PHOENIX
ENVIRONMENTAL SCIENCES

Detailed flora and vegetation survey and reconnaissance survey for groundwater dependent vegetation for the Napier Downs Irrigation Project

Prepared for Australian Capital Equity Pty Ltd

April 2023

Final

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Version history

Author/s	Reviewer/s	Version	Version number	Date submitted	Submitted to
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EXECUTIVE SUMMARY

Australian Capital Equity Pty Ltd (ACE) is investigating the feasibility of developing the Napier Downs Irrigation Project (the Project) located approximately 78 km from Derby, Western Australia. The Project will entail the development of centre irrigation pivots with water sourced from the Grant Group Aquifer. The Project is located in the Dampierland bioregion and the Northern Botanical Province.

Phoenix Environmental Sciences Pty Ltd (Phoenix) was commissioned by ACE to undertake a detailed survey of Scrubby Paddock (detailed study area) and a reconnaissance survey for groundwater dependent vegetation (GDV) within a 15km radius of this (reconnaissance study area) to inform environmental approvals for the Project.

Field surveys were preceded by a desktop assessment where database searches and a literature review were undertaken to identify and prepare a list of significant flora and vegetation that may occur within the detailed study area. The desktop assessment determined that a number of significant flora species have been recorded in proximity to the detailed study area, there was potential for the occurrence of restricted vegetation types and groundwater dependent vegetation, very little of the mapped vegetation associations within the detailed study area that are protected in conservation estate and the region that the study area occurs in is, to a certain extent, unknown in terms of flora and vegetation values. Subsequently a detailed flora and vegetation survey was necessary.

Field surveys were conducted for the Project in spring 2021 and autumn (May) 2022. A detailed survey was conducted for the detailed study area, which comprised survey of permanently marked quadrats visited during both survey periods and targeted searches for significant flora and vegetation. A reconnaissance survey was conducted for GDV in the reconnaissance study area, which comprised targeting water bodies and searching for GDV indicator species.

A total of 104 flora taxa representing 40 families and 78 genera identified to species level were recorded in the detailed study area, comprised of included 76 perennial species and 28 annual or short-lived species. No introduced species were recorded. The most prominent families recorded were Fabaceae (15 spp.), Myrtaceae (10 spp.), Poaceae (9 spp.) and Malvaceae (8 spp.).

No Threatened flora were recorded during the field survey. Two Priority flora, *Lophostemon grandiflorus* subsp. *grandiflorus* (P3) and *Goodenia sepalosa* var. *glandulosa* (P3) were recorded. A significant range extension was recorded for *Phyllanthus* sp. B Kimberley Flora (T.E.H. Aplin et al. 809) and therefore this record is considered locally significant for the species.

A total of 8 new populations for *Lophostemon grandiflorus* subsp. *grandiflorus* were recorded, 7 in the reconnaissance survey and one in the detailed study area. These populations represent the first records of the species for the Fitzroy Trough subregion. The records from the field survey indicate that *Lophostemon grandiflorus* subsp. *grandiflorus* is relatively abundant in the area and it is likely there are further populations of the species in the broader area.

Goodenia sepalosa var. *glandulosa* has previously been recorded in the Fitzroy Trough subregion and in similar habitat, Pindan vegetation. Previous records of *Goodenia sepalosa* var. *glandulosa* indicate typically small populations. The record in the current survey had a foliage cover of 0.1% indicating the species was present in low numbers.

The records for *Phyllanthus* sp. B Kimberley flora are the first for the Fitzroy Trough subregion and the Dampierland bioregion, with the single confirmed previous record for the species occurring in the Mitchell subregion of the Northern Kimberley bioregion. The habitat in which the species was recorded in the current survey matches the previous records.

A total of 4 vegetation types were defined for the detailed study area, comprised of *Melaleuca* woodlands over mixed herbs and grasses, tall *Acacia tumida* var. *tumida* mixed shrubland over *Sorghum* and *Chrysopogon* tussock grassland, and low open *Eucalyptus* woodland over open mixed shrublands and mixed tussock grasses. The tall *Acacia tumida* var. *tumida* mixed shrubland and

Eucalyptus woodland comprised 98.9% of the detailed study area. The *Melaleuca* woodlands were restricted to a small soak.

