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Environmental desktop review for the Napier Downs Irrigation Project – Report Addendum

Prepared for Australian Capital Equity Pty Ltd

November 2020

Final Report

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Final Report

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Date: 10 November 2020

Submitted to: James McMahon

Version history		
Name	**Version**	**Date**
Shenade Findlay	Draft to client	5/11/2020
Karen Crews	Final to client	5/11/2020

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Project code: 1248-NAP-ACE-ECO

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1 INTRODUCTION AND SCOPE

In March 2019, Phoenix Environmental Sciences Pty Ltd (Phoenix) was commissioned by Australian Capital Equity (ACE) to undertake an environmental desktop assessment for the Napier Downs Project (the Project), an irrigated agriculture project located on Napier Downs Station (NDS) in the Shire of Derby-West Kimberley, Western Australia (WA) (Figure 1-1). The Project will entail the development of approximately six centre irrigation pivots which will be used to produce fodder crops for cattle stocked on Napier Downs and nearby stations, with water to be sourced from the Grant Aquifer.

The initial desktop assessment relevant to this addendum report (Phoenix 2019) focussed on two potential sites (Options) for the Project. Option 1, initially the preferred option, is located in Naradong Paddock adjacent to the Lennard River on Gibb River Road, and Option 2 is located in Hawkstone Paddock, approximately 23 km west-northwest (WNW) of Option 1 and 3.6 km from the river (Figure 1-1).

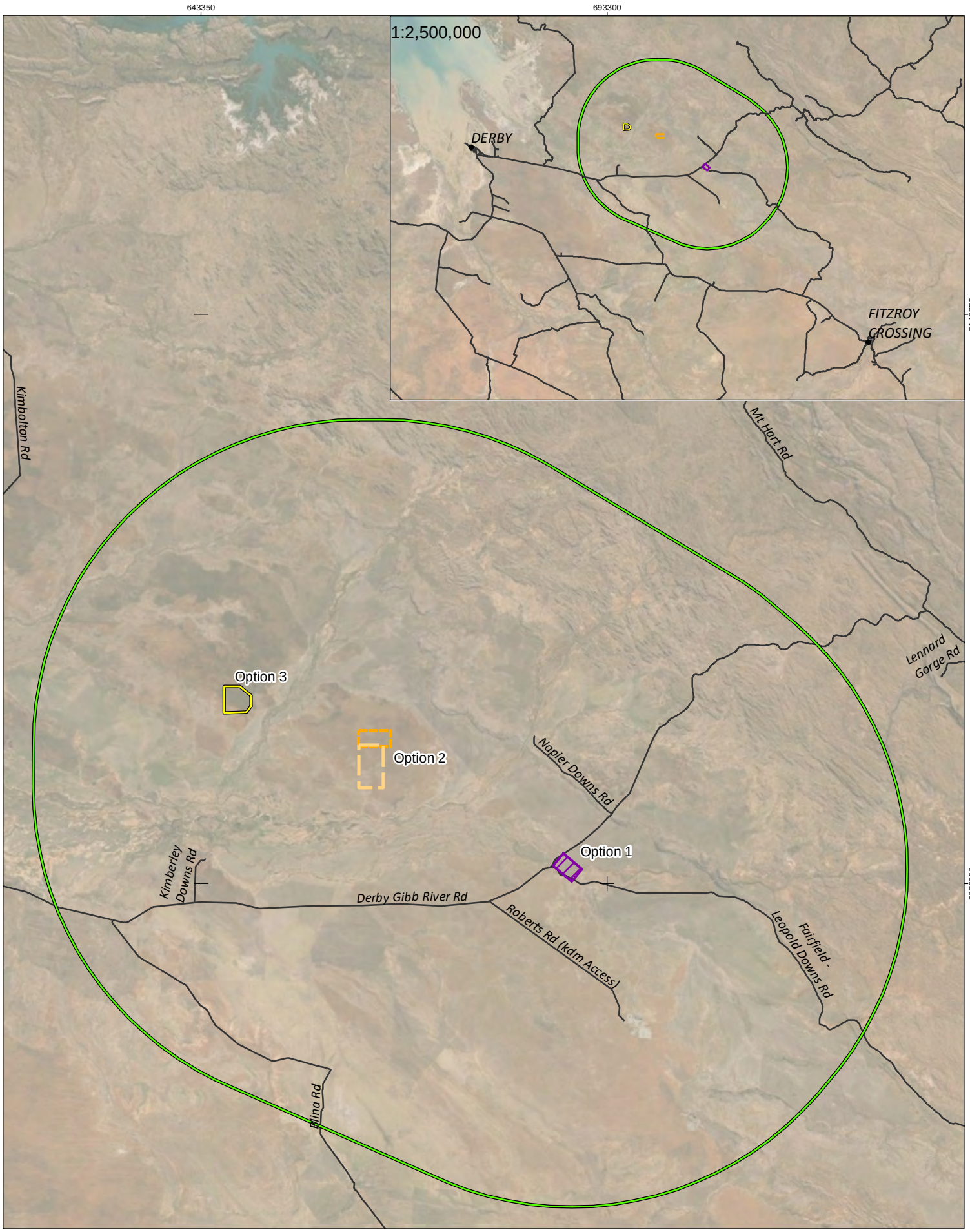
Following completion of the desktop assessment for Option 1 and 2 (Phoenix 2019), and preliminary hydrogeological investigations, a third potential site (Option 3) is under investigation. Option 1 is no longer being considered, primarily due to its proximity to the Lennard River and associated environmental values and potential groundwater-surface water linkages. Preliminary pump testing at Option 3 has identified this site as a preferred site over Option 2, with better flow rates.

This report addendum reviews the desktop assessment findings presented in Phoenix (2019), for their relevance specifically to Option 3. Option 3 is located in Scrubby paddock, 14.2 km WNW of Option 2 (Figure 1-1). The site is within the area of the desktop review for the initial desktop assessment.

1.1 SCOPE OF WORK

The scope of work for this addendum report was as follows:

- review the desktop assessment results from Phoenix (2019) and identify the potential environmental values that may be present in Option 3 for the following environmental factors:
    - terrestrial flora and vegetation in accordance with relevant Environmental Protection Authority (EPA) guidance (Department of Mines and Petroleum 2016; EPA 2016e)
    - terrestrial fauna including vertebrates and short-range endemic (SRE) invertebrate fauna in accordance with relevant EPA guidance (Department of Mines and Petroleum 2016; EPA 2016b, f)
    - subterranean fauna in accordance with relevant EPA guidance (EPA 2016a, d, e).
- identify any potential values for the above environmental factors that may represent significant constraints for Option 3
- identify field survey requirements for the above environmental factors Option 3.



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Map author	KC

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Kilometers

1:600,000 (at A4) GDA 1994 MGA Zone 51

- Option 1
- Previous location of option 2
- Option 2 – current
- Option 3
- Desktop study area

Figure 1–1

Project location and study area

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2 RESULTS

2.1 EXISTING ENVIRONMENT

2.1.1 National heritage places, conservation reserves and Environmentally Sensitive Areas

Option 3 is situated within the West Kimberley National Heritage Place, which is listed on the National Heritage List and therefore a matter of National Environmental Significance (NES; Figure 2-1). The listing is vast in extent, covering 949.91 km^2 of the Kimberley region, and is recognised as nationally significant under several criteria (DoEE 2019), with many specific significant features identified, including (but not limited to):

- the King Leopold orogen, Kimberley ria coast, Lennard Shelf – for geological significance
- the Devonian Reefs, Gogo fossil sites, Dampier Coast – for evolutionary/fossil record
- northern Kimberley coast and islands, the Kimberley Plateau and the west Kimberley Devonian reefs – for their rich biodiversity
- vine thickets – for endemic invertebrates
- river systems (the Drysdale, Prince Regent, Roe, Moran, Carson, Isdell, Mitchell and King Edward Rivers) – as refuges for freshwater fish species
- Roebuck Bay – for Migratory shorebird habitat
- Kimberley coast from the Buccaneer Archipelago to King George River, Mitchell River National Park, King George Falls, King George River, Geiki Gorge Conservation Park, Geikie Gorge National Park, Windjana Gorge National Park, King Leopold Ranges and the Kimberley coast from the Buccaneer Archipelago to King George River – for aesthetic landscape values
- numerous indigenous heritage sites of national significance.

Option 3 is situated over the King Leopold Orogen geological province; it does not intersect any of the other specific features described in the West Kimberley National Heritage Place; the Monsoon vine thickets and Camaenid land snails of limestone ranges (Napier Range) Priority Ecological Community (PEC) is the closest, located approximately 20.8 km north east.

Option 3 is not situated within any conservation reserves or Environmentally Sensitive Areas (ESAs); however, Wilinggin an Indigenous Protected Area (IPA) is located 3 km to the east. The closest conservation reserve, King Leopold Ranges Conservation Park, is situated 58 km northeast and the closest ESA is 33.5 km northeast (Figure 2-1).

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- Desktop study area
- Option 3
- Conservation Reserves
- Environmentally Senistive Areas
- National Heritage places

