A report on the desktop assessment of likely bilby (*Macrotis lagotis*) and mulgara (*Dasycercus* spp.) presence and potentially suitable habitat on the proposed Jartaku Conservation Area, Yandeyarra Aboriginal Reserve and Kangan Pastoral Lease.

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Summary
A database and literature review was undertaken to ascertain the likely occurrence of bilbies (*Macrotis lagotis*) and mulgara (*Dasycercus spp.*) on the Yandeyarra Aboriginal Reserve and Kangan Pastoral Lease. The areas of potentially suitable bilby and mulgara habitat were estimated from three sources of geographical information. Calculations from Land System data, Geological Surfaces and Regolith data estimated suitable habitat for bilbies at 13 516, 24 565, and 20 407 ha respectively. From these estimates, between 28-51 % of the study area contains potentially suitable bilby and mulgara habitat. Since both species have been recorded within 40 km of the study area, it is possible that both exist in the study area.

Introduction
The Yandeyarra Aboriginal Reserve and Kangan Pastoral Lease (study area) is located on the on the Great Northern Highway approximately 130 km south from Port Hedland and 75 km north from the Fortescue Marsh (Figures 1 and 2). It lies within the distributional range of the bilby (*Macrotis lagotis*), and both species of mulgaras (Van Dyke and Strahan 2008). The taxonomy and status of both mulgara species (*Dasycercus blythi* and *D. cristicauda*) is as yet unresolved in the Pilbara region (Woolley 2005, 2008; Masters 2008). Therefore from this point forward both species will be referred to as mulgara.

The aims of this desktop assessment were to:

1. Determine the likelihood of bilbies and mulgara being present in the study area from database records as well as recent literature;
2. Define suitable bilby and mulgara habitat from the literature;
3. Determine from geographical information the presence and size of potentially suitable bilby and mulgara habitat in the study area.

Bilby Records
Records of bilbies in the Pilbara region are scattered, mostly recorded north of the Fortescue River (Figure 1). However, the highest density of bilby records in the Pilbara occurs just to the east of the study area (Figure 2). This is likely a result of extensive surveys of rail corridors in this area. These records are within 40 km of the study area (Figure 2).

Biological surveys recording evidence of bilbies near the study area are listed in Table 1. The number of bilby records near the study area, both from database records and recent biological surveys indicate that if suitable habitat is present in the study area, bilbies could be present in the study area.

Mulgara Records
Records of mulgara in the Pilbara region are also scattered in patches (Figure 1). Like bilbies, mulgaras have been recorded within 40 km of the study area (Figure 2), again likely a result of extensive surveys of rail corridors in this area.

Biological surveys recording evidence of mulgara near the study area are listed in Table 1. Again, like bilbies, the number of records of mulgara near the study area, both from database records and recent biological surveys indicate that if suitable habitat is present in the study area, mulgara could be present in the study area.

