)	P3			DPaW databases

Family	Taxon	Status	Description	Habitat	Source
Lamiaceae	*Spartothamnella puberula*	P2	Shrub, 0.35-1.5 m high. Flowers blue-white, Sep to Nov.	Rocky loam, sandy or skeletal soils, clay. Sandplains, hills.	DPaW databases, Naturemap (DPaW 2007-)
Lamiaceae	*Teucrium pilbaranum*	P1	Upright shrub, 0.2 m high. Flowers white, May or Sep.	Clay. Crab hole plain in a river floodplain, margin of calcrete table.	DPaW databases
Malvaceae	*Hibiscus* sp. Mt Brockman (E. Thoma ET 1354)	P1			DPaW databases, Naturemap (DPaW 2007-)
Malvaceae	*Sida* sp. Barlee Range (S. van Leeuwen 1642)	P3	Spreading shrub, to 0.5 m high. Flowers yellow, Aug.	Skeletal red soils pockets. Steep slope.	DPaW databases, Naturemap (DPaW 2007-), Ecoscape 2011
Malvaceae	*Sida* sp. Hamersley Range (K. Newbey 10692)	P1			DPaW databases, Naturemap (DPaW 2007-)
Poaceae	*Astrebla lappacea*	P3	Tufted perennial, grass-like or herb, 0.3-0.8 m high. Flowers green/purple, Jun to Jul	Clay, loam.	DPaW databases, Naturemap (DPaW 2007-)
Poaceae	*Eragrostis surreyana*	P3			DPaW databases
Poaceae	*Themeda* sp. Hamersley Station (M.E. Trudgen 11431)	P3	Tussocky perennial, grass-like or herb, 0.9-1.8 m high. Flowers Aug.	Red clay. Clay pan, grass plain.	DPaW databases
Scrophulariaceae	*Eremophila magnifica* subsp. *magnifica*	P4	Shrub, 0.5-1.5 m high. Flowers blue, Aug to Nov.	Skeletal soils over ironstone. Rocky screes.	DPaW databases, Naturemap (DPaW 2007-)

Family	Taxon	Status	Description	Habitat	Source
Scrophulariaceae	*Eremophila magnifica* subsp. *velutina*	P3	Shrub, 0.5-1.5 m high. Flowers blue-purple, Aug to Sep.	Skeletal soils over ironstone. Summits.	DPaW databases, Naturemap (DPaW 2007-)
Rubiaceae	*Oldenlandia* sp. Hamersley Station (A.A. Mitchell PRP 1479)	P3	Spreading annual, herb, 0.05-0.1 m high. Flowers blue, Mar	Cracking clay, basalt. Gently undulating plain with large surface rocks, flat crabholed plain.	DPaW databases

P Priority listed (DPaW)

Table D.2 Flora species recorded in the Study area during the July-August field assessment

Family	Genus	Species	Status
Acanthaceae	*Rostellularia*	*adscendens* var. *latifolia*	P3
Amaranthaceae	*Achyranthes*	*aspera*	
Amaranthaceae	*Alternanthera*	*nana*	
Amaranthaceae	*Amaranthus*	*undulatus*	
Amaranthaceae	*Gomphrena*	*affinis* subsp. *pilbarensis*	
Amaranthaceae	*Ptilotus*	*astrolasius*	
Amaranthaceae	*Ptilotus*	*calostachyus*	
Amaranthaceae	*Ptilotus*	*exaltatus*	
Amaranthaceae	*Ptilotus*	*fusiformis*	
Amaranthaceae	*Ptilotus*	*nobilis* subsp. *nobilis*	
Amaranthaceae	*Ptilotus*	*obovatus*	
Amaranthaceae	*Ptilotus*	*rotundifolius*	
Apocynaceae	*Marsdenia*	*australis*	
Araliaceae	*Trachymene*	*oleracea* subsp. *oleracea*	
Asteraceae	*Apowollastonia*	*hamersleyensis*	
Asteraceae	*Bidens*	*bipinnata*	*
Asteraceae	*Pluchea*	*dentex*	
Asteraceae	*Pluchea*	*tetranthera*	
Asteraceae	*Pterocaulon*	*sphacelatum*	
Asteraceae	*Sonchus*	*oleraceus*	*
Asteraceae	*Streptoglossa*	*liatroides*	
Boraginaceae	*Ehretia*	*saligna* var. *saligna*	
Boraginaceae	*Heliotropium*	sp. (insufficient material)	
Boraginaceae	*Heliotropium*	*tenuifolium*	
Boraginaceae	*Trichodesma*	*zeylanicum* var. *zeylanicum*	
Capparaceae	*Capparis*	*lasiantha*	
Capparaceae	*Capparis*	*spinosa var. nummularia*	
Caryophyllaceae	*Polycarpaea*	*corymbosa*	
Caryophyllaceae	*Polycarpaea*	*holtzei*	
Caryophyllaceae	*Polycarpaea*	*longiflora*	
Chenopodiaceae	*Dysphania*	*rhadinostachya* subsp. *rhadinostachya*	
Chenopodiaceae	*Rhagodia*	*eremaea*	
Cleomaceae	*Cleome*	*viscosa*	
Convolvulaceae	*Bonamia*	*erecta*	
Convolvulaceae	*Duperreya*	*commixta*	
Convolvulaceae	*Evolvulus*	*alsinoides* var. *decumbens*	
Convolvulaceae	*Evolvulus*	*alsinoides* var. *villosicalyx*	
Cucurbitaceae	*Cucumis*	*maderspatanus*	
Cyperaceae	*Bulbostylis*	sp. (insufficient material)	
Cyperaceae	*Bulbostylis*	*turbinata*	
Cyperaceae	*Cyperus*	*vaginatus*	
Cyperaceae	*Eleocharis*	*geniculata*	

Family	Genus	Species	Status
Cyperaceae	*Fimbristylis*	*simulans*	
Euphorbiaceae	*Euphorbia*	*australis*	
Euphorbiaceae	*Euphorbia*	*biconvexa*	
Euphorbiaceae	*Euphorbia*	*coghlanii*	
Fabaceae	*Acacia*	*adoxa var. adoxa*	
Fabaceae	*Acacia*	*ancistrocarpa*	
Fabaceae	*Acacia*	*atkinsiana*	
Fabaceae	*Acacia*	*dictyophleba*	
Fabaceae	*Acacia*	*elachantha*	
Fabaceae	*Acacia*	*hilliana*	
Fabaceae	*Acacia*	*inaequilatera*	
Fabaceae	*Acacia*	*maitlandii*	
Fabaceae	*Acacia*	*monticola*	
Fabaceae	*Acacia*	*orthocarpa*	
Fabaceae	*Acacia*	*pyrifolia* var. *morrisonii*	
Fabaceae	*Acacia*	*pyrifolia* var. *pyrifolia*	
Fabaceae	*Acacia*	sp. (insufficient material)	
Fabaceae	*Acacia*	*tenuissima*	
Fabaceae	*Acacia*	*trudgeniana*	
Fabaceae	*Acacia*	*tumida* var. *pilbarensis*	
Fabaceae	*Cajanus*	*cinereus*	
Fabaceae	*Gastrolobium*	*grandiflorum*	
Fabaceae	*Gompholobium*	*oreophilum*	
Fabaceae	*Gossypium*	*robinsonii*	
Fabaceae	*Indigofera*	*monophylla*	
Fabaceae	*Indigofera*	sp. Bungaroo Creek (S. van Leeuwen 4301)	P3
Fabaceae	*Isotropis*	*atropurpurea*	
Fabaceae	*Mirbelia*	*viminalis*	
Fabaceae	*Rhynchosia*	*minima*	
Fabaceae	*Senna*	*artemisioides* subsp. *helmsii*	
Fabaceae	*Senna*	*artemisioides* subsp. *oligophylla*	
Fabaceae	*Senna*	*artemisioides* subsp. *oligophylla x glutinosa*	
Fabaceae	*Senna*	*ferraria*	
Fabaceae	*Senna*	*glutinosa* subsp. *glutinosa*	
Fabaceae	*Senna*	*glutinosa* subsp. *pruinosa*	
Fabaceae	*Senna*	*notabilis*	
Fabaceae	*Senna*	*venusta*	
Fabaceae	*Swainsona*	*formosa*	
Fabaceae	*Tephrosia*	*rosea* var. Fortescue creeks (M.I.H Brooker 2186)	
Fabaceae	*Tephrosia*	sp. Bungaroo Creek (M.E. Trudgen 11601)	
Fabaceae	*Tephrosia*	sp. Fortescue (A.A. Mitchell 606)	
Goodeniaceae	*Dampiera*	*candicans*	
Goodeniaceae	*Goodenia*	*microptera*	