Figure 2–1

National Heritage places, conservation reserves and ESAs

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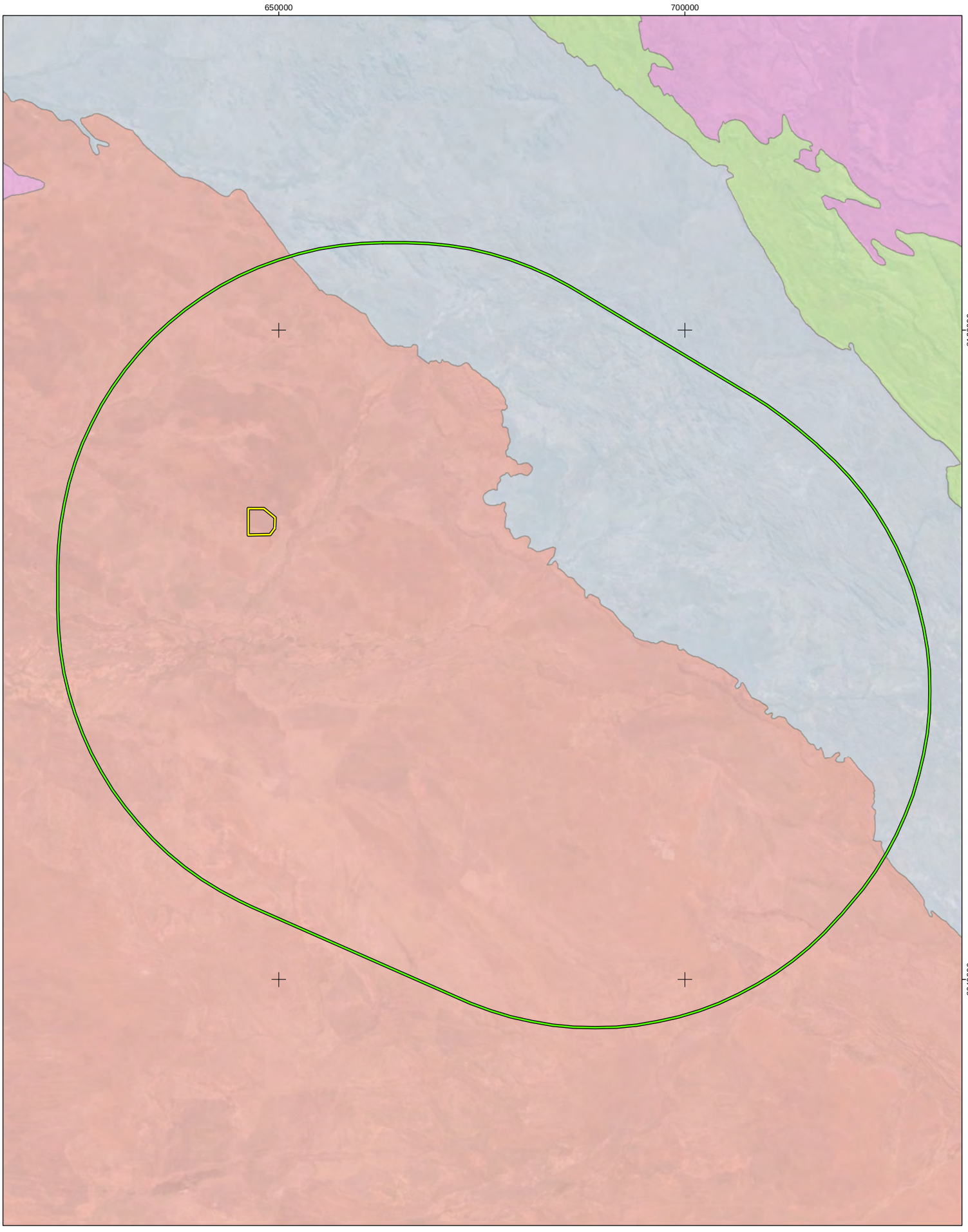
2.1.2 Interim Biogeographical Regionalisation of Australia (IBRA)

Option 3 is located entirely within Fitzroy Trough (DL1) subregion of the Dampierland bioregion (Figure 2-2). The Fitzroy Trough subregion comprised of four basic components, described as (Graham 2001):

- Quaternary sandplain overlying Jurassic and Mesozoic sandstones with Pindan, with hummock grasslands on hills.
- Quaternary marine deposits on coastal plains, with mangal, samphire – *Sporobolus* spp. Grasslands, *Melaleuca alsophila* low forests, and *Spinifex* spp. – *Crotalaria* spp., strand communities.
- Quaternary alluvial plains associated with the Permian and Mesozoic sediments of Fitzroy Trough support tree savannahs of ribbon grass (*Chrysopogon* spp.), bluegrass (*Dichanthium* spp.) and Mitchell grass (*Astrebla* spp.) scattered coolabah (*Eucalyptus microtheca*) – *Bauhinia cunninghamii*, with riparian forests of river red gum (*Eucalyptus camaldulensis*) and Cadjeput (*Melaleuca* spp.) fringe drainages.
- Devonian reef limestones in the north and east supporting sparse tree steppe over lobed spinifex (*Triodia intermedia*) and limestone spinifex (*T. wiseana*) hummock grasses.

The subregion experiences a dry hot tropical and semi-arid climate with summer rainfall, with average rainfall between 500–800 mm, often, often influenced by cyclonic activity in the northwest of WA.



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Desktop study area
Option 3

IBRA region and subregion

Central Kimberley, Mount Eliza
Central Kimberley, Pentecost
Dampierland, Fitzroy Trough
Northern Kimberley, Mitchell

Figure 2–2

IBRA region

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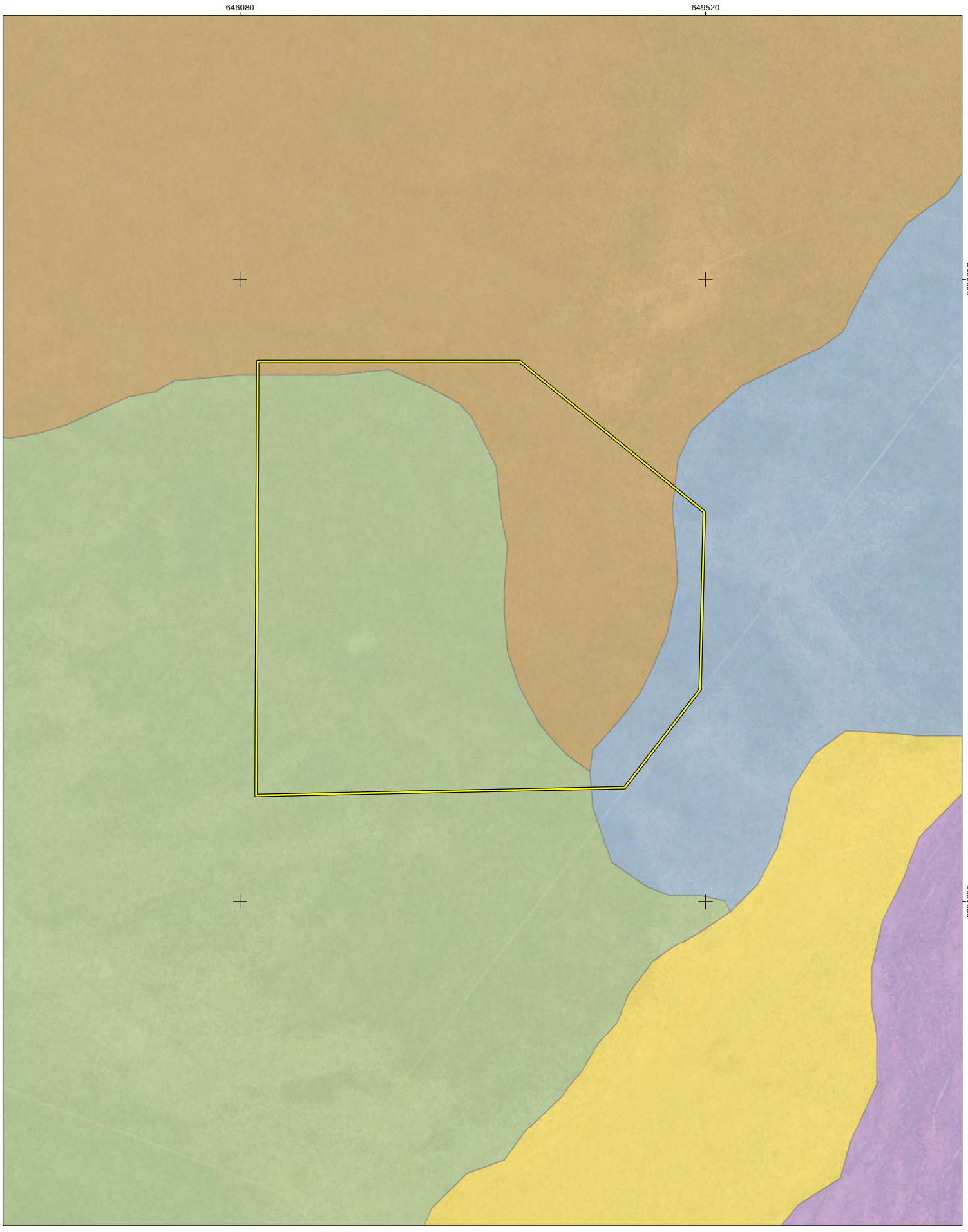
2.1.3 Land systems

Option 3 intersects four land systems, as mapped by the Department of Agriculture and Food Western Australia (Figure 2-3; Table 2-1). Option 3 lies primarily within one land system, the Yeeda system, with a small proportion overlapping the Sisters systems. Table 4-2 below shows the areas and percentages of each land system for Option 3.

Table 2-1 Description of land systems intersecting Option 3

Land system	Land system description	Option 3	
		Area (ha)	% of Option 3 area
Sisters	Low sandy plateaux and sandplain with thorough-going drainage, deep red sands and yellow loamy soils, pindan and tall woodlands.	575.65	60.6
Wanganut	Sandplains and dunes with pindan woodlands and spinifex/tussock grasslands.	65	6.8
Yeeda	Red sandplains supporting pindan vegetation with dense acacia shrubs, scattered bloodwood and grey box trees and curly spinifex and ribbon grass.	309.25	32.5
Total		**949.91**	**100**



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Kilometers

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Option 3

Land system

- Djada System
- Duffer System
- Sisters System
- Wanganut System
- Yeeda System

Figure 2-3

Land systems

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2.1.4 Surface and groundwater values