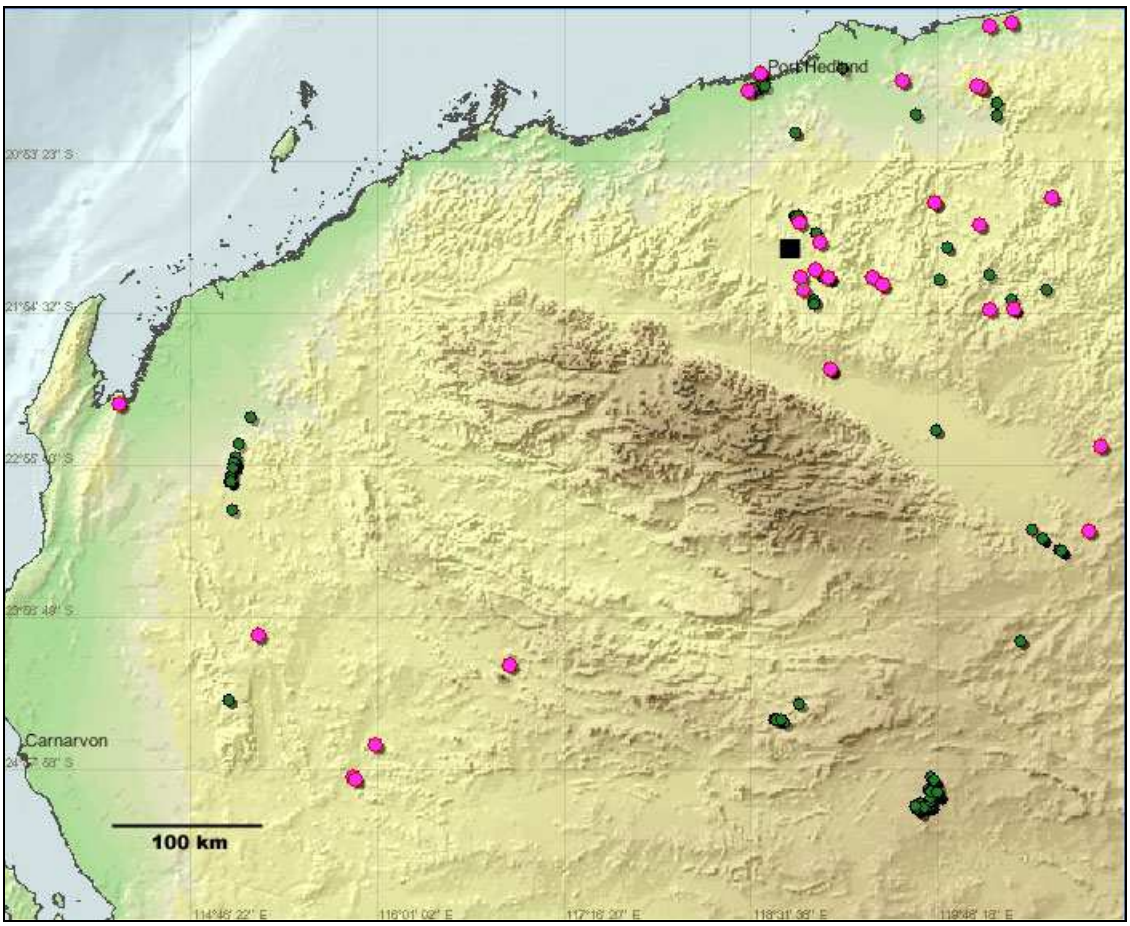

Figure 1. Bilby (●) and mulgara (●) records in the Pilbara Region. ■ = Study area location. Source: DEC Naturemap (2012).