Family	Genus	Species	Status
Goodeniaceae	*Goodenia*	*muelleriana*	
Goodeniaceae	*Goodenia*	*nuda*	P4
Goodeniaceae	*Goodenia*	*stobbsiana*	
Goodeniaceae	*Goodenia*	*triodiophila*	
Goodeniaceae	*Scaevola*	*parvifolia* subsp. *pilbarae*	
Gyrostemonaceae	*Codonocarpus*	*cotinifolius*	
Lamiaceae	*Clerodendrum*	*floribundum* var. *angustifolium*	
Lauraceae	*Cassytha*	*capillaris*	
Loranthaceae	*Amyema*	*sanguinea* var. *sanguinea*	
Loranthaceae	*Diplatia*	*grandibractea*	
Loranthaceae	*Lysiana*	*casuarinae*	
Malvaceae	*Abutilon*	sp. (insufficient material)	
Malvaceae	*Abutilon*	sp. Dioicum (A.A. Mitchell PRP 1618)	
Malvaceae	*Corchorus*	*lasiocarpus*	
Malvaceae	*Corchorus*	*parviflorus*	
Malvaceae	*Corchorus*	sp. (insufficient material)	
Malvaceae	*Gossypium*	*australe*	
Malvaceae	*Hibiscus*	*coatesii*	
Malvaceae	*Hibiscus*	*sturtii* var. *campylochlamys*	
Malvaceae	*Keraudrenia*	*nephrosperma*	
Malvaceae	*Keraudrenia*	*velutina* subsp. *elliptica*	
Malvaceae	*Malvastrum*	*americanum*	*
Malvaceae	*Sida*	*arenicola*	
Malvaceae	*Sida*	*echinocarpa*	
Malvaceae	*Sida*	*rohlenae* subsp. *rohlenae*	
Malvaceae	*Sida*	sp. (insufficient material)	
Malvaceae	*Waltheria*	*virgata*	
Menispermaceae	*Tinospora*	*smilacina*	
Molluginaceae	*Mollugo*	*molluginea*	
Moraceae	*Ficus*	*brachypoda*	
Myrtaceae	*Corymbia*	*deserticola* subsp. *deserticola*	
Myrtaceae	*Corymbia*	*ferriticola* subsp. *ferriticola*	
Myrtaceae	*Corymbia*	*hamersleyana*	
Myrtaceae	*Eucalyptus*	*camaldulensis*	
Myrtaceae	*Eucalyptus*	*gamophylla*	
Myrtaceae	*Eucalyptus*	*leucophloia*	
Myrtaceae	*Eucalyptus*	*leucophloia* subsp. *leucophloia*	
Myrtaceae	*Eucalyptus*	*victrix*	
Myrtaceae	*Eucalyptus*	*xerothermica*	
Myrtaceae	*Melaleuca*	*bracteata*	
Nyctaginaceae	*Boerhavia*	*coccinea*	
Oleaceae	*Jasminum*	*didymum* subsp. *lineare*	
Phyllanthaceae	*Phyllanthus*	*maderspatensis*	
Plantaginaceae	*Stemodia*	*grossa*	

Family	Genus	Species	Status
Plumbaginaceae	*Plumbago*	*zeylanica*	
Poaceae	*Aristida*	*contorta*	
Poaceae	*Aristida*	*holathera*	
Poaceae	*Aristida*	*holathera* var. *holathera*	
Poaceae	*Aristida*	*nitidula*	
Poaceae	*Cenchrus*	*ciliaris*	*
Poaceae	*Cymbopogon*	*ambiguus*	
Poaceae	*Cymbopogon*	*obtectus*	
Poaceae	*Enneapogon*	*lindleyanus*	
Poaceae	*Enneapogon*	*polyphyllus*	
Poaceae	*Eragrostis*	*cumingii*	
Poaceae	*Eragrostis*	*tenellula*	
Poaceae	*Eriachne*	*ciliata*	
Poaceae	*Eriachne*	*mucronata*	
Poaceae	*Eriachne*	*pulchella* subsp. *dominii*	
Poaceae	*Eulalia*	*aurea*	
Poaceae	*Mnesithea*	*formosa*	
Poaceae	*Paraneurachne*	*muelleri*	
Poaceae	*Paspalidium*	*tabulatum*	
Poaceae	*Schizachyrium*	*fragile*	
Poaceae	*Themeda*	sp. Mt Barricade (M.E. Trudgen 2471)	
Poaceae	*Themeda*	*triandra*	
Poaceae	*Triodia*	*epactia*	
Poaceae	*Triodia*	*melvillei*	
Poaceae	*Triodia*	*wiseana*	
Portulaceae	*Portulaca*	*oleracea*	
Proteaceae	*Grevillea*	*pyramidalis*	
Proteaceae	*Grevillea*	*wickhamii*	
Proteaceae	*Hakea*	*chordophylla*	
Proteaceae	*Hakea*	*lorea*	
Pteridaceae	*Cheilanthes*	*lasiophylla*	
Rhamnaceae	*Ventilago*	*viminalis*	
Rubiaceae	*Oldenlandia*	*crouchiana*	
Rubiaceae	*Synaptantha*	*tillaeacea* var. *tillaeacea*	
Santalaceae	*Santalum*	*lanceolatum*	
Sapindaceae	*Dodonaea*	*coriacea*	
Sapindaceae	*Dodonaea*	*lanceolata* var. *lanceolata*	
Scrophulariaceae	*Eremophila*	*longifolia*	
Solanaceae	*Nicotiana*	*occidentalis* subsp. *occidentalis*	
Solanaceae	*Solanum*	*diversiflorum*	
Solanaceae	*Solanum*	*lasiophyllum*	
Solanaceae	*Solanum*	*phlomoides*	
Violaceae	*Hybanthus*	*aurantiacus*	

* = introduced species; P = Priority listed by the Department of Parks and Wildlife

RELEVE DATA SHEETS

Appendix E - Fauna Data

Compiled Species list from desktop searches, previous reports and this survey

Likelihood of occurrence assessment for conservation significant fauna species in the Study area.

Table E.1 Compiled Species list from desktop searches, previous reports and this survey

Family	Genus	Species	Common Name	Status		Source			
				Federal (EPBC Act)	State	Nature Map (DPaW 2007)	EPBC Act PMST (DotE 2014)	Eco-scape (2011b)	Observed this survey
Birds									
Acanthizidae	*Acanthiza*	*apicalis*	Inland Thornbill			X			X
Acanthizidae	*Acanthiza*	*chrysorrhoa*	Yellow-rumper Thornbill					X	
Acanthizidae	*Acanthiza*	*robustirostris*	Slaty-backed Thornbill			X			
Acanthizidae	*Acanthiza*	*uropygialis*	Chestnut-rumped Thornbill			X			
Acanthizidae	*Gerygone*	*fusca*	Western Gerygone			X			
Acanthizidae	*Smicrornis*	*brevirostris*	Weebill			X		X	X
Accipitridae	*Accipiter*	*cirrocephalus cirrocephalus*	Collared Sparrowhawk			X			
Accipitridae	*Accipiter*	*fasciatus fasciatus*	Brown Goshawk			X		X	X
Accipitridae	*Aquila*	*audax*	Wedge-tailed Eagle			X		X	X
Accipitridae	*Circus*	*assimilis*	Spotted Harrier			X			
Accipitridae	*Elanus*	*axillaris*	Black Shouldered Kite			X			
Accipitridae	*Haliaeetus*	*leucogaster*	White-bellied Sea-eagle	Mi	S3		X		
Accipitridae	*Hamirostra*	*isura*	Square-tailed Kite			X			
Accipitridae	*Milvus*	*migrans*	Black Kite						X
Aegothelidae	*Aegotheles*	*cristatus*	Australian Owlet-nightjar			X		X	
Alaudidae	*Mirafra*	*javanica*	Horsfield's Bushlark			X			
Anatidae	*Anus*	*gracilis*	Grey Teal			X			
Anatidae	*Anus*	*superciliosa*	Black Duck			X			
Anatidae	*Chenonetta*	*jubata*	Wood Duck			X			
Anatidae	*Dendrocygna*	*eytoni*	Plumed Whistling Duck			X			
Apodidae	*Apus*	*pacificus*	Fork-tailed Swift	Mi	S3	X	X		
Ardeidae	*Egretta*	*novaehollandiae*	White-faced Heron			X		X	