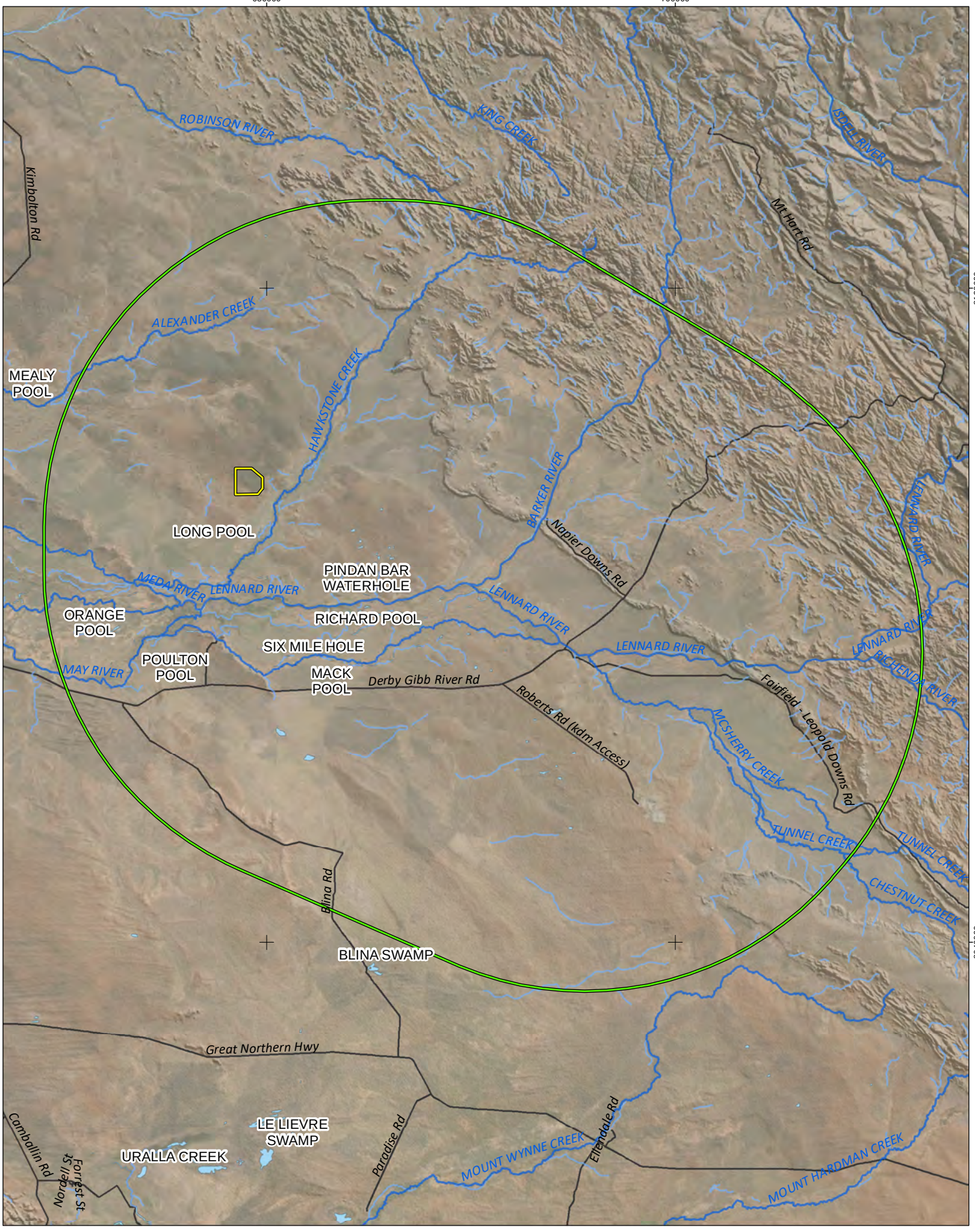
No rivers or mapped drainage lines intersect the Option 3. There are some minor drainage lines east of the Option 3 area that drain into the Hawkstone Creek. The Hawkstone Creek runs north to south-west adjacent, ~5 kms east of, Option 3; however, its floodplains come within ~1.4 km of the option 3 area (Figure 2-4).

There are no Ramsar or other significant wetlands within Option 3 or the wider desktop search extent. No perennial wetlands are present in Option 3.

Option 3 is located in the Canning-Kimberley groundwater subarea of the Canning-Kimberley groundwater area as proclaimed under the *Rights in Water and Irrigation Act 1914* (RIWI Act). There are no public water drinking source areas in proximity to Option 3.

The target aquifer for the Project is the Grant Group (Figure 2-5; see section 2.1.5).

Several groundwater springs are present outside Option 3 within the desktop search extent. The closest to the Option 3 is Ngooderoodyne Spring located 10 kms to the west. Oodinjil Spring is located 46 kms to the northwest (Figure 2-5).



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Kilometers

1:600,000 (at A4) GDA 1994 MGA Zone 51

- Desktop study area
- Option 3
- River
- Minor watercourse
- Wetland

Figure 2–4

Surface water values

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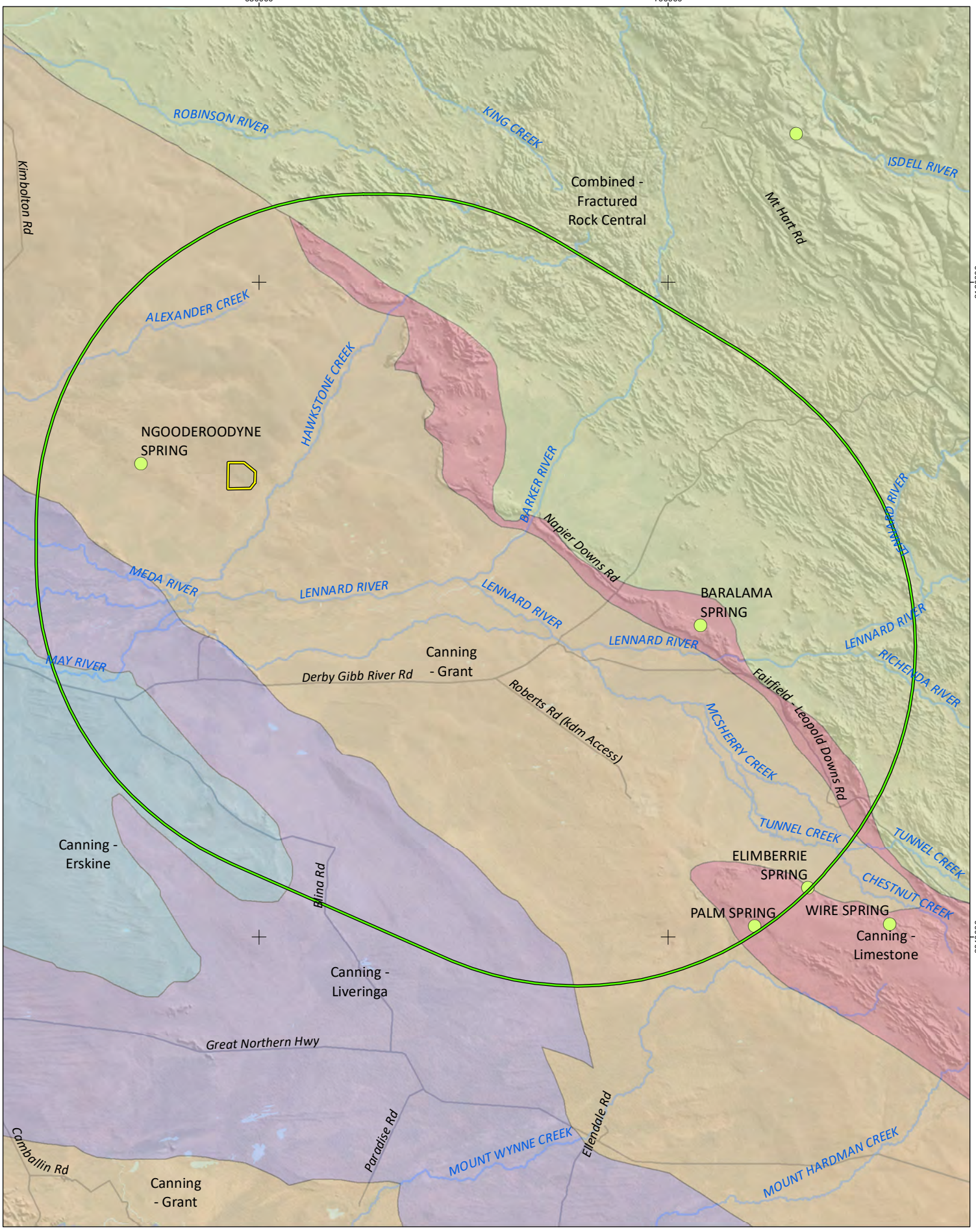

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Map author	MH

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Desktop study area
Option 3
Spring
River

WRIMS aquifer
- Canning - Erskine
- Canning - Grant
- Canning - Limestone
- Canning - Liveringa
- Combined - Fractured Rock Central

Figure 2–5

Groundwater values

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2.1.5 Geology and hydrogeology

According to the Lennard River map sheet (GSWA 1992), Option 3 overlies an area dominated by shallow- dipping rocks of the Phanerozoic Canning Basin succession. It falls within the King Leopold Orogen geological province which includes the Palaeoproterozoic metasedimentary and igneous rocks of the Hooper Complex and the deformed margins of the Speewah and Kimberley Basins (Stewart *et al.* 2016). The southwestern margin of the Hooper Complex ends northeast of Option 3, beyond the narrow Napier Range located approximately 20 km northeast of Option 3. Napier Range is comprised of exhumed Devonian limestone reef complex.

The Grant Group aquifer area occurs at the northern extremity of the expansive Canning Basin, which consists predominantly of Palaeozoic sedimentary rocks with a thin Mesozoic and Tertiary cover (Paul *et al.* 2013). Most of the underlying geology of the Canning Basin is covered by Cainozoic colluvium and alluvium.

The Grant Group aquifer is a thick sedimentary sequence consisting mainly of Carboniferous and Permian sandstones, with minor Devonian sandstone on the northeast margin included with the aquifer (DWER). The sandstones often contain fine-grained facies in the middle (Harrington & Harrington 2015). Grant Group rocks mainly outcrop in the anticlinal structures and form some of the ranges, such as the Grant Range near Liveringa, and the St George Ranges southeast of Noonkanbah middle (Harrington & Harrington 2015).

Option 3 study area is mapped as Cainozoic (Czc) geological unit, described as ‘sand or gravel plains; quartz sand sheets commonly with ferruginous pisoliths or pebbles, minor clay; local calcrete, laterite, silcrete, silt, clay, alluvium, colluvium, aeolian sand’ (Figure 2-6).

Regolith mapping for Option 3 shows the area occurs over sandplain, described as ‘mainly eolian, including some residual deposits’ (Figure 2-7). The site is close to (~1 km of) Alluvium and Colluvium deposits associated with Hawkstone Creek.

The Grant Group aquifer is expansive and, according to the DWER WRIMS Aquifer dataset (DWER), is mostly unconfined. Salinity is assumed to be fresh given the aquifer is a target water resource.