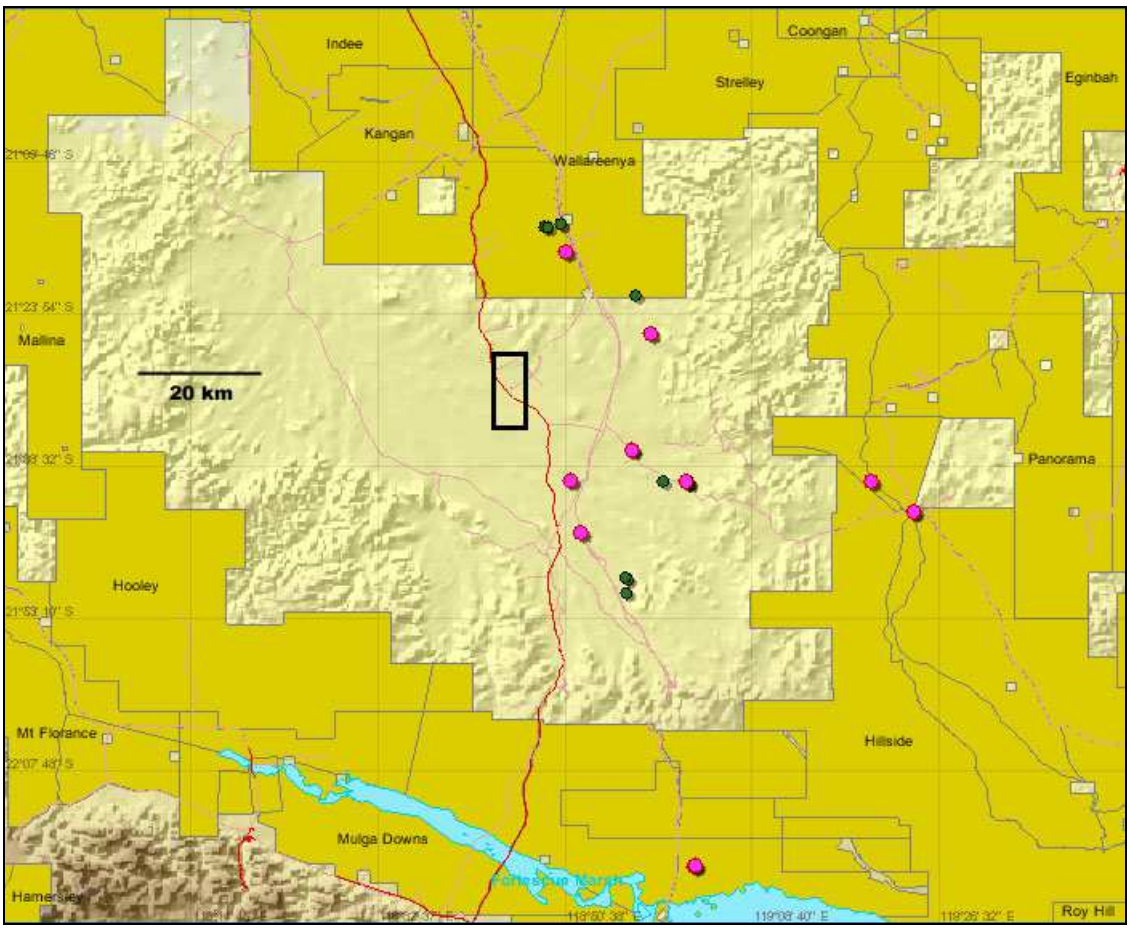

Figure 2. Bilby (●) and mulgara (●) records within 80 km of the study area. ☐ = Study area location. Dark yellow areas indicate pastoral leases. Paler shadings are other uses. Source: DEC Naturemap (2012).

Table 1. Surveys that recorded evidence of bilbies and mulgara near the Yandeyarra Aboriginal Reserve and Kangan Pastoral Lease.

Year	Observation	Location	Distance from study area (km)	Direction	Source
Bilbies					
1991	Animals	Abydos Plains	50	SE	How *et al*. (1991)
2005	Animal	Mulga Downs Station	70	S	Biota (2005)
2005	Possible burrows	11km south-east of the Cloud Break mine	110	SE	Davis *et al*. (2005)
2007	Active burrows	FMG rail corridor access road to the north of the Marble Bar Road. These were inspected in 2008 and found to be inactive	140	E	Thompson and Thompson (2008)
2011	Old burrows + animal	Abydos Plain section of the Roy Hill rail corridor Old burrows were found in within the Roy Hill rail corridor. The bilby was sighted just outside the Roy Hill corridor adjacent to the FMG corridor.	0 to 50 (not specified)	N/E/S	Terrestrial Ecosystems (2011)
Mulgara (both species)					
2004	Scats + tracks	Cloud Break mine	100	SE	Biota (2004)
2007	Diggings, scats + tracks	Port Hedland to Cloud Break rail line corridor – numerous areas	Closest section: 10-20 km	E	ATA (2007)
2008	Animals translocated	FMG rail corridor at Marble Bar Road	140	E	Thompson and Thompson (2007)
2008	Animals translocated	Northern end of the FMG rail corridor to an area adjacent to the Roy Hill rail corridor	~70 km	N	Thompson and Thompson (2008)
2011	Tracks	Northern portions of the Roy Hill rail corridor	~70 km	N	Terrestrial Ecosystems (2011a)

Suitable bilby habitat characteristics
Bilbies once inhabited the arid and semiarid regions throughout most of the Australian mainland south of about latitude 18°S, but their distribution is now limited to the Tanami Desert in the Northern Territory west into Western Australia (to include the Pilbara and southern Kimberley) and isolated populations in south-western Queensland (Johnson 2008). In these areas, habitat types that bilbies currently occur in are shown in Table 2.

From the literature summarized in Table 2, suitable habitat for bilbies can be defined as level or undulating plains including watercourses and dune systems, composed of cracking clay, soil or sand that allows burrowing, with vegetation consisting of open-tussock Mitchell grass (in SW Queensland) or hummock grassland (spinifex), with low shrubland, usually *Acacia* dominated. Habitat which is steep and/or rocky which does not allow burrowing may be used for foraging if it is adjacent to suitable burrowing habitat. Note that there are few, if any published accounts of bilby habitat in WA.