Family	Genus	Species	Common Name	Status		Source			
				Federal (EPBC Act)	State	Nature Map (DPaW 2007)	EPBC Act PMST (DotE 2014)	Eco-scape (2011b)	Observed this survey
Ardeidae	*Ardea*	*ibis*	Cattle Egret	Mi	S3		X		
Ardeidae	*Ardea*	*modesta*	Great Egret	Mi	S3		X		
Ardeidae	*Ardea*	*pacifica*	White-necked Heron			X			
Artamidae	*Artamus*	*cinereus*	Black-faced Woodswallow			X		X	X
Artamidae	*Artamus*	*minor*	Little Woodswallow			X			X
Artamidae	*Artamus*	*personatus*	Masked Woodswallow			X		X	X
Artamidae	*Cracticus*	*nigrogularis*	Pied Butcherbird			X		X	X
Artamidae	*Cracticus*	*tibicen*	Australian Magpie			X		X	
Artamidae	*Cracticus*	*torquatus*	Grey Butcherbird			X		X	X
Burhinidae	*Burhinus*	*grallarius*	Bush Stone-curlew		P4	X			X
Cacatuidae	*Cacatua*	*sanguinea westralensis*	Little Corella			X			X
Cacatuidae	*Eolophus*	*roseicapilla*	Galah			X		X	X
Cacatuidae	*Nymphicus*	*hollandicus*	Cockatiel			X			
Campephagidae	*Coracina*	*maxima*	Ground Cuckoo-shrike			X			
Campephagidae	*Coracina*	*novaehollandiae*	Black-faced Cuckoo-Shrike			X			X
Campephagidae	*Lalage*	*sueurii*	White-winged Triller			X			X
Casuariidae	*Dromaius*	*novaehollandiae*	Emu			X		X	X
Charadriidae	*Charadrius*	*veredus*	Oriental Plover	Mi	S3		X		
Charadriidae	*Elseyornis*	*melanops*	Black-fronted Dotterel			X			
Charadriidae	*Vanellus*	*tricolor*	Banded Lapwing			X			
Climacteridae	*Climacterus*	*melanura wellsi*	Black-tailed treecreeper			X			X
Columbidae	*Geopelia*	*cuneata*	Diamond Dove			X		X	
Columbidae	*Geopelia*	*striata*	Peaceful Dove			X			X
Columbidae	*Geophaps*	*plumifera*	Spinifex Pigeon			X		X	X
Columbidae	*Ocyphaps*	*lophotes*	Crested Pigeon			X		X	X

Family	Genus	Species	Common Name	Status		Source			
				Federal (EPBC Act)	State	Nature Map (DPaW 2007)	EPBC Act PMST (DotE 2014)	Eco-scape (2011b)	Observed this survey
Columbidae	*Phaps*	*chalcoptera*	Common Bronzewing			X		X	X
Corvidae	*Corvus*	*bennetti*	Little Crow			X			
Corvidae	*Corvus*	*orru cecilae*	Torresian Crow			X		X	X
Cuculidae	*Chalcites*	*basilis*	Horsfield's Bronze-cuckoo			X			
Cuculidae	*Cacomantis*	*pallidus*	Pallid Cuckoo			X			X
Cuculidae	*Centropus*	*phasianinus*	Pheasant Coucal			X			
Estrildidae	*Emblema*	*pictum*	Painted Finch			X		X	X
Estrildidae	*Taeniopygia*	*guttata*	Zebra Finch			X		X	X
Eurostopodidae	*Eurostopodus*	*argus*	Spotted Nightjar			X			X
Falconidae	*Falco*	*cenchroides*	Nankeen Kestrel			X		X	X
Falconidae	*Falco*	*berigora*	Brown Falcon			X		X	X
Falconidae	*Falco*	*peregrinus*	Peregrine Falcon		S4	X			
Halcyonidae	*Dacelo*	*leachii*	Blue-winged Kookaburra			X			X
Halcyonidae	*Todiramphus*	*pyrrhopygius*	Red-backed Kingfisher						X
Halcyonidae	*Todiramphus*	*sanctus*	Sacred Kingfisher			X		X	
Hirundinidae	*Hirundo*	*ariel*	Fairy Martin			X			
Hirundinidae	*Hirundo*	*neoxena*	Welcome Swallow			X			
Hirundinidae	*Hirundo*	*nigricans*	Tree Martin			X			
Maluridae	*Amytornis*	*striatus striatus*	Striated Grasswren (inland)			X			
Maluridae	*Amytornis*	*striatus whitei*	Striated Grasswren			X			
Maluridae	*Malurus*	*lamberti assimilis*	Variegated Fairy-wren			X		X	X
Maluridae	*Malurus*	*lamberti rogersi*	Variegated Fairy-wren			X			
Maluridae	*Malurus*	*leucopterus*	White-winged Fairy-wren			X		X	
Maluridae	*Stipiturus*	*ruficeps*	Rufous-crowned Emu-wren			X			X
Megaluridae	*Cinclorumphus*	*cruralis*	Brown Songlark			X			

Family	Genus	Species	Common Name	Status		Source			
				Federal (EPBC Act)	State	Nature Map (DPaW 2007)	EPBC Act PMST (DotE 2014)	Eco-scape (2011b)	Observed this survey
Megaluridae	*Cinclorumphus*	*mathewsii*	Rufous Songlark			X			
Megaluridae	*Eremiornis*	*carteri*	Spinifexbird			X		X	X
Meliphagidae	*Acanthagenys*	*rufogularis*	Spiny-cheeked Honeyeater			X		X	X
Meliphagidae	*Certhionyx*	*variegatus*	Pied Honeyeater			X			
Meliphagidae	*Epthianura*	*tricolor*	Crimson Chat			X			
Meliphagidae	*Lichenostomus*	*keartlandi*	Grey-headed Honeyeater					X	X
Meliphagidae	*Lichenostomus*	*penicillatus*	White-plumed Honeyeater					X	X
Meliphagidae	*Lichenostomus*	*virescens*	Singing Honeyeater					X	X
Meliphagidae	*Lichmera*	*indistincta*	Brown Honeyeater			X		X	X
Meliphagidae	*Manorina*	*flavigula*	Yellow-throated Miner			X		X	X
Meliphagidae	*Melithreptus*	*gularis*	Black-chinned Honeyeater			X			
Meropidae	*Merops*	*ornatus*	Rainbow Bee-eater	Mi	S3	X	X	X	X
Monarchidae	*Grallina*	*cyanoleuca*	Magpie-lark			X		X	
Nectariniidae	*Dicaeum*	*hirundinaceum*	Mistletoebird			X			X
Neosittidae	*Daphoenositta*	*chrysoptera*	Varied Sittella			X			
Otididae	*Ardeotis*	*australis*	Australian Bustard		P4	X			X
Pachycephalidae	*Colluricincla*	*harmonica rufiventris*	Grey Shrike-thrush			X		X	X
Pachycephalidae	*Oreoica*	*gutturalis*	Crested Bellbird			X		X	X
Pachycephalidae	*Pachycephala*	*rufiventris*	Rufous Whistler			X		X	X
Pardalotidae	*Pardalotus*	*rubricatus*	Red-browed Pardalote			X		X	X
Pardalotidae	*Pardalotus*	*striatus uropygialis*	Striated Pardalote			X		X	
Petroicidae	*Petroica*	*cucullata*	Hooded Robin			X		X	
Petroicidae	*Petroica*	*goodenovii*	Red-capped Robin			X			
Phasianidae	*Coturnix*	*pectoralis*	Stubble Quail			X			
Phasianidae	*Coturnix*	*ypsilophora*	Brown Quail			X			