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Kilometers

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Option 3

Surface geology

- Czl
- Czs
- DClf
- Pslj
- Qa
- Qd
- Qrlb

Figure 2-6

Surface geology

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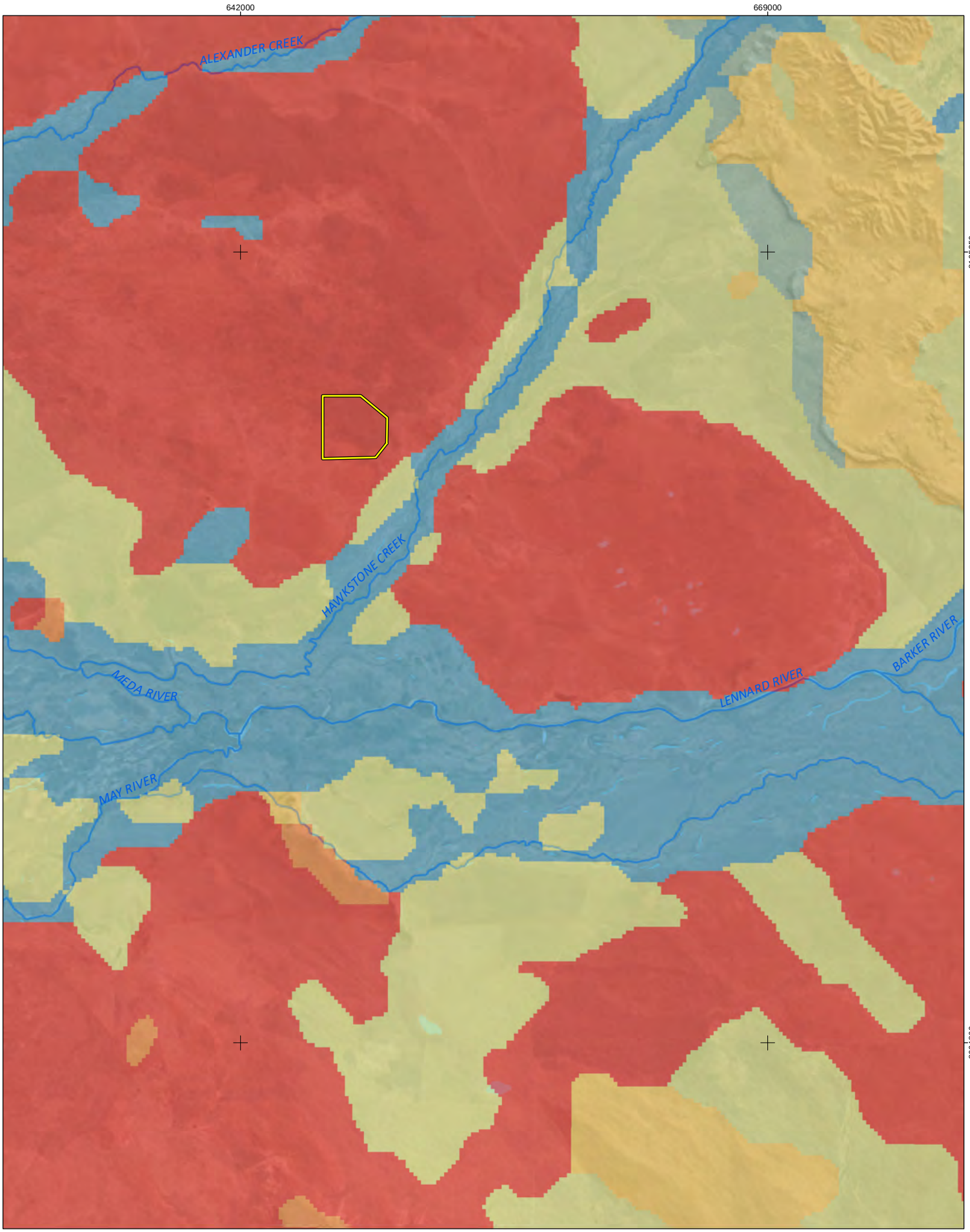

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Kilometers

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Option 3

Regolith type

- Alluvium
- Calcrete
- Colluvium
- Exposed
- Residual
- Sandplain

Figure 2-7

Regolith

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2.2 FLORA AND VEGETATION DESKTOP ASSESSMENT

2.2.1 Vegetation

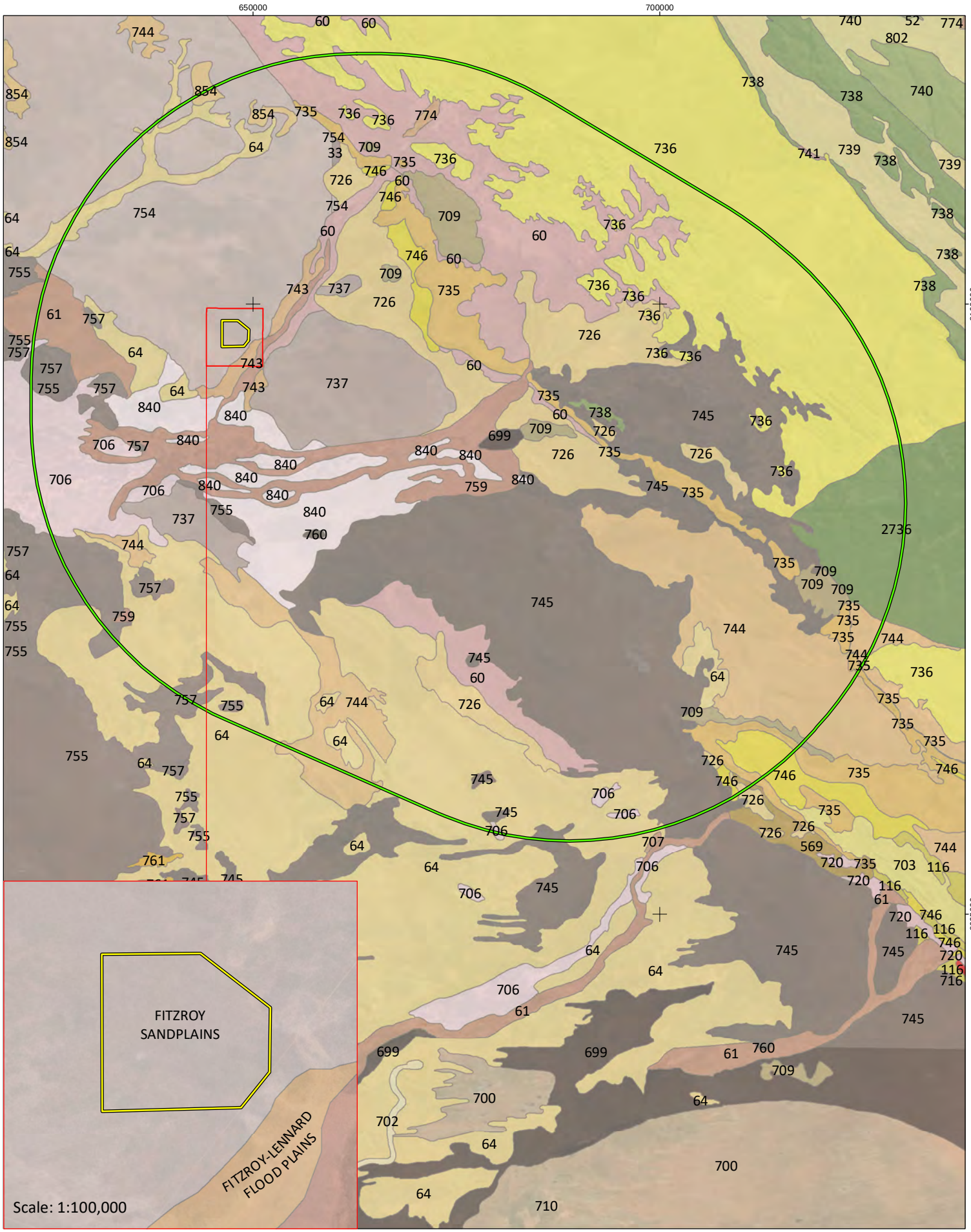
2.2.1.1 Native vegetation extent and status

Regional scale vegetation mapping by Shepherd *et al.* (2002) mapped one vegetation association within Option 3 (Figure 2-8). The association 754, Fitzroy Sandplains, comprises 100% of the Option 3 area.

Association 754 has 100% or nearly so of its pre-European extent remaining and is classified as of Least Concern (Table 2-2). The vegetation association is not well represented in DBCA managed lands.

Table 2-2 Extent and conservation status of the Shepherd *et al.* (2002) vegetation association intersecting Option 3 (DBCA 2018a).

Assoc.	Description	State Bioregion	State Bioregion	State Bioregion	Current DBCA managed lands (ha)	Status	Area (ha)	% of Option 3
		Pre-European extent (ha)	Current extent (ha)	% remaining				
754	Acacia thicket with eucalypt woodland over spinifex *Acacia tumida*, *Eucalyptus tectifica*, *Corymbia grandifolia*, *Triodia pungens*, *T. bitextura*	195,333.24	195,333.24	100.00	172.33	Least concern	949.91	100% of Option 3
Total							**949.91**	**100%**



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Map author	MH

0 10 20
Kilometers

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Desktop study area

Option 3

Figure 2-8

Vegetation associations (Sheperd *et al*. 2002)

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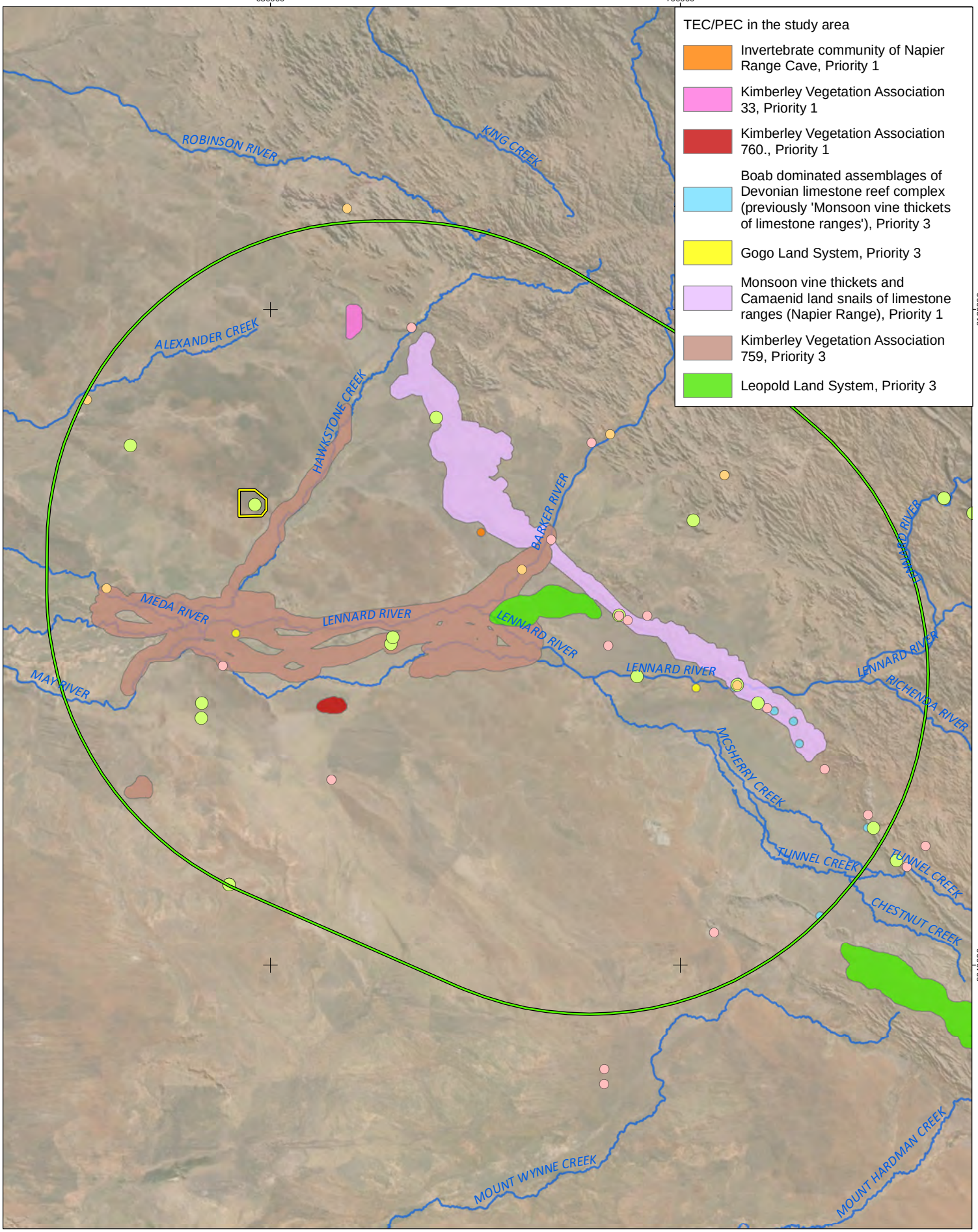
2.2.1.1 Threatened and priority ecological communities

A number of Priority Ecological Communities occur in the vicinity of the Option 3 area (Figure 2-9; Table 2-3). In total, seven PECs occur close to Option 3, with the closest buffer zone, of the Kimberley Vegetation Association 759 PEC, approximately 0.9 km to the east of Option 3, which is associated with the riparian and floodplain zones of the Lennard River and Hawkstone Creek. Option 3 area does not intercept the buffer zones of the PECs.