Suitable mulgara habitat characteristics
Mulgara are distributed throughout much of the inland arid zone of the Northern Territory, South Australia and Western Australia (Masters 2008; Woolley 2008). Throughout this distribution, habitat types that mulgara currently occur in are shown in Table 3.

From the literature summarized in Table 3, suitable habitat for mulgara can be defined as plains, ridges and dunes as well as low lying areas, composed of soil or sand that allows burrowing, with vegetation comprising predominantly spinifex sometimes, with sparse shrubland. Habitat which is steep and/or rocky which does not enable burrowing can be excluded as suitable mulgara habitat.

The decisive characteristic of suitable habitat for both bilbies and mulgara is the availability of a soil or sand substrate that enables the construction of burrows. Rocky areas which do not enable burrowing to occur can be excluded as suitable habitat for both species.

Table 2. Accounts of suitable bilby habitat characteristics.

Substrate	Vegetation	Terrain	Area	Reference
Soils from 0.6 m depth to siliceous sands >2 m depth. Textures of soils from coarse sand to light medium clay. Uniform texture profiles, non-calcareous gradational soils and duplex soils	Woodlands of low (<10 m) trees with Acacia spp. Rich understory. Shrub steppe communities, to tussock/forb grasslands in SE Queensland.	Level plains to undulating plains and rises, gently inclined, slope never exceeding 6 %.	Central deserts and SE Queensland	Southgate (1990)
Stone-free Cretaceous sediments of cracking clays, friable on the surface (usually 35 % clay) with a denser (45-70 % clay) subsoil	Grassland downs, Mitchell grass (*Astrebla pectinata*) and feathertop wiregrass (*Aristida latifolia*) in the form of open-tussock grassland, saltbush (*Atriplex* spp.) herblands and open succulent shrubland of Queensland bluebush (*Chenopodium auricomum*) and canegrass (*Eragrostis australasica*)	Adjacent to watercourses, not hilly.	SW Queensland	Lavery and Kirkpatrick (1997)
Sandy soils with rocky outcrops, laterite rises and low-lying palaeodrainage systems	Spinifex grasslands (mainly *Triodia basedowii*, *T. pungens* and *T. schinzii*) with low shrub cover of *Acacia* species. *Melaleuca* spp. In palaeodrainage channels.	Rises and low-lying drainage systems	Tanami Desert, Northern Territory	Southgate *et al*. (2005)
Dune and sand substrate, laterite/rock features and drainage/calcrete substrates	3 spinifex or hummock grass species (*Triodia pungens*, *T. schinzii*, and *T. basedowii*), with an overstorey of scattered shrubs and trees; shrub species	Rises and low-lying drainage systems	Tanami Desert, Northern Territory	Southgate *et al*. (2007)
Cracking clays, sandplains, dunefields sometimes containing laterite, massive red earths.	Mitchell grass (*Astrebla pectinata*), hummock grassland (*Triodia* spp.) and acacia shrubland.	Plains, dune fields.	Extant range	Johnson (2008)
Sand dunes and sandplains around ephemeral saline lakes and claypans	*Acacia* shrublands with occasional *Eucalyptus* over *Triodia* hummock grasslands.	Dune fields surrounding drainage systems	Lorna Glen, WA	Morris *pers comm*

Table 3. Suitable mulgara habitat characteristics.

Substrate	Vegetation	Terrain	Area	Reference
Sand	Spinifex	Top of sandhill; spinifex flat	Extant range	Woolley (2005)
Sand	Mature spinifex *Triodia basedowii*, which had not been burnt for 20 years, covered about a third of the area; low shrub *Rulingia lexophylla*	Sand plain interspersed with low dunes	Uluru, Northern Territory	Körtner *et al.* (2007)
Sandy-clay soils	Mature spinifex	-	Pilbara, Western Australia	ATA (2007)
Sand	Burrows at the base of sandhill canegrass, *Zygochloa paradoxa*; spinifex grassland; nitre bush (*Nitraria billardieri*)	slopes and crests of sandridges; areas around salt lakes; sand dunes	Extant range	Masters (2008) and Woolley (2008)
Sand, red earth, earthy sands or sand soils, stoney gibber (desert pavement)	Sparse shrub overstorey and understorey of tussock and hummock grasses	Sand ridges – extensive north–south-running dunefields; gently undulating sandplain; gibber plain including low-lying and undulating plains and rises	Simpson Desert, Northern Territory	Pavey *et al*. (2011)
Deep sandy and sandy clay soils	Triodia hummock grassland with an overstorey of *Eucalyptus* and *Acacia*	Sandplains, Bullimore landscape	Lorna Glen	Morris *pers comm*