Family	Genus	Species	Common Name	Status		Source			
				Federal (EPBC Act)	State	Nature Map (DPaW 2007)	EPBC Act PMST (DotE 2014)	Eco-scape (2011b)	Observed this survey
Podargidae	*Podargus*	*strigoides*	Tawny Frogmouth			X			
Pomatostomidae	*Pomatostomus*	*temporalis*	Grey-crowned Babbler			X		X	X
Psittacidae	*Barnardius*	*zonarius zonarius*	Port Lincoln Parrot			X		X	X
Psittacidae	*Melopsittacus*	*undulatus*	Budgerigar			X			
Psittacidae	*Neophema*	*bourkii*	Bourkes Parrot			X			
Ptilonorhynchidae	*Ptilonorhynchus*	*maculatus guttatus*	Western Bowerbird			X		X	X
Rallidae	*Porzana*	*fluminea*	Australian Spotted Crake			X			
Rhipiduridae	*Rhipidura*	*leucophrys leucophrys*	Willie Wagtail			X		X	X
Rostratulidae	*Rostratula*	*australis*	Australian Painted Snipe	Mi, En	T		X		
Strigidae	*Ninox*	*novaeseelandiae*	Southern Boobook Owl			X			
Tunicidae	*Turnix*	*velox*	Little Button-quail			X		X	X
Reptiles									
Agamidae	*Amphibolurus*	*longirostris*	Long-snouted Water Dragon			X		X	X
Agamidae	*Ctenophorus*	*caudocinctus caudocinctus*	Ring-tailed Dragon			X		X	X
Agamidae	*Ctenophorus*	*isolepis citrinus*	Crested Central Military Dragon			X			
Agamidae	*Ctenophorus*	*isolepis isolepis*	Central Military Dragon			X		X	
Agamidae	*Diporiphora*	*valens*	Southern Pilbara Tree Dragon			X			
Agamidae	*Pogona*	*minor minor*	Dwarf Bearded Dragon			X			
Agamidae	*Pogona*	*minor mitchelli*	Mitchell's Bearded Dragon			X		X	X
Agamidae	*Tympanocryptis*	*cephalus*	Pebble Dragon			X			
Boidae	*Antaresia*	*perthensis*	Pygmy Python			X			
Boidae	*Antaresia*	*stimsoni stimsoni*	Stimson's Python			X		X	
Boidae	*Aspidites*	*melanocephalus*	Black-headed Python			X			

Family	Genus	Species	Common Name	Status		Source			
				Federal (EPBC Act)	State	Nature Map (DPaW 2007)	EPBC Act PMST (DotE 2014)	Eco-scape (2011b)	Observed this survey
Boidae	*Liasis*	*olivaceus barroni*	Pilbara Olive Python	Vu	T	X	X	X	
Carphodactylidae	*Nephrurus*	*wheeleri cinctus*	Banded Knob-tailed Gecko			X		X	
Carphodactylidae	*Underwoodisaurus*	*milli*	Barking Gecko			X		X	
Diplodactylidae	*Diplodactylus*	*conspicillatus*	Fat-tailed Gecko			X		X	
Diplodactylidae	*Diplodactylus*	*savagei*	Southern Pilbara Beak-faced Gecko			X		X	
Diplodactylidae	*Lucasium*	*stenodactylum*	Sand-plain Gecko			X			
Diplodactylidae	*Lucasium*	*wombeyi*	Pilbara Ground Gecko			X			
Diplodactylidae	*Oedura*	*marmorata*	Marbled Velvet Gecko			X		X	X
Diplodactylidae	*Rhynchoedura*	*ornata*	Western Beaked Gecko			X			
Diplodactylidae	*Strophurus*	*elderi*	Jewelled Gecko			X			
Diplodactylidae	*Strophurus*	*strophurus*	Western Spiny-tailed Gecko			X			
Diplodactylidae	*Strophurus*	*wellingtonae*	Western-shield Spiny-tailed Gecko			X		X	
Elapidae	*Acanthophis*	*wellsi*	Pilbara Death Adder			X			
Elapidae	*Brachyurophus*	*approximans*	North-western Shovel-nosed Snake			X		X	
Elapidae	*Demansia*	*psammophis cupreiceps*	Yellow-faced Whipsnake			X			
Elapidae	*Demansia*	*rufescens*	Rufous Whipsnake			X			
Elapidae	*Furina*	*ornatus*	Moon Snake			X		X	
Elapidae	*Parasuta*	*monachus*	Munk Snake			X			
Elapidae	*Pseudechis*	*australis*	Mulga Snake			X		X	
Elapidae	*Pseudonaja*	*mengdeni*	Gwardar			X			
Elapidae	*Pseudonaja*	*modesta*	Ringed Brown Snake			X			
Elapidae	*Suta*	*fasciata*	Rosen's Snake			X			

Family	Genus	Species	Common Name	Status		Source			
				Federal (EPBC Act)	State	Nature Map (DPaW 2007)	EPBC Act PMST (DotE 2014)	Eco-scape (2011b)	Observed this survey
Elapidae	*Suta*	*punctata*	Spotted Snake			X			
Elapidae	*Vermicella*	*snelli*	Pilbara Bandy Bandy			X		X	
Gekkonidae	*Crenadactylus*	*ocellatus*	Clawless Gecko			X		X	
Gekkonidae	*Gehyra*	*pilbara*	Pilbara Dtella			X		X	X
Gekkonidae	*Gehyra*	*variagata*	Tree Dtella			X			
Gekkonidae	*Gehyra*	*punctata*	Spotted Dtella			X		X	
Gekkonidae	*Heteronia*	*binoe*	Binoe's Gecko			X		X	
Gekkonidae	*Heteronia*	*spelea*	Desert Cave Gecko			X		X	
Pygopodidae	*Delma*	*butleri*	Butler's Legless Lizard			X		X	
Pygopodidae	*Delma*	*elegans*	Pilbara Delma			X		X	
Pygopodidae	*Delma*	*nasuta*	Sharp-snouted Delma			X		X	
Pygopodidae	*Delma*	*pax*	Pax Legless Lizard			X		X	
Pygopodidae	*Delma*	*tincta*	Black-necked Delma			X			
Pygopodidae	*Lialis*	*burtonis*	Burton's Legless Lizard			X		X	
Pygopodidae	*Pygopus*	*nigriceps*	Hooded Scaly-foot			X			
Scincidae	*Carlia*	*munda*	Shaded-litter Rainbow Skink			X		X	X
Scincidae	*Carlia*	*tricantha*	Tri-keeled Rainbow Skink			X			
Scincidae	*Cryptoblephorus*	*buchananii*	Buchanan Snake-eyed Skink			X			
Scincidae	*Cryptoblephorus*	*plagiocephalus*	Peron's Snake-eyed Skink			X			
Scincidae	*Cryptoblephorus*	*ustulatus*	Russet Snake-eyed Skink			X		X	
Scincidae	*Ctenotus*	*duricola*	Pilbara Ctenotus			X		X	
Scincidae	*Ctenotus*	*grandis titan*	Grand skink			X		X	X
Scincidae	*Ctenotus*	*helenae*	Helen's Skink			X			
Scincidae	*Ctenotus*	*leonhardii*	Leon's Skink			X			
Scincidae	*Ctenotus*	*pantherinus acripes*	Panthers Skink			X		X	X

Family	Genus	Species	Common Name	Status		Source			
				Federal (EPBC Act)	State	Nature Map (DPaW 2007)	EPBC Act PMST (DotE 2014)	Eco-scape (2011b)	Observed this survey
Scincidae	*Ctenotus*	*pantherinus ocellifer*	Panthers Skink			X			
Scincidae	*Ctenotus*	*robustus*	Robust Skink			X			
Scincidae	*Ctenotus*	*rubicundus*	Ruddy Ctenotus			X			
Scincidae	*Ctenotus*	*rutilans*	Rusty-shouldered Ctenotus			X			
Scincidae	*Ctenotus*	*saxatilis (inornatus)*	Rock Ctenotus			X		X	X
Scincidae	*Ctenotus*	*schomburgkii*	Barred Wedge-snouted Ctenotus			X			
Scincidae	*Ctenotus*	*serventyi*	Serventy's Skink			X			
Scincidae	*Cyclodomorphus*	*melanops melanops*	Slender Bluetongue			X		X	
Scincidae	*Egernia*	*cygnitos*	Western Pilbara Spiny-tailed skink						X
Scincidae	*Egernia*	*formosa*	Goldfield's Crevice Skink			X			
Scincidae	*Eremiascincus*	*fasciolatus*	Narrow-banded Sand-swimmer					X	
Scincidae	*Eremiascincus*	*richardsonii*	Broad-banded Sand-swimmer			X			
Scincidae	*Lerista*	*flammicauda*	Pilbara Flame-tailed Slider			X		X	
Scincidae	*Lerista*	*jacksoni*	Jackson's Three-toed Slider			X			
Scincidae	*Lerista*	*muelleri*	Mueller's Three-toed slider			X		X	
Scincidae	*Lerista*	*verhmens*	Powerful Three-toed Slider			X			
Scincidae	*Lerista*	*zietzi*	Pilbara Blue-tailed Slider			X			
Scincidae	*Menetia*	*greyii*	Common Dwarf Skink			X		X	X
Scincidae	*Menetia*	*surda surda*	Surd's Dwarf Skink			X			
Scincidae	*Morethia*	*ruficauda exquisita*	Fire-tailed Skink			X		X	X
Scincidae	*Notoscincus*	*butleri*	Lined-soil Crevice Skink		P4	X			
Scincidae	*Tiliqua*	*multifasciata*	Central Blue-tongue Skink			X		X	