Table 2-3 Threatened and Priority Ecological Communities within 40 km of Option 3

Community ID	Community name	Cons. status	Buffer (km)	Proximity to study area
Gogo Land System	Gogo Land System	Priority 3	0.5	25 km south of Option 3
Leopold Land System	Leopold Land System	Priority 3	0.5	30.5 km south-east of Option 3
Napier Range Cave	Invertebrate community of Napier Range Cave	Priority 1	0.5	51.6 km east of Option 3
Napier Range	Monsoon vine thickets and Camaenid land snails of limestone ranges (Napier Range)	Priority 1	0.5	21.7 km east of Option 3
Vegetation Association 33	Kimberley Vegetation Association 33 As defined by John Beard's vegetation mapping for the Kimberley (Beard 1979). Shrublands, pindan; acacia shrubland with eucalypt medium woodland over curly spinifex	Priority 1	0.5	22 km north-east of Option 3
Vegetation Association 759	Kimberley Vegetation Association 759 As defined by John Beard's vegetation mapping for the Kimberley (Beard 1979). Grasslands, tall bunch grass savanna woodland, coolabah over ribbon/blue grass (*Botriochloa* spp.)	Priority 3	0.5	0.9 km east of Option 3
Vegetation Association 760	Kimberley Vegetation Association 760 As defined by John Beard's vegetation mapping for the Kimberley (Beard 1979). Shrublands, pindan; *Acacia tumida* shrubland with scattered low bloodwood & *Eucalyptus setosa* (not current name) over ribbon & curly spinifex.	Priority 1	0.5	24 km south of Option 3



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Kilometres

1:600,000 (at A4) GDA 1994 MGA Zone 51

Desktop study area
Option 3

Significant flora conservation status

- P1
- P2
- P3

Figure 2-9

Desktop records of significant flora and ecological communities

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2.2.1.2 Groundwater dependent ecosystems

Interrogation of the groundwater dependent ecosystems atlas (BoM 2020) determined that major creek/river systems in the vicinity of Option 3, including Lennard River, have been ranked as having moderate potential as groundwater dependent ecosystems.

2.2.2 Flora

A search of the DBCA database *Naturemap* (DBCA 2018b) showed a total of 910 species recorded in the vicinity of Option 3, from 447 genera and 80 Families. The most prolific families were the Poaceae (grasses) and Fabaceae (legumes) with 44 and 65 species respectively. Other well represented Families are the Malvaceae (38), Myrtaceae (15) and Amaranthaceae (15).

2.2.2.1 Significant Flora

A search of Florabase (WA Herbarium 2020) determined that there were no Threatened flora recorded for the Fitzroy Trough IBRA subregion. Twenty significant flora species were identified in the database searches, all Priority flora (Figure 2-9; Table 2-4). Two very old records of *Stylidium pindanicum* (P3) were returned within Option 3 (Figure 2-9). Of the remaining species, three were assessed as likely to occur in the Option 3 area, seven as possibly occurring and nine as unlikely (Table 2-4).

Table 2-4 Significant flora records and likelihood of occurrence in Option 3 area

Species	Cons. status	Nearest record to Option 3	Description and habitat (DBCA 2019a)	LOO[1] in Option 3	Criteria
Acacia monticola x *tumida* var. *kulparn*	P3	23.5 km S of study area	Shrub to 2 m, grey bark fissured to reveal reddish stems. Coastal cliffs.	Unlikely	Closest record 23.5 km S of study area. Habitat not suitable
Alysicarpus major	P3	45 km SE of Option 3	Prostrate perennial herb. Plains, floodplains, valleys, scree slopes, loam over basalt, laterite.	Unlikely	Closest record 45 km SE of Option 3. Habitat not suitable
Alysicarpus suffructicosus	P2	21.7 km NW of study area	Erect compact shrub to 0.3 m. Sandy clay, creek crossing.	Possible	Closest record 21.7 km NE of study area. Habitat appears suitable.
Blumea pungens	P2	32 km E of Option 3	Erect herb 0.6-1.5 m. Riverine, hillslopes, gorges. Sand over sandstone.	Unlikely	Closest record 32 km E of Option 3. Habitat appears unsuitable.
Clerodendrum inerme	P1	18 km S of study area	Erect dense tree or multi-stemmed shrub to 4m. Coastal swales, sandstone.	Unlikely	Closest record 18 km SW of study area. Habitat unsuitable.
Corymbia pedimontana	P1	66 km SE of Option 3	Tree to 10 m, brown-red bark. Plains at base of hills. Red sandy soils or loam over limestone.	Unlikely	Closest record 66 km SE of Option 3. Habitat appears to be specific, not represented in Option 3.
Cucumis sp. Bastion Range (A.A. Mitchell et al. AAM 10710) PN	P1	46.6 km SE of Option 3	Annual vine. Limestone, sandstone scree, watercourses.	Unlikely	Closest record 46.6 km SE of Option 3. Habitat appears unsuitable.
Decaisnina biangulata	P3	23 km NW of Option 3	Hemiparasitic aerial shrub on *Lophostemon*, *Syzygium*, *Tristania*, *Terminalia*.	Possible	Closest record 23 km NW of Option 3. Habitat appears suitable.
Gomphrena cucullata	P3	22.4 km WNW of Option 3	Spreading or erect annual herb to 0.25 m. Open floodplains. Red sandy loam, clayey sand.	Possible	Closest record 22.4 km SE of Option 3. Suitable habitat may be present.
Heliotropium aenigmatum	P1	35.5 km NE of Option 3	Ascending or spreading herb 0.15-0.6 m. Variety of habitats.	Likely	Closest record 35.5 km NE of study area. Habitat suitable.
Heliotropium calvariavis	P1	40.5 km E of Option 3	Ascending to spreading-ascending annual, herb, to 0.15 m high. Sandy soils.	Likely	Closest record 40.5 km E of Option 3. Habitat suitable.
Heliotropium parviantrum	P1	33.5 km S of Option 3	Erect annual, herb, to 0.15 m high. Flats, plains, rocky slopes. Sandy soils.	Likely	Closest record 33.5 km ENE of Option 3. Habitat suitable.

Species	Cons. status	Nearest record to Option 3	Description and habitat (DBCA 2019a)	LOO[1] in Option 3	Criteria
Ipomoea johnsoniana	P1	27.5 km NE of Option 3	Dense shrub to 1 m, twining stems. Sandy flats over limestone, sandstone.	Possible	Closest record 27.5 km NE of Option 3. Habitat may be suitable
Pterocaulon globuliflorum	P2	61.8 km SE of Option 3	Erect, much-branched perennial, herb or shrub, 0.4-0.6 m. Sandstone cliffs and scree slopes.	Unlikely	Closest record 61.8 km SE of Option 3. No suitable habitat.
Schoenoplectiella humillima	P2	18.3 km SW of Option 3	Sedge to 5 cm. Seepages, pools, red-brown clay.	Possible	Closest record 18.3 km SW of Option 3. Suitable habitat potentially present.
Stylidium pindanicum	P3	Within Option 3	Annual herb to 30cm, leaves basally rosetted. Damp, sandy soils, clay flats.	Recorded	Record within Option 3.
Tephrosia rosea var. Napier Range (C.R. Dunlop 7760 & B.K. Simon)	P3	14.4 km NW of Option 3	Silver leafed perennial herb to 0.5 m. Valley floors, skeletal soils.	Unlikely	Closest record 14.4 km NW of Option 3. Habitat unlikely to be suitable.
Tephrosia sp. Mistake Creek (A.C. Beauglehole 54424)	P3	62 km E of Option 3	Erect open shrub to 2 m. Flats/banks, drainage.	Possible	Closest record 62 km E of Option 3. Marginal floodplain possibly present.
Trachymene oleracea subsp. *sedimenta*	P1	45.5 km SE of Option 3	Annual herb to 0.6 m. Limestone or sandstone on inland ranges.	Unlikely	Closest record 45.5 km SE of Option 3. Habitat unlikely to be suitable
Triodia pascoeana	P1	81.6 km S of Option 3	Tussock-forming grass 1-3 m high. Limestone ranges & gorges, floodplains	Possible	Closest record 81.6 km S of Option 3. Marginal floodplain possibly present.

[1] LOO – Likelihood of occurrence.

2.2.2.2 Introduced species

A total of 18 weed species have been recorded from Option 3, from eight families and 16 genera (Table 2-5). None of these are WoNS or Declared Pests.

Table 2-5 Weed species recorded by the desktop assessment near the Option 1 study area

Family	Species	WoNS	Declared Pests
Asteraceae	**Bidens pilosa* var. *pilosa*	N	N
Poaceae	**Cenchrus ciliaris*	N	N
Poaceae	**Cenchrus echinatus*	N	N
Poaceae	**Cynadon dactylon*	N	N
Poaceae	**Digitaria ciliaris*	N	N
Poaceae	**Echinochloa colona*	N	N
Poaceae	**Echinochloa oryzoides*	N	N
Malvaceae	**Malvastrum americanum*	N	N
Malvaceae	**Malvastrum coromandelianum*	N	N
Malvaceae	**Melochia pyramidata*	N	N
Lamiaceae	**Mesosphaerum suaveolens*	N	N
Lamiaceae	**Ocimum americanum*	N	N
Passifloraceae	**Passiflora foetida* var. *hispida*	N	N
Portulacaceae	**Portulaca pilosa*	N	N
Malvaceae	**Sida acuta* subsp. *acuta*	N	N
Poaceae	**Sorghum bicolor*	N	N
Fabaceae	**Vachellia farnesiana*	N	N
Lamiaceae	**Vitex trifolia*	N	N

2.3 TERRESTRIAL FAUNA

2.3.1 Vertebrate fauna

A total of 42 species of conservation significance were identified in the desktop review, comprising 20 species listed under the EPBC Act and/or BC Act as Threatened (CR, EN, VU) or Specially Protected (OS) (Table 2-6; Figure 2-10). A further 18 species are listed as Migratory under the EPBC Act and BC Act and nine species are listed as Priority species by the DBCA (Table 2-6).