Extent of potentially suitable bilby and mulgara habitat in the study area

The size of the study area measured from the GIS data provided by Roy Hill is 48 037 ha. Three sets of geographical information were available with enough resolution in the study area to make an assessment of potentially suitable bilby and mulgara habitat. These were:

1. Land Systems (1:250,000 Landsystem Mapping, Department of Agriculture Western Australia
2. Geological Surfaces (1:100,000 Geological Maps, Geological Survey of Western Australia)
3. Regolith **(**1:500 000 Regolith Map, Geological Survey of Western Australia)

An assessment of potentially suitable bilby and mulgara habitat can be made from each of these sets of data, resulting in three different calculations of the size of potentially suitable bilby and mulgara habitat.

Land Systems

Potentially suitable bilby and mulgara habitat in the study area based on Land Systems is shown in Figure 3. The proportions of potentially suitable bilby and mulgara habitat are shown in Table 4. The total available area of potentially suitable bilby and mulgara habitat based on Land Systems is 13 516 ha.

Table 4. Potentially suitable bilby and mulgara habitat in the study area assessed from Land Systems.

Land System (total area available in study area)	Description	Estimated proportion of Land System that is potentially suitable habitat (%)	Equivalent Size (ha)
Macroy (31 256 ha)	Stony plains and occasional tor fields based on granite supporting hard and soft spinifex grasslands	25	7 708
River (5 467 ha)	Active flood plains, major rivers and banks supporting grassy eucalypt woodlands, tussock grasslands and soft spinifex grasslands	70	3 827
Boolaloo (11 314 ha)	Granite hills, domes and tor fields and sandy plains with shrubby spinifex grasslands	17.5	1 980
Total (48 037 ha)			13 516

Geological Surfaces

Potentially suitable bilby and mulgara habitat in the study area based on Geological Surfaces is shown in Figure 4. The proportions of potentially suitable bilby and mulgara habitat are shown in Table 5. The total available area of potentially suitable bilby and mulgara habitat based on Geological Surfaces is 24 565 ha.

Table 5. Potentially suitable bilby and mulgara habitat in the study area assessed from Geological Surfaces

Geological Surface	Description	Proportion of study area (%)	Size (ha)
Qaa	Alluvial sand and gravel in rivers and creeks; clay, silt, and sand in channels on floodplains	8.7	4 166
Qab	Alluvial sand, silt, and clay in floodplains, with gilgai surface in areas of expansive clay	0.05	26
Qao	Overbank deposits; alluvial sand, silt, and clay in floodplains adjacent to main drainage channels	7.0	3 389
Qrg	Quartzofeldspathic eluvial sand, with quartz and rock fragments; overlying and derived from granitoid rock	14.5	6 953
Czag	Alluvial gravel; variably consolidated; dissected by recent drainage	4.5	2 185

Czcg	Quartzofeldspathic sand, silt, clay, and gravel derived from granitoid rock; variably consolidated; dissected	16.3	7 846
Total			24 565

Regolith

Potentially suitable bilby and mulgara habitat in the study area based on Regolith is shown in Figure 5. The proportions of potentially suitable bilby and mulgara habitat are shown in Table 6. The total available area of potentially suitable bilby and mulgara habitat based on Regolith is 20 407 ha.

Table 6. Potentially suitable bilby and mulgara habitat in the study area assessed from Regolith*.