Family	Genus	Species	Common Name	Status		Source			
				Federal (EPBC Act)	State	Nature Map (DPaW 2007)	EPBC Act PMST (DotE 2014)	Eco-scape (2011b)	Observed this survey
Typhlopidae	*Anilios*	*ammodytes*	Pilbara Blindsnake			X			
Typhlopidae	*Anilios*	*ganei*	Gane's Blindsnake		P1	X		X	
Typhlopidae	*Anilios*	*grypus*	Black ended Blindsnake			X		X	
Typhlopidae	*Anilios*	*pilbarensis*	Pilbara Hook-snouted Blind snake			X			
Varanidae	*Varanus*	*accanthurus*	Ridge-tailed Monitor			X		X	X
Varanidae	*Varanus*	*brevicauda*	Short-tailed Pygmy Monitor			X		X	
Varanidae	*Varanus*	*bushi*	Pilbara Mulga Monitor			X			
Varanidae	*Varanus*	*caudolineatus*	Pygmy Mulga Monitor			X			
Varanidae	*Varanus*	*eremius*	Rusty Monitor			X		X	
Varanidae	*Vananus*	*giganteus*	Perentie					X	
Varanidae	*Vananus*	*pilbarensis*	Pilbara Rock Monitor			X			
Varanidae	*Vananus*	*panopties rubidus*	Yellow spotted Monitor			X		X	X
Varanidae	*Vananus*	*tristis*	Racehorse Monitor			X		X	X
Mammals									
Canidae	*Canus*	*lupis domesticus*	Dog/Dingo	*		X		X	X
Canidae	*Vulpes*	*vulpes*	Red Fox	*			X		
Dasyuridae	*Dasykaluta*	*rosamondae*	Little Red Kaluta			X		X	
Dasyuridae	*Dasyurus*	*hallicatus*	Northern Quoll	En	T		X	X	
Dasyuridae	*Ningaui*	*timealeyi*	Pilbara Ningaui			X		X	
Dasyuridae	*Planigale*	*ingrami*	Long-tailed Planigale			X			
Dasyuridae	*Planigale*	*maculata*	Common Planigale			X		X	
Dasyuridae	*Pseudantechinus*	*woolleyae*	Woolley's Pseudantechinus			X		X	
Dasyuridae	*Sminthopsis*	*longicaudata*	Long-tailed Dunnart		P4	X			
Dasyuridae	*Sminthopsis*	*macroura*	Striped-faced Dunnart			X			

Family	Genus	Species	Common Name	Status		Source			
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Emballonuridae	*Saccolaimus*	*flaviventris*	Yellow-bellied Sheathtailed-bat			X			
Emballonuridae	*Taphozous*	*georgianus*	Common Sheathtail-bat			X			
Emballonuridae	*Taphozous*	*hilli*	Hill's Sheathtail-bat			X			
Equidae	*Eqqus*	*asinus*	Donkey	*		X	X		X
Equidae	*Eqqus*	*caballus*	Horse	*			X		
Felidae	*Felis*	*catus*	Cat	*		X	X	X	X
Hippossideridae	*Rhinonicteris*	*aurantius*	Pilbara Leaf-nosed Bat	Vu	T		X		
Leporidae	*Oryctolagus*	*cuniculus*	Rabbit	*			X		
Macropodidae	*Lagorchestes*	*conspicillatus leichardti*	Spectacled Hair-wallaby		P3				possible
Macropodidae	*Macropus*	*robustus*	Euro			X		X	X
Macropodidae	*Petrogale*	*spp.*	Rock Wallaby					X	
Megadermatidae	*Macroderma*	*gigas*	Ghost Bat		P4	X		X	
Molossidae	*Chaerephon*	*jobensis*	Northern Freetail Bat			X			
Molossidae	*Mormopterus*	*beccarii*	Beccari's Freetail Bat			X			
Muridae	*Leggadina*	*lakedownensis*	Short-tailed Mouse		P4	X			
Muridae	*Mus*	*musculus*	House Mouse	intro*		X	X		X
Muridae	*Pseudomys*	*chapmani*	Western Pebble-mound Mouse		P4	X		X	X
Muridae	*Pseudomys*	*desertor*	Desert Mouse			X		X	
Muridae	*Pseudomys*	*hermannsburgensis*	Sandy Inland Mouse			X			
Muridae	*Zyzomys*	*argurus*	Common Rock Rat			X		X	
Peramelidae	*Macrotis*	*lagotis*	Greater Bilby	Vu	T		X		
Phalangeridae	*Trichosurus*	*vulpecula arnhemensis*	Brushtail Possum					X	
Tachyglossidae	*Tachyglossus*	*aculeatus*	Echidna						X

Family	Genus	Species	Common Name	Status		Source			
				Federal (EPBC Act)	State	Nature Map (DPaW 2007)	EPBC Act PMST (DotE 2014)	Eco-scape (2011b)	Observed this survey
Vespertilionidae	*Chalinolobus*	*gouldii*	Gould's Wattle Bat			X		X	
Vespertilionidae	*Nyctophilus*	*geoffroyi*	Lesser Long-eared Bat			X			
Vespertilionidae	*Scotorepens*	*greyii*	Little Broad-nosed Bat			X		X	
Vespertilionidae	*Vespadelus*	*finlaysoni*	Finlayson's Cave Bat			X		X	
Amphibia									
Hylidae	*Cyclorana*	*maini*	Main's Frog			X			
Hylidae	*Litoria*	*rubella*	Little Red Tree Frog			X		X	
Myobatrachidae	*Pseudophryne*	*douglasi*	Gorge Toadlet			X			
Myobatrachidae	*Uperoleia*	*glandulosa*	Glandular Toadlet					X	
Myobatrachidae	*Uperoleia*	*saxatilis*	Pilbara Toadlet			X			

Source: DPaW (2007–), DotE (2014). Note migratory species includes species solely listed as migratory wetland or migratory terrestrial under the EPBC Act.

P1 = Priority 1; P2 = Priority 2; P3 = Priority 3; P4 = Priority 4; P5 = Priority 5; under DPaW supplementary listings.

S3 and S4 = Schedules 3 and 4, other specially protected fauna under WC Act, T = Threatened under the WC Act.

En = Endangered; V = Vulnerable; Mi = migratory under the EPBC Act

* = Introduced Species

X = Species identified

Table E.2 Likelihood of occurrence assessment for conservation significant fauna species in the Study area.