No desktop records were returned for any significant fauna species within Option 3; however, several significant species were recorded in 2013 from an apparent flood plain site on the eastern side of Hawkstone Creek, 4.9 km east of the Option 3 area: Northern Quoll (EN), Gull-billed Tern (Mig.), Glossy Ibis (Mig.), Common Greenshank (Mig.) and Freshwater Crocodile (OS). An assessment of the likelihood of each significant species identified in the desktop review occurring in the Option 3 area is summarised in Table 2-6.

The value of the habitats in the Option 3 area to riparian/river associated species such as Freshwater Crocodile and the migratory birds is likely to be lower than floodplain/creekline habitats present just to the east (associated with Hawkstone Creek). Based on Shepherd *et al.* (2002) vegetation association mapping, land systems mapping and aerial imagery, the Option 3 area appears to occur in the upland sandplains, with potentially only a single habitat type present – *Acacia* thicket with eucalypt woodland over spinifex. There is generally lower likelihood of these species being present, but this requires field assessment to confirm.

The Option 3 area occurs outside of mapped priority area for Night Parrot (EN/CR), and records are extremely sparse and sporadic. The Shepherd *et al.* (2002) vegetation association mapped in the Option 3 area includes spinifex (*Triodia* spp.); Night Parrot has been recorded in old growth spinifex and therefore warrants site assessment.

Due to their large foraging ranges, conservation significant raptor species such as Red Goshawk (VU), Grey Falcon (VU) and Peregrine Falcon (OS) may occasionally occur within the Option 3 area to forage; however, the potential for nesting needs to be determined in a site assessment.

The Kimberley subspecies of Marked Owl (VU/P1) may occasionally occur within the Option 3 area to forage; however, the likelihood of the species nesting in the area is dependent on the presence of suitable nesting hollows and requires site assessment.

Despite historic decline of the distribution of Golden Bandicoot, the species still occupies small areas in the western Kimberley and is known to occur in a wide range of habitats and may occur in the Option 3 area as a resident.

Although the Option 3 area occurs just outside the current known range for Bilby (VU), suitable habitat may be present and requires field assessment.

The nearby record of Northern Quoll (EN) suggests the riparian habitat of the Hawkstone Creek is at least providing a movement or dispersal corridor for the species. The Option 3 area appears unlikely to contain rocky habitat that may act as denning habitat for the species but potentially provides foraging habitat.

Likelihood of occurrence of all four significant bat species is considered possible as the Option 3 area may provide foraging habitat. The Bare-rumped Sheath-tailed Bat (P3) has the potential to roost in the Option 3 area, as this species is known to roost in hollow trunks and branches in woodland habitats.

Woodland occurring species such as the Kimberley Brush-tailed Phascogale (VU) and Northern Brushtail Possum (VU) may occur within the Option 3 area if suitable vegetation types and structures are present, including the presence of hollow bearing trees in which the species may use to roost.

ACE has advised that no pools or springs have been observed in the Option 3 area but it is possible that river pools associated with Hawkstone Creek are present to the east of the site. The Department of Water and Environment Regulation, in previous correspondence to ACE (letter from G. Humphreys to J. McMahon 2/10/2019) noted a recent (2019) sighting of the Freshwater Sawfish *Pristis Pristis* (VU EPBC Act; P3 DBCA) in a pool on the Lennard River, near Gibb River Road crossing. This species was not returned in the desktop review results but DWER identified the Lennard River as a likely migration route for the sawfish to Windjana Gorge. It is unclear if the sawfish may also occur in Hawkstone Creek. Based on review of available datasets, Option 3 is unlikely to contain any pools associated with Hawkstone Creek but there may be aquatic refuges associated with Hawkstone Creek to the east of the Option 3 area. Further ground investigation is warranted to assess potential for these to occur and potential for impact by the Project.

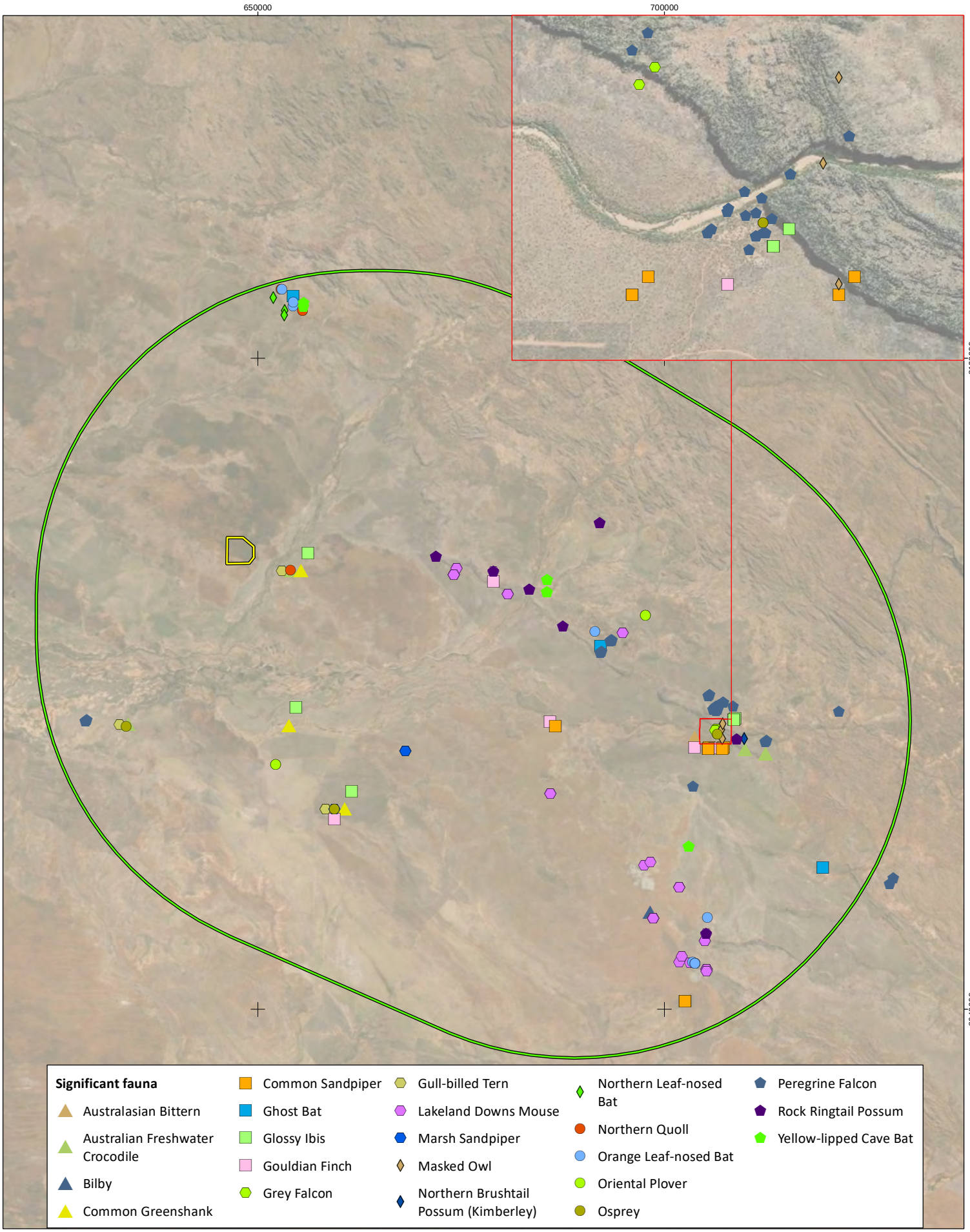
Table 2-6 Significant fauna identified in the desktop review and likelihood of occurrence in Option 3 area

Species	Common name	Status[1]			LOO[2] in Option 3 area
		EPBC Act	BC Act	DBCA	
Reptiles					
Crocodylus johnstoni	Freshwater Crocodile		OS		Unlikely
Crocodylus porosus	Salt-water Crocodile		OS		Unlikely
Birds					
Actitis hypoleucos	Common Sandpiper	Mig	Mig		Unlikely
Apus pacificus	Fork-tailed Swift	Mig	Mig		Possible
Botaurus poiciloptilus	Australasian Bittern	EN	EN		Possible
Calidris acuminata	Sharp-tailed Sandpiper	Mig	Mig		Possible
Calidris ferruginea	Curlew Sandpiper	CR/Mig	VU/Mig		Unlikely
Calidris melanotos	Pectoral Sandpiper	Mig	Mig		Unlikely
Cecropis daurica	Red-rumped Swallow	Mig	Mig		Unlikely
Charadrius veredus	Oriental Plover	Mig	Mig		Unlikely
Erythrotriorchis radiatus	Red Goshawk	VU	VU		Possible
Erythrura gouldiae	Gouldian Finch	EN		P4	Possible
Falco hypoleucos	Grey Falcon		VU		Possible
Falco peregrinus	Peregrine Falcon		OS		Possible
Gelochelidon nilotica	Gull-billed Tern	Mig	Mig		Possible
Glareola maldivarum	Oriental Pratincole	Mig	Mig		Possible
Hirundo rustica	Barn Swallow	Mig	Mig		Possible
Motacilla cinerea	Grey Wagtail	Mig	Mig		Possible
Motacilla flava	Yellow Wagtail	Mig	Mig		Possible
Numenius madagascariensis	Eastern Curlew	CR/Mig	VU/Mig		Unlikely
Pandion cristatus	Osprey	Mig	Mig		Unlikely
Pezoporus occidentalis	Night Parrot	EN	CR		Possible
Plegadis falcinellus	Glossy Ibis	Mig	Mig		Possible

Species	Common name	Status[1]			LOO[2] in Option 3 area
Polytelis alexandrae	Princess Parrot	VU		P4	Possible
Rostratula australis	Australian Painted Snipe	EN	EN		
Tringa glareola	Wood Sandpiper	Mig	Mig		Unlikely
Tringa nebularia	Common Greenshank	Mig	Mig		Unlikely
Tringa stagnatilis	Marsh Sandpiper	Mig	Mig		Unlikely
Tyto novaehollandiae kimberli	Masked Owl	VU		P1	Possible
Mammals					
Dasyurus hallucatus	Northern Quoll	EN	EN		Possible
Hipposideros stenotis	Northern Leaf-nosed Bat			P2	Possible
Isoodon auratus auratus	Golden Bandicoot	VU	VU		Possible
Leggadina lakedownensis	Northern Short-tailed Mouse			P4	Likely
Macroderma gigas	Ghost Bat	VU	VU		Possible
Macrotis lagotis	Bilby	VU	VU		Possible
Petrogale lateralis subsp. (West Kimberley)	West Kimberley Black-footed Rock-wallaby	VU	EN		Unlikely
Petropseudes dahli	Rock Ringtail Possum			P3	Unlikely
Phascogale tapoatafa kimberleyensis	Kimberley Brush-tailed Phascogale	VU	VU		Possible
Rhinonicteris aurantia	Orange Leaf-nosed Bat	VU		P4	Possible
Saccolaimus saccolaimus nudicluniatus	Bare-rumped Sheath-tailed Bat			P3	Possible
Trichosurus vulpecula arnhemensis	Northern Brushtail Possum		VU		Possible
Vespadelus douglasorum	Yellow-lipped Cave Bat			P2	Unlikely

[1] CR – Critically Endangered; EN – Endangered; VU – Vulnerable; OS – Specially Protected; Mig – Migratory; P1–4 – Priority 1–4.