Regolith	Description	Proportion of study area (%)	Size (ha)
Alluvium	In drainage channels, floodplains, and deltas	13.2	6 338
Residual	Includes ferruginous, siliceous, and calcareous duricrust	0.1	63
Sandplain	Mainly eolian, includes some residual deposits	0.4	177
Colluvium	Slope deposits, including colluvium and sheetwash	28.8	13 829
Total			20 407

* other than exposed rock (excludes northern half of study area)

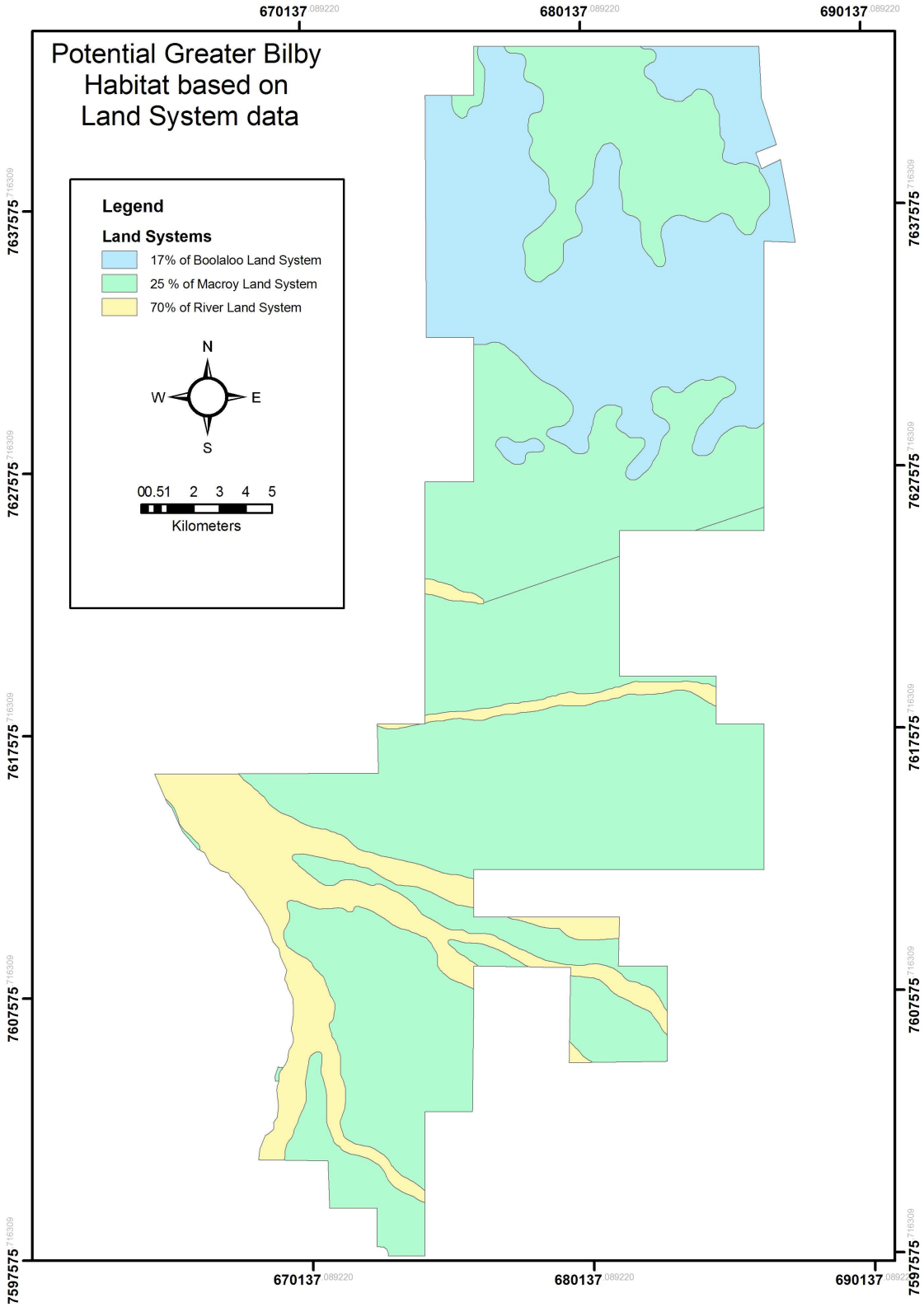

Figure 3. Land Systems and proportions of Land Systems estimated as potentially suitable bilby and mulgara habitat in the study area.