Species	Status		Description	Source	Likelihood of Occurrence
	Federal	State			
Mammals					
Northern Quoll (*Dasyurus hallucatus*)	Endangered	Schedule 1	The Northern Quoll once occurred across the majority of northern Australia but its range has significantly contracted. It occurs in the Pilbara region but in disjunct populations. The Northern Quoll inhabits a range of vegetation types but is especially abundant on dissected rocky escarpment and eucalypt woodland within 200 km of the coast. It is known to den and utilise (favour) rocky habitats. They are predominantly nocturnal but are occasionally active during the day, particularly during the mating season and are known to have a large home range (Van Dyck and Strahan 2008).	EPBC Act PMST (DotE 2014)	Likely, this species was identified in the region by Ecoscape 2011. While no evidence was observed of the species presence during the survey, habitat is present.
Ghost Bat (*Macroderma gigas*)		Priority 4	The Ghost Bat occurs in a wide range of habitats, and requires an undisturbed cave, deep fissure or disused mine shaft in which to roost. It is patchily distributed across Australia, and is sensitive to disturbance (Van Dyck and Strahan 2008).	Nature Map Search (DPaW 2007-)	Unlikely, this species was identified in the region by Ecoscape 2011, however no caves suitable for the species to utilise are present in the Study area.
Greater Bilby (*Macrotis lagotis*)	Vulnerable	Schedule 1	The current Greater Bilby distribution in Western Australia is restricted to northern Australia. The Greater Bilby spends the daytime in burrows, often built against termite mounds, spinifex hummock or shrubs (Van Dyck and Strahan 2008). Extant populations of the Greater Bilby occur in a variety of habitats, usually on landforms with level to low slope topography and light to medium soils. It occupies three major vegetation types; open tussock grassland on uplands, mulga woodland/shrubland growing on ridges and rises, and hummock grassland in plains and alluvial areas. These habitat support shrub species, such as *Acacia kempeana, A. hilliana* and *A. rhodophloia*, which have root-dwelling larvae that provide a constant food source for the Greater Bilby. Bilbies are largely solitary, widely dispersed and found in low numbers. The current occurrence of the Greater Bilby is strongly associated with higher rainfall and temperatures, which promote areas of higher plant and food production. The Greater Bilby may also prefer these conditions as higher rainfall and temperatures are not well tolerated by foxes (Pavey 2006; Southgate et al. 2007).	EPBC Act PMST (DotE 2014)	Highly Unlikely, from Naturemap records no animals have been recorded in the Hamersley Ranges. The closest records are 150 km west and 170 km east of the Study area.

Species	Status		Description	Source	Likelihood of Occurrence
	Federal	State			
Western Pebble-mound Mouse (*Pseudomys chapmani*)		Priority 4	The Western Pebble-mound Mouse is restricted to the Pilbara region where it is recognised as an endemic species. Habitat for the Western Pebble-mound Mouse can be found on stony hillsides with hummocky grasslands and little or no soil. It constructs large mounds of pebbles on stony slopes which cover an area of 0.5-9.0 square metres. 'Active' mounds are characterized by volcano-like cones capped by 'craters' that mark occluded entrances to subterranean burrow systems in which the mice live, often gregariously (Van Dyck and Strahan 2008).	Nature Map Search (DPaW 2007-)	Present this species was identified from pebble mounds during the survey.
Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*) (Pilbara form)	Vulnerable	Schedule 1	The Pilbara Leaf-nosed Bat roosts in deep caves or mines in the wet season and forages nearby. This species occurs in the Pilbara region where its populations are scattered and localised. There are a few known populations of this species in the western Pilbara, roosting in caves formed in gorges that dissect massive siliceous sedimentary geology. It is most often observed in flight over waterholes in gorges (Van Dyck and Strahan 2008). Optimal roosts are thought to occur in caves that form between ascending rock layers, where humidity is maintained from seeping groundwater (Van Dyck and Strahan 2008). Roosts are commonly located over pools of water, or areas deep within the mine or cave structure which provides elevated temperature and humidity. Foraging habitat includes: *Triodia* hummock grasslands covering low rolling hills and shallow gullies, with *Eucalyptus* spp. along the creeks; over small watercourses throughout granite boulder terrain; over pools and low shrubs in ironstone gorges; and in and around gravelly watercourses with *Melaleuca* spp.	EPBC Act PMST (DotE 2014)	Unlikely this species was identified in the area by Ecoscape 2011, however within the Study are no caves suitable for the species to utilise are present.
Long-tailed Dunnart (*Sminthopsis longicaudata*)		Priority 4	The Long-tailed Dunnart occurs throughout the Gibson Desert, Murchison, southern Carnarvon Basin and the Pilbara in Western Australia. Its habitat includes rugged, rocky areas with hummock grasses, shrubs and tall open shrublands and woodlands. In the Young Range in the Gibson Desert, the Long-tailed Dunnart has been found to be associated with plateaus, composed of boulders and stones, with some fine red soils, and sparsely vegetated Mulga (*Acacia aneura*) and Miniritchie (*A. grasbyi*) shrubs over spinifex (Van Dyck and Strahan 2008).	Nature Map Search (DPaW 2007-)	Likely, the species has been captured in the general area and habitat is present for the species.
Lakeland Downs Mouse (*Leggadina*		Priority 4	The Lakeland Downs Mouse occupies a diverse range of habitats from the monsoon tropical coast to semiarid climates, including spinifex and tussock grasslands, samphire, sedgelands, shrublands, tropical woodlands and	Nature Map Search	Likely, the species has been captured in the general area and habitat

Species	Status		Description	Source	Likelihood of Occurrence
	Federal	State			
lakedownensis)			stony ranges. Most habitats, however, are seasonally inundated on red or white sandy-clay soils. They are nocturnal, largely solitary, and individuals spend the day in single-chambered burrows (Van Dyck and Strahan 2008).	(DPaW 2007-)	is present for the species.
Reptiles					
Pilbara Olive Python (*Liasis olivaceus barroni*)	Vulnerable	Schedule 1	The Olive Python (Pilbara subspecies) is a dull olive-brown to pale fawn or rich-brown python with a white underside and pale finely dotted lips. This species reaches an average size of 2.5 m but can grow up to 4 m long. The Olive Python's range is restricted to the Pilbara region, north Western Australia, and the Dampier Archipelago. Habitat consists of rocky escarpments, gorges and waterholes within the Pilbara region. The preferred microhabitats for this species are under rock piles, on top of rocks, and under spinifex as well as in man-made features such as overburden heaps, railway embankments and sewerage treatment ponds. The species' breeding season occurs from June to August, with males moving long distances in search of breeding females (Wilson and Swan 2010).	EPBC Act PMST (DotE 2014), Nature Map Search (DPaW 2007-)	Likely, this species was identified in the area by Ecoscape 2011 and habitat is present in the Study area
Lined Soil-crevice Skink (*Notoscincus butleri*)		Priority 4	Lined Soil-crevice Skink is a pale coppery-brown skink with bold black vertebral and dorsal stripes, broad black upper lateral stripes, white mid lateral stripes and an arrow dark ventro-lateral stripe. Lined Soil-crevice Skink range is restricted to arid, rocky areas of near-coastal Pilbara region. Habitat is found in spinifex dominated areas near creek and river margins (Wilson and Swan 2010).	Nature Map Search (DPaW 2007-)	Likely, the species has been captured in the general area and habitat is present for the species.
Birds					
Australian Painted Snipe (*Rostratula australis*)	Vulnerable, Migratory	Schedule 1 and 3	The Australian Painted Snipe is rarely seen as it is extremely secretive, keeping to dense vegetation of swamps, emerging only in subdued light of dawn and dusk. The preferred habitat of this species includes surrounds and shallows of wetlands that are well vegetated with dense low cover (Morcombe 2004).	EPBC Act PMST (DotE 2014)	Unlikely, no records of this species have been identified in the Hamersley Ranges.
Striated Grasswren (inland) (*Amytornis striatus striatus*)		Priority 4	The inland sub- species of the Striated Grasswren occurs in spinifex, preferring big old clumps on sand dunes, and in the eastern part of the range large spinifex clumps under mallee. The Striated Grasswren has a wide range from the sandy deserts of interior WA through to mallee areas of north-western Victoria (Morcombe, 2004).	Nature Map Search (DPaW 2007-)	Likely, the species has been captured in the general area and habitat is present for the species.