[2] Likelihood of occurrence.



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Map author	MH

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Kilometres

1:600,000 (at A4) GDA 1994 MGA Zone 51

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Desktop study area
Option 3

Figure 2-10

Desktop records of significant vertebrate fauna

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2.3.2 Short-range endemic invertebrates

Four terrestrial invertebrates listed as Threatened under the BC Act and three Priority species were identified in the desktop review (Table 2-7). All are molluscs (land snails) in the family Camaenidae and are potential SREs; the records are associated with rocky habitats of the surrounding ranges, mainly Napier Range (Figure 2-11). Two PECs (section 2.2.1.1) are associated with the SRE invertebrates: Invertebrate community of Napier Range Cave, located 27 km east of Option 3, and Monsoon vine thickets and Camaenid land snails of limestone ranges, 20 km northeast (Figure 2-11).

Records of a further 51 potential terrestrial SRE species were identified through the WA Museum database searches (Table 2-7; Figure 2-11). None of these are from within Option 3 but there is one record of an opilione (Assamiidae sp., potential SRE) 2.9 km west of the Option 3 area. No habitat information is provided for this record but the site is within the same broad vegetation association (Shepherd *et al.* 2002) as the Option 3 area, adjacent to a drainage line.

The SREs have been collected from a wide range of habitat types, including rocky habitats (rocky outcrops, limestone outcrops, rock piles, boulders, rubble, rock crevices, rock/scree slopes, rocky gullies, bases of escarpments and cliffs), on plains under spinifex, open woodlands, caves/cave entrances, embayments, vine thickets and on roots, creek beds, trunk and/or branches of trees (Boabs).

Habitat of the Option 3 area is unlikely to support any of the Threatened or Priority Camaenids or the invertebrate associated PECs. However, there is potential for other SRE taxa to occur, based on the habitat descriptions above.

Table 2-7 Terrestrial SRE invertebrates identified in desktop review

Higher taxon, Family	Species	Conservation status	SRE status
Malacostraca - Isopoda (isopods)			
Armadillidae	*Kimberleydillo waldockae*		Potential
Gastropoda - Pulmonata (land snails)			
Camaenidae	*Amplirhagada carinata*		Potential
Camaenidae	*Amplirhagada napierana*		Potential
Camaenidae	*Amplirhagada percita*		Potential
Camaenidae	*Amplirhagada percita ignora*		Potential
Camaenidae	*Kendrickia ignivenatus*		Potential
Camaenidae	*Kimboraga mccorryi*		Potential
Camaenidae	*Kimboraga micromphala*	P2 (DBCA)	Potential
Camaenidae	*Kimboraga yammerana*	P1 (DBCA)	Potential
Camaenidae	*Mouldingia occidentalis*	CR (BC Act)	Potential
Camaenidae	*Parrhagada commoda*		Potential
Camaenidae	*Parrhagada detecta*		Potential
Camaenidae	*Parrhagada ferrosa*		Potential
Camaenidae	*Rhagada basedowana*		Potential
Camaenidae	*Rhagada* cf. *construa*		Potential
Camaenidae	*Rhagada* cf. *gatta*		Potential
Camaenidae	*Rhagada construa*		Potential
Camaenidae	*Rhagada gibbensis*	P1 (DBCA)	Potential
Camaenidae	*Rhagada mimika*		Potential
Camaenidae	*Rhagada sutra*		Potential
Camaenidae	*Tenuigada ignara*		Potential
Camaenidae	*Tenuigada percita*		Potential
Camaenidae	*Torresitrachia crawfordi*		Potential
Camaenidae	*Trachia frogatti*		Potential
Camaenidae	*Trachia orthocheila*		Potential
Camaenidae	*Westraltrachia alterna*	VU (BC Act)	Potential
Camaenidae	*Westraltrachia commoda*		Potential
Camaenidae	*Westraltrachia complanata*		Potential
Camaenidae	*Westraltrachia cunicula*		Potential
Camaenidae	*Westraltrachia derbyi*		Potential
Camaenidae	*Westraltrachia froggatti complanata*		Potential
Camaenidae	*Westraltrachia froggatti froggatti*		Potential

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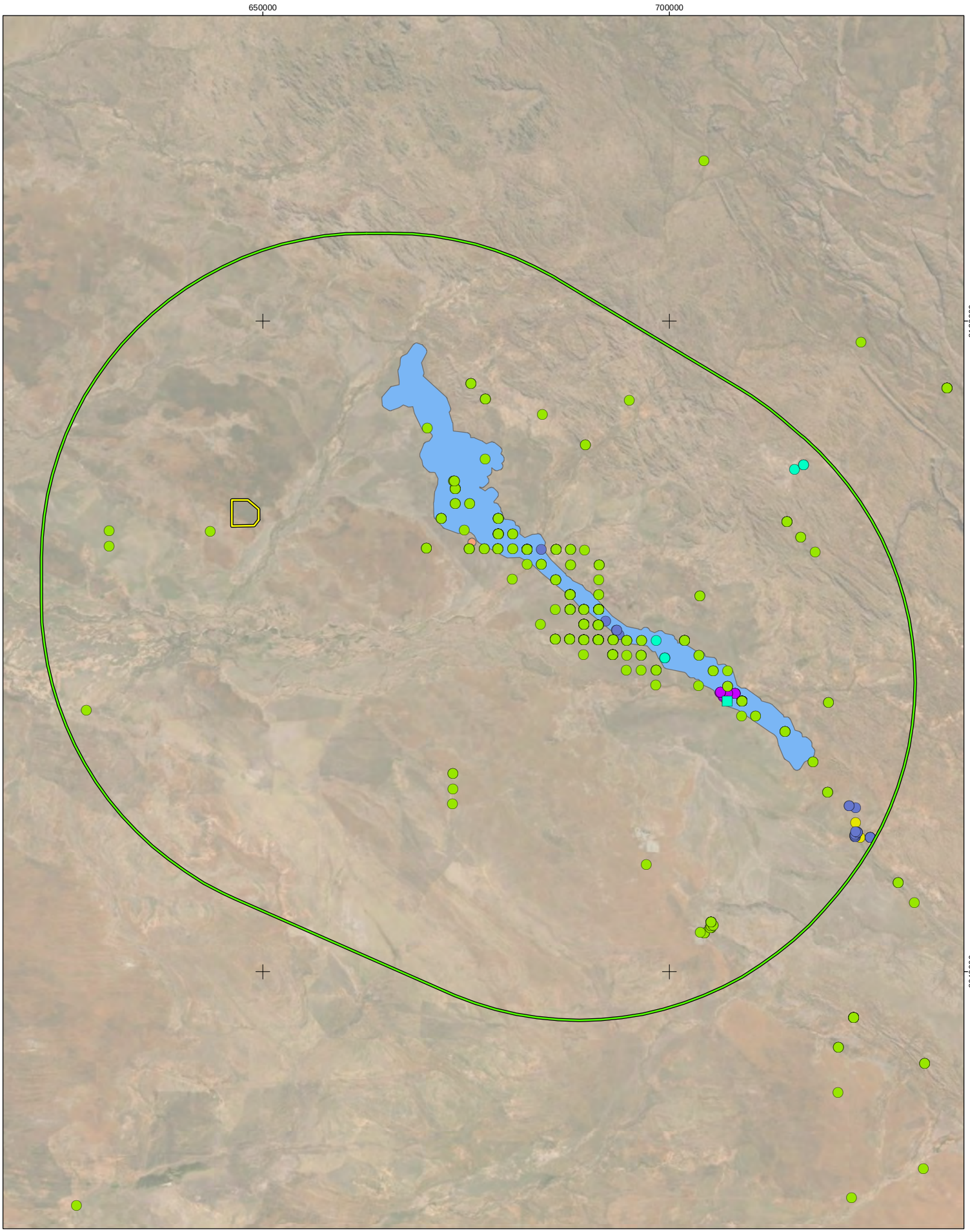
Higher taxon, Family	Species	Conservation status	SRE status
Camaenidae	*Westraltrachia froggatti*		Potential
Camaenidae	*Westraltrachia froggatti complanata*		Potential
Camaenidae	*Westraltrachia increta*		Potential
Camaenidae	*Westraltrachia inopinata*	VU (BC Act)	Potential
Camaenidae	*Westraltrachia instita*		Potential
Camaenidae	*Westraltrachia lievreana*		Potential
Camaenidae	*Westraltrachia limbana*		Potential
Camaenidae	*Westraltrachia rotunda*		Potential
Camaenidae	*Westraltrachia* sp.1		Potential
Camaenidae	*Westraltrachia* sp.2		Potential
Camaenidae	*Westraltrachia subtila*		Potential
Camaenidae	*Westraltrachia tropida*		Potential
Camaenidae	*Westraltrachia turbinata*	VU (BC Act)	Potential
Camaenidae	*Westraltrachia woodwardi*		Potential
Viviparidae	*Viviparidae cf. Notopala sp.*		Potential
Viviparidae	*Viviparidae* cf. *Larina* sp.		Potential
Arachnida - Mygalomorphae (trapdoor spiders)			
Euagridae	*Cethegus* `sp. nov.`		Potential
Halonoproctidae	*Conothele* `MYG542`		Potential
Halonoproctidae	*Conothele* sp.		Potential
Idiopidae	*Idiosoma `occidentalis* sp. group`		Potential
Arachnida - Araneomophae (modern spiders)			
Selenopidae	*Karaops jenniferae*		Potential
Sparassidae	*Heteropoda cavernicola*		Potential
Arachnida - Opiliones (harvestmen)			
Assamiidae	*Dampetrus* sp.		Potential
Assamiidae	*Assamiidae* sp.		Potential
Arachnida - Pseudoscorpiones (pseudoscorpions)			
Chthoniidae	*Austrochthonius `minutissimus`*		Potential
Diplopoda (millipedes)			
Paradoxosomatidae	*Helicopodosoma* `Mt Hart`		Potential