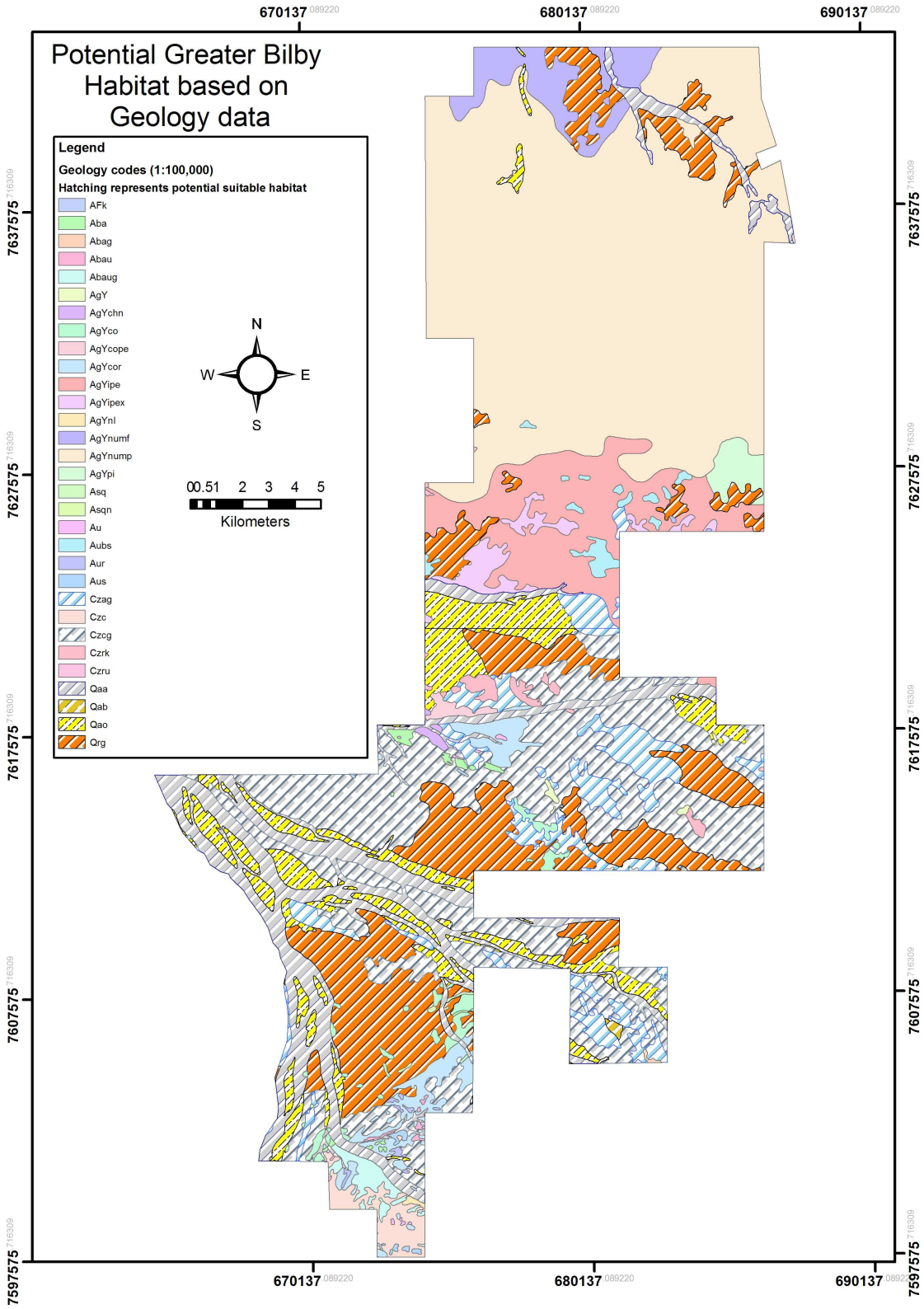

Figure 4. Potentially suitable bilby and mulgara habitat in the study area estimated from Geological Surfaces. Hatched areas represent suitable bilby and mulgara habitat.