Species	Status		Description	Source	Likelihood of Occurrence
	Federal	State			
Australian Bustard (*Ardeotis australis*)		Priority 4	The Australian Bustard occurs across much of Australia, including across most of Western Australian, except in heavily wooded areas in the south. The Australian Bustard occurs mainly in open country, such as grasslands, low heath or lightly wooded grassland. This species is typically widespread and nomadic, but locally scarce (Morcombe, 2004).	Nature Map Search (DPaW 2007-)	Present, prints of this species were observed close to the Study area.
Bush Stone-curlew (*Burhinus grallarius*)		Priority 4	The Bush-stone Curlew inhabits dry open woodlands, lightly timbered country, mallee and mulga; anywhere with groundcover of small sparse shrubs, grass or litter of twigs (Morcombe 2004). It avoids dense forest and closed canopy habitats (Morcombe, 2004).	Nature Map Search (DPaW 2007-)	Present, prints of this species were observed close to the Study area.
Peregrine Falcon (*Falco peregrinus*)		Schedule 4	The Peregrine Falcon is uncommon but wide-ranging across Australia. Habitat is extremely diverse, from rainforest to arid scrub, from coastal heath to alpine. The Peregrine Falcon nests primarily on ledges of cliffs, shallow tree hollows, and ledges of building in cities (Morcombe 2004).	Nature Map Search (DPaW 2007-)	Likely, the species has been recorded in the general area and habitat is present for the species.
White-bellied Sea-Eagle (*Haliaeetus leucogaster*)	Migratory	Schedule 3	Coastal habitats (especially those close to the sea-shore) as well as any habitat characterized by the presence of large areas of open water (larger rivers, swamps, lakes, the sea) (Morcombe, 2004).	EPBC Act PMST (DotE 2014)	Unlikely, this species is typically restricted to coastal areas or along large rivers. Three records are known from the Hamersley Ranges. However these are opportunistic and not considered a regular visitor.
Rainbow Bee-eater (*Merops ornatus*)	Migratory	Schedule 3	Open forests and woodlands, shrublands, and in various cleared or semi-cleared habitats, including farmland and areas of human habitation. It also inhabits sand dune systems in coastal areas and at inland sites that are in close proximity to water (Morcombe, 2004).	EPBC Act PMST (DotE 2014)Nature Map Search (DPaW 2007-)	Present this species was identified in the region by Ecoscape 2011 and observed during this assessment.

Species	Status		Description	Source	Likelihood of Occurrence
	Federal	State			
Fork-tailed Swift (*Apus pacificus*)	Migratory	Schedule 3	Eastern Ospreys occur in littoral and coastal habitats and terrestrial wetlands of tropical and temperate Australia and offshore islands. They are mostly found in coastal areas but occasionally travel inland along major rivers, particularly in northern Australia. They require extensive areas of open fresh, brackish or saline water for foraging (Marchant and Higgins 1993). They frequent a variety of wetland habitats including inshore waters, reefs, bays, coastal cliffs, beaches, estuaries, mangrove swamps, broad rivers, reservoirs and large lakes and waterholes.	EPBC Act PMST (DotE 2014) Nature Map Search (DPaW 2007-)	Unlikely, the species has been recorded flying in the general area but terrestrial habitat is not considered suitable for this species.
Cattle Egret (*Ardea ibis*)	Migratory	Schedule 3	The Cattle Egret occurs in tropical and temperate grasslands, wooded lands and terrestrial wetlands. It has occasionally been seen in arid and semi-arid regions however this is extremely rare. High numbers have been observed in moist, low-lying poorly drained pastures with an abundance of high grass; it avoids low grass pastures. It uses predominately shallow, open and fresh wetlands including meadows and swamps with low emergent vegetation and abundant aquatic flora. They have sometimes been observed in swamps with tall emergent vegetation (Marchant and Higgins 1990).	EPBC Act PMST (DotE 2014)	Unlikely, this species has not previously been recorded in the Hamersley Ranges. The closest known record is from 280 km south east of the Study area.
Great Egret (*Ardea modesta*)	Migratory	Schedule 3	The Eastern Great Egret has been reported in a wide range of wetland habitats (for example inland and coastal, freshwater and saline, permanent and ephemeral, open and vegetated, large and small, natural and artificial). These include swamps and marshes; margins of rivers and lakes; damp or flooded grasslands, pastures or agricultural lands; reservoirs; sewage treatment ponds; drainage channels; salt pans and salt lakes; salt marshes; estuarine mudflats, tidal streams; mangrove swamps; coastal lagoons; and offshore reefs. The Eastern Great Egret may retreat to permanent wetlands or coastal areas when other wetlands are dry (for example, during drought). This may occur annually in some regions with regular wet and dry seasons or erratically where the availability of wetland habitat is also erratic (Marchant and Higgins 1990).	EPBC Act PMST (DotE 2014)	Likely, the species has been recorded in the general area and habitat is seasonally present for the species.

Species	Status		Description	Source	Likelihood of Occurrence
	Federal	State			
Oriental Plover (*Charadrius veredus*)	Migratory	Schedule 3	Immediately after arriving in non-breeding grounds in northern Australia, Oriental Plovers spend a few weeks in coastal habitats such as estuarine mudflats and sandbanks, on sandy or rocky ocean beaches or nearby reefs, or in near-coastal grasslands, before dispersing further inland. Thereafter they usually inhabit flat, open, semi-arid or arid grasslands, where the grass is short and sparse, and interspersed with hard, bare ground, such as claypans, dry paddocks, playing fields, lawns and cattle camps or open areas that have been recently burnt (Storr, 1980).	EPBC Act PMST (DotE 2014)	Unlikely, this species is a seasonal visitor to Australia and few records are present in the Pilbara. A historical record is present approximately 50 km north of the Study area.

Source: DPaW (2007–), DotE (2014). Note migratory species includes species solely listed as migratory wetland or migratory terrestrial under the EPBC Act.

P1 = Priority 1; P2 = Priority 2; P3 = Priority 3; P4 = Priority 4; P5 = Priority 5; under DPaW supplementary listings.

Schedule 3 and Schedule 4 = Schedules 3 and 4, other specially protected fauna under WC Act, Schedule 1 = Threatened under the WC Act.

En = Endangered; Vu = Vulnerable; Migratory = migratory under the EPBC Act

Table E.3 Termite mounds located within the Village Site 1

Feature	Easting	Northing
Termite mounds	542890	7547306
Termite mounds	542894	7547300
Termite mounds	542895	7547247
Termite mounds	542844	7547191
Termite mounds	542863	7547298
Termite mounds	542884	7547422
Termite mounds	542828	7547445
Termite mounds	542833	7547416
Termite mounds	542987	7547421
Termite mounds	542987	7547283
Termite mounds	542988	7547258
Termite mounds	542975	7547215
Termite mounds	543031	7547117

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		Name	Signature	Name	Signature	Date
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0	M. Dilly G. Gaikhorst	J. Reid		J. Reid		24.09.2014

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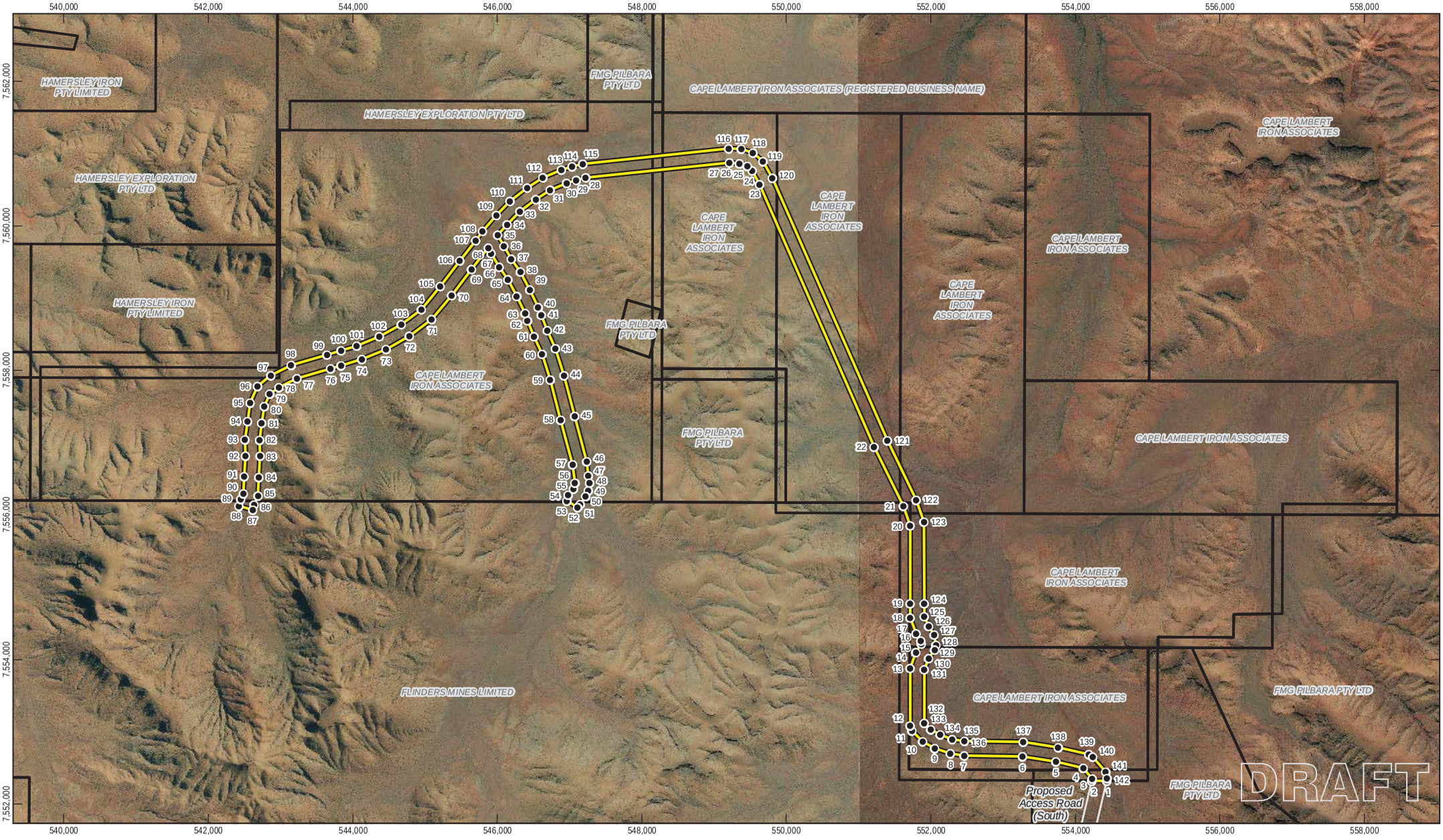
Appendix B – Tenement maps