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Desktop study area
Option 3

TEC/PEC in the study area

Invertebrate community of Napier Range Cave, Priority 1

Monsoon vine thickets and Camaenid land snails of limestone ranges (Napier Range), Priority 1

SRE status, Conservation Significant Status

- Potential
- Potential, P1
- Potential, P2
- Potential, CR
- Potential, VU
- Uncertain

Figure 2-11

Desktop records of short-range endemic invertebrates

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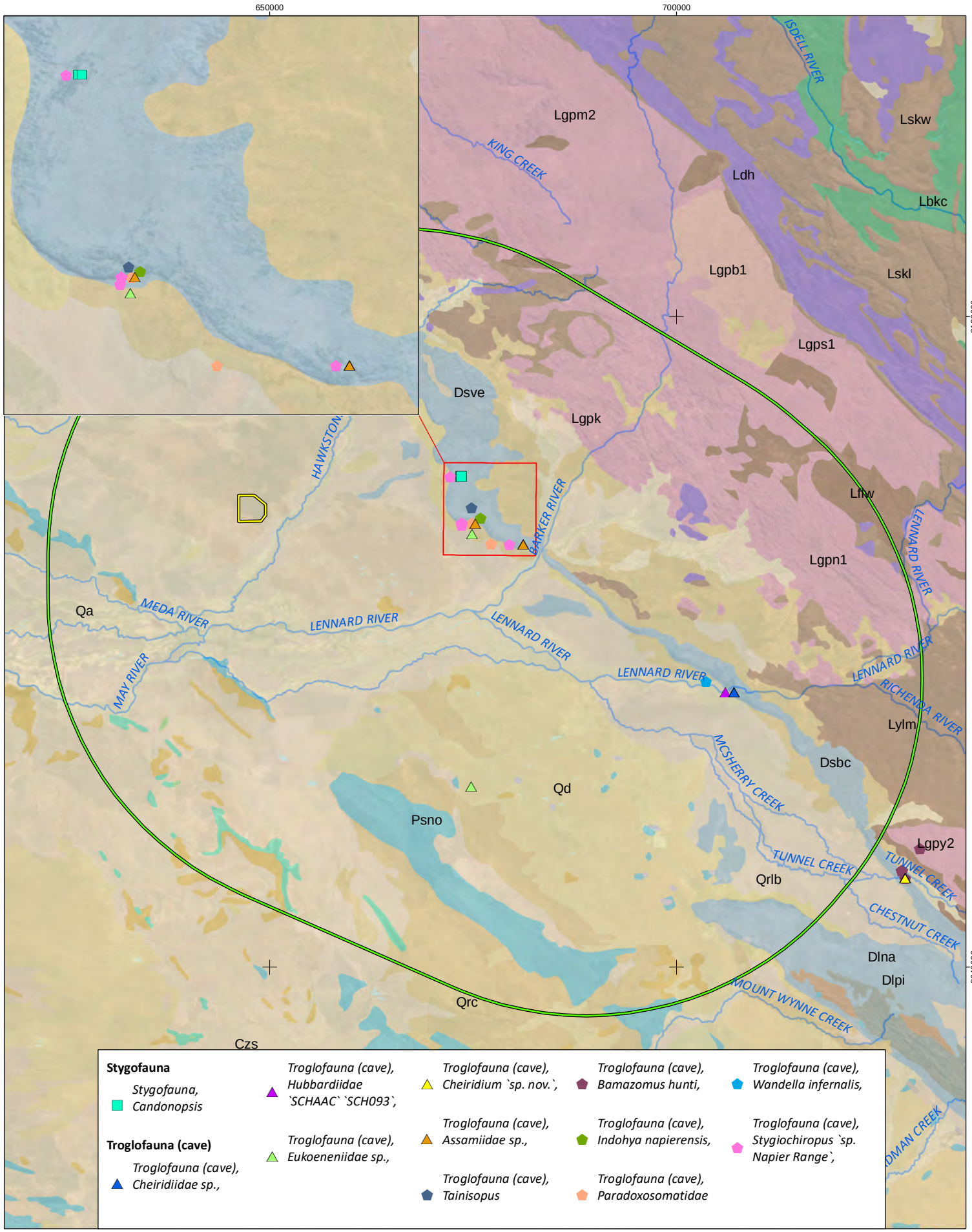
2.4 SUBTERRANEAN FAUNA

Records of 12 troglofauna and a single stygofauna species were returned in the database searches (Table 2-8; Figure 2-12). No subterranean species listed as Threatened or Priority were returned in the database searches. All of the troglofauna are associated with caves of Napier Range over 20 km east of the Option 3 area, and several are known from only a single cave (e.g. Harvey 2001; Harvey & Volschenk 2007). However, stygofauna have also been collected from wells, bores, cave pools and springs in the west Kimberley (Humphreys 1995; Karanovic 2005).

Lack of records for troglofauna other than the restricted cave fauna and the very limited records for stygofauna are likely to be a consequence of limited sampling in the region. The main geologies suitable for subterranean fauna in the Kimberley are karst / limestone, sandstone and alluvium (EPA 2016d; Humphreys 1995). Based on geology and hydrogeology data for the Option 3 area (section 2.1.5), there is potential for stygofauna and troglofauna to occur.

Table 2-8 Subterranean fauna identified in desktop review

Higher taxon, Family	Species	SRE status	Troglofauna/stygofauna
Arachnida - Araneomophae (modern spiders)			
Filistatidae	*Wandella infernalis*	Potential	Troglofauna (cave)
Arachnida - Opiliones (harvestmen)			
Assamiidae	*Assamiidae* sp.	Potential	Troglofauna (cave)
Arachnida - Palpigradi (microwhip scorpions)			
Eukoeneniidae	*Eukoeneniidae* sp.	Potential	Troglofauna (cave)
Arachnida - Pseudoscorpiones (pseudoscorpions)			
Cheiridiidae	*Cheiridium* `sp. nov.`	Potential	Troglofauna (cave)
Cheiridiidae	*Cheiridiidae* sp.	Potential	Troglofauna (cave)
Hyidae	*Indohya napierensis*	Confirmed	Troglofauna (cave)
Arachnida - Schizomida (short-tailed whipscorpions)			
Hubbardiidae	*Hubbardiidae* `SCHAAC` `SCH093`	Confirmed	Troglofauna (cave)
Hubbardiidae	*Apozomus eberhardi*	Confirmed	Troglofauna (cave)
Hubbardiidae	*Bamazomus hunti*	Confirmed	Troglofauna (cave)
Diplopoda (millipedes)			
Paradoxosomatidae	*Stygiochiropus* `sp. Napier Range`	Confirmed	Troglofauna (cave)
Paradoxosomatidae	*Paradoxosomatidae* sp.	Potential	Troglofauna (cave)
Malacostraca - Isopoda (isopods)			
Tainisopidae	*Tainisopus napierensis*	Potential	Troglofauna (cave)
Ostracoda - Podocopida (ostracods)			
Candonidae	*Candonopsis kimberleyi*	Potential	Stygofauna



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Kilometres

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Desktop study area
Option 3

Figure 2-12
Desktop records of subterranean fauna

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3 DISCUSSION AND RECOMMENDATIONS

3.1 FLORA AND VEGETATION

Desktop records exist for several Priority flora species in proximity to the Option 3 area, including one (*Stylidium pindanicum,* P3) within the Option 3 area. Based on the likelihood of occurrence assessment, up to 11 Priority flora species may occur in the Option 3 area. A targeted flora survey at appropriate time of year will be required to confirm significant flora values.

While several PECs occur in the vicinity of Option 3, it is outside existing buffer zones for all of these. It is therefore unlikely that examples of these PECs will be found in Option 3, although they should be surveyed for the possibility, as DBCA mapping of the PECs may not have been ground-truthed in the field.

Due to the proximity of the Option 3 area to the Hawkstone Creek and associated floodplains, a detailed survey of riparian vegetation types is recommended to identify whether groundwater dependent vegetation is present in Option 3. While no springs or other surface water features were identified within the Option 3 area, ground assessment of the presence of any such features is also warranted.

Option 3 occurs in a region that is, to a certain extent, unknown in terms of flora and vegetation values, and very little is protected in DBCA managed lands such as nature reserves or National Parks. A detailed survey incorporating quadrat sampling should be conducted on Option 3 in accordance with (EPA 2016c). A detailed survey is necessary for proposals where the desktop review finds that the area supports a high diversity of flora or vegetation or has only received minimal survey effort in the past. This will allow for a detailed description of the vegetation and flora occurring within Option 3 and an assessment of its significant values or otherwise.

3.2 TERRESTRIAL FAUNA

Several significant fauna species have the potential to occur in the Option 3 area, including 10 mammal and 16 bird species. Field verification of habitats is required to further assess suitability of the Option 3 area for these species. This includes investigation of the value of the site to significant fauna for its proximity to Hawkstone Creek and associated riparian/floodplain habitat.

Potential value of Option 3 to SREs, particularly land snails requires field assessment. The Kimberley is poorly surveyed for SREs and given the proximity of several SRE records from the area of the desktop review and diversity of habitats that SREs have been collected from in the region, it is possible that SRE taxa are present in Option 3.

A targeted Level 2 is recommended and should include:

- detailed habitat assessment and mapping
- targeted survey for significant mammals that may occur (Bilby, Northern Quoll, Golden Bandicoot, Kimberley Brush-tailed Phascogale, Northern Brushtail Possum and Northern Short-tailed Mouse), including
    - including plot sampling for Bilby within and adjacent to the Option 3 area
    - camera trapping within the Option 3 area and along Hawkstone Creek
    - searches for signs of presence
- acoustic recordings for the significant bat species and Night Parrot

- avifauna surveys, targeting both significant species in Table 2-6 and avifauna assemblage generally
- Level 2 survey for SRE invertebrates, including systematic sampling and characterisation and mapping of SRE habitats
- searches for presence of any pools or other surface water features in the Option 3 area and adjacent toward Hawkstone Creek that may serve as refuges for the Freshwater Sawfish.

3.3 SUBTERRANEAN FAUNA

There is potential for stygofauna and troglofauna to be present in the subterranean habitats underlying Option 3. In accordance with EPA guidance (EPA 2016e), a survey for subterranean fauna is typically required where a desktop identifies potential for subterranean fauna to be present. However, requirement for survey is likely to depend on potential for impacts, in particular whether there is potential for confined geologies to be present that may harbour range restricted species, as well as the anticipated level of impact. As a minimum a risk assessment should be conducted based on the findings of the H3 hydrological report for the Project.

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