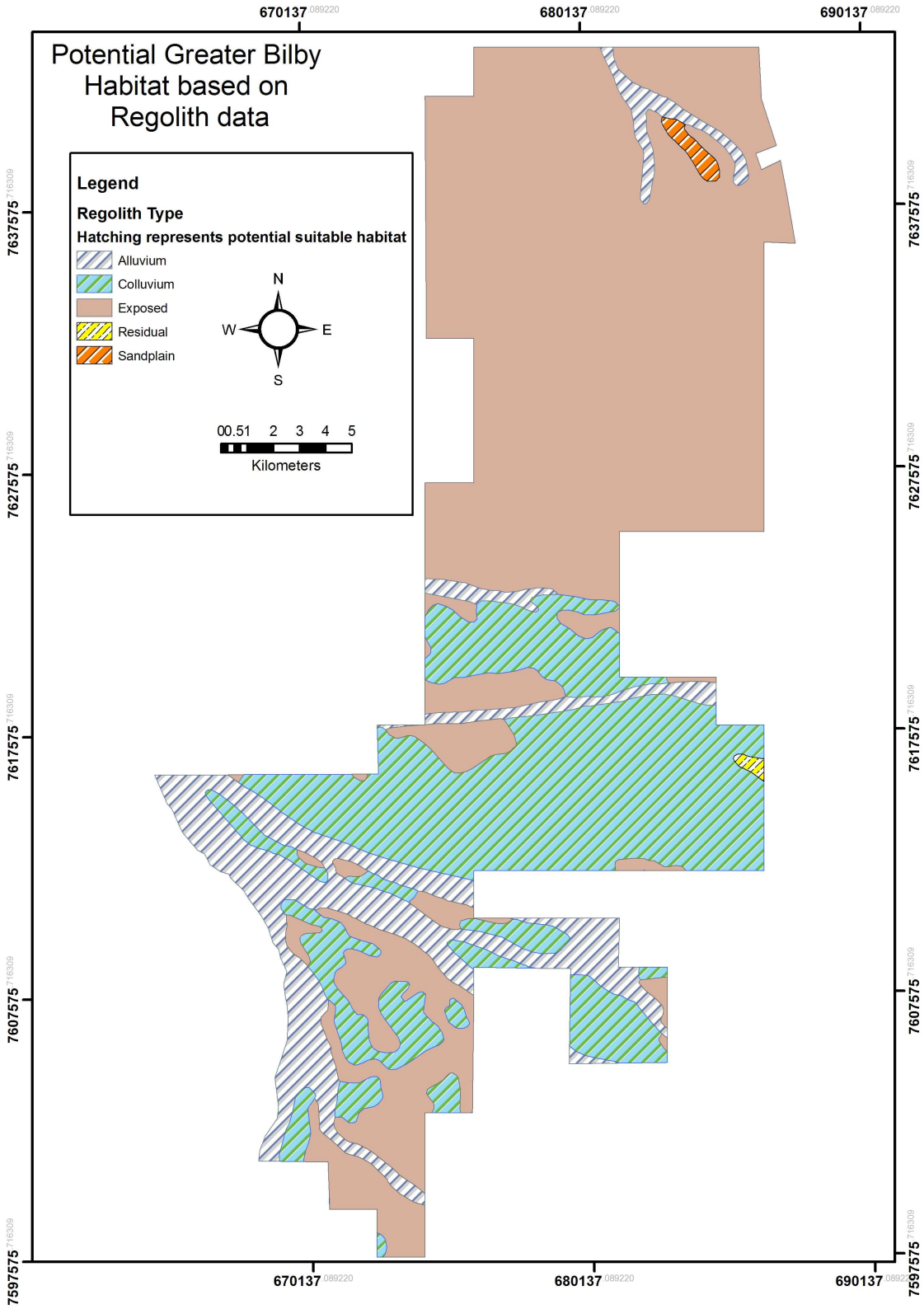

Figure 5. Potentially suitable bilby and mulgara habitat in the study area estimated from Regolith Data. Hatched areas represent suitable bilby and mulgara habitat.

Conclusions

Based on published habitat characteristics (Table 1 and 2), the calculated available areas of potentially suitable bilby and mulgara habitat is shown in Table 7. The study area would need to be ground truthed to determine which of the estimates provided in Table 7 is most accurate. This means that from desktop assessment, between 28-51 % of the study area is potentially suitable bilby and mulgara habitat. Since both species have been recorded within 40 km of the study area, it is possible that they exist in the study area. This would need to be confirmed by field survey.

Table 7. Summary of area of potentially suitable bilby and mulgara habitat calculated from the three geographical datasets.

Geographical dataset	Area of potentially suitable bilby and mulgara habitat (ha)
Land Systems	13 516
Geological Surfaces	24 565
Regolith	20 407

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