Proposed Access Road (North) Tenement

Proposed Access Road (South) Tenement

Proposed Airstrip Tenement

Proposed Mining Village Tenement



1:70,000 Paper size : A4

0 0.5 1 1.5 2

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

LEGEND

- Proposed Access Road (North) Area Point
- Proposed Access Road (North) Area Boundary
- Proposed Access Road (South) Boundary
- Mining Tenement

Flinders Mines
Blacksmith Prospect
Environmental and Engineering Services

Job Number	61-31147
Revision	A
Date	01 Sep 2014

Proposed Access Road (North) Tenement

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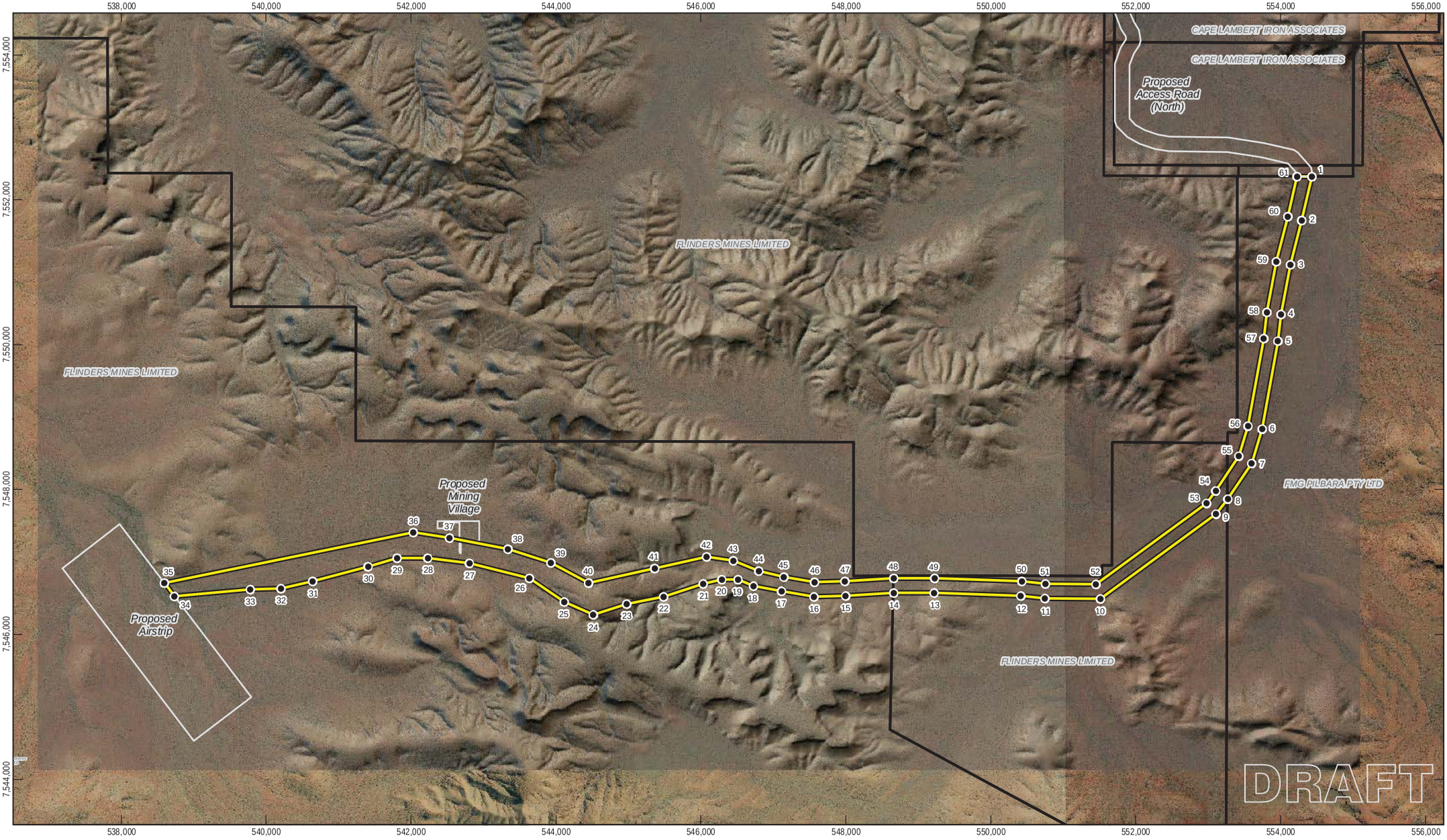
239 Adelaide Terrace Perth WA 6004 Australia T 61 8 6222 8222 F 61 8 6222 8555 E permail@ghd.com.au W www.ghd.com.au

Data source: GHD: Proposed Access Road (South) Area - 20140819; DMP: Mining Tenement; Flinders Mines: Proposed Access Road (North) Area. Created by: AF



1:70,000 Paper size : A4

0 0.5 1 1.5 2

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

LEGEND

- Proposed Access Road (South) Area Point
- Proposed Access Road (South) Boundary
- Other Proposed Tenement Boundary
- Mining Tenement

Flinders Mines

Blacksmith Prospect
Environmental and Engineering Services

Job Number	61-31147
Revision	A
Date	01 Sep 2014

Proposed Access Road (South) Tenement

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239 Adelaide Terrace Perth WA 6004 Australia T 61 8 6222 8222 F 61 8 6222 8555 E permail@ghd.com.au W www.ghd.com.au

Data source: GHD: Proposed Access Road (South) Area, Other Proposed Tenement - 20140819; DMP: Mining Tenement; Flinders Mines: Proposed Access Road (North). Created by: AF

1:25,000 Paper size : A4

0 200 400 600 800

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

LEGEND

- Proposed Airstrip Area Point
- Proposed Airstrip Area Boundary
- Proposed Access Road (South) Boundary
- Mining Tenement

Flinders Mines
Blacksmith Prospect
Environmental and Engineering Services

Job Number 61-31147
Revision A
Date 01 Sep 2014

Proposed Airstrip Tenement

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Data source: GHD: Proposed Access Road (South) Area, Proposed Airstrip Area - 20140819; DMP: Mining Tenement. Created by: AF

1:15,000 Paper size : A4

0 100 200 300 400 500

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

LEGEND

- Proposed Mining Village Area Point
- Proposed Mining Village Area Boundary
- Proposed Access Road (South) Boundary

Flinders Mines
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Environmental and Engineering Services

Job Number 61-31147
Revision A
Date 01 Sep 2014

Proposed Mining Village Tenement

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239 Adelaide Terrace Perth WA 6004 Australia T 61 8 6222 8222 F 61 8 6222 8555 E permail@ghd.com.au W www.ghd.com.au

Data source: GHD: Proposed Mining Village Area, Proposed Access Road (South) Area - 20140819. Created by: AF

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		Name	Signature	Name	Signature	Date
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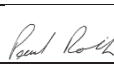
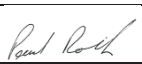
0	D Morgan	P Rokich		P Rokich		24/9/2014

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