The majority (99.1%) of vegetation in the detailed study area was recorded to be in Excellent condition. Only 0.3% of the detailed study area was cleared.

The tall *Acacia tumida* var. *tumida* mixed shrubland and *Eucalyptus* woodland are representative of the pre-European vegetation association 754 mapped for the detailed study area that has a current extent of 195,333.24 ha and is classed as least concern. This indicates that a considerable area of similar vegetation occurs outside of the detailed study area.

None of the vegetation types of the detailed study area were considered to represent any to the Priority Ecological Communities identified in the desktop assessment and no mapped locations of any significant vegetation intercepted the detailed study area.

The tall *Acacia tumida* var. *tumida* mixed shrubland was considered locally significant as habitat for the significant flora *Goodenia sepalosa* var. *glandulosa.* As this vegetation type is representative of the broader vegetation association this indicates a large amount of suitable habitat for this species outside of the detailed study area.

The *Melaleuca* woodlands were considered locally significant as:

- they were habitat for significant flora, *Lophostemon grandiflorus* subsp. *grandiflorus* (P3), and *Phyllanthus* sp. B Kimberley flora
- *Lophostemon grandiflorus* subsp. *grandiflorus* was prominent in the upper canopy
- they comprised a novel range of species not seen elsewhere in the detailed study area
- had a restricted, >1% combined, distribution in the detailed study area.

Sites visited in the reconnaissance survey included seasonally wet depressions, small lakes and riparian vegetation of 2 creek systems including Hawkstone Creek. At least one GDV indicator species was recorded at each of the sites.

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1 INTRODUCTION

Australian Capital Equity Pty Ltd (ACE) is investigating the feasibility of developing the Napier Downs Irrigation Project (the Project). The Project is located approximately 78 km from Derby in the Shire of Derby-West Kimberley, Western Australia (WA; Figure 1-1). The Project will entail the development of centre irrigation pivots which will be used to produce fodder crops for cattle stocked on Napier Downs and nearby stations. Water will be sourced from the Grant Group Aquifer.

In August 2021, Phoenix Environmental Sciences Pty Ltd (Phoenix) was commissioned by ACE to undertake a detailed flora and vegetation survey of the proposed irrigation area (detailed study area) and a reconnaissance survey of groundwater dependent vegetation (GDV) within a 15 km buffer of this (reconnaissance study area). The outcomes of the baseline studies are to be used to inform environmental approvals for the Project.

1.1 BACKGROUND

Phoenix (2019) were engaged by ACE in March 2019 to conduct a desktop assessment of terrestrial flora and vegetation for the Project in accordance with (EPA 2016b). The desktop assessment (Phoenix 2019) was undertaken for 2 previous options for the irrigation area. A desktop addendum was later prepared specifically for a third option, in Scrubby Paddock (Phoenix 2020).

The objective of the desktop assessments was to identify the following:

- potential significant flora and vegetation values that may be present in the study area
- any potential values that may represent significant constraints for the Project
- proposed scope of field survey requirements for the Project.

The desktop assessment determined that:

- a number of significant flora species have been recorded in proximity to the Scrubby Paddock, with a record of one significant species, *Stylidium pindanicum* (P3) located within 250 m of the study area
- potential for the occurrence of restricted vegetation types and groundwater dependent vegetation in the study area
- the region that the study area occurs in is, to a certain extent, unknown in terms of flora and vegetation values
- there is very little of the mapped vegetation associations within the study area that are protected in Department of Biodiversity, Conservation and Attractions (DBCA) managed lands, such as nature reserves or National Parks.

Detailed flora and vegetation survey is necessary for proposals where the desktop review finds that the area supports a high diversity of flora or vegetation or if the area contains restricted landforms or vegetation units, or has only received minimal survey effort in the past (EPA 2016b). As the study area is expected to contain species of significant flora and potentially significant vegetation, a detailed survey was deemed necessary.

Discussions of desktop assessment results and proposed flora and survey methodology with the Department of Water and Environmental Regulation (DWER) were undertaken and it was agreed that the proposed surveys appeared adequate to inform environmental impact assessment for the study area (Ryan Mincham, letter dated 29/1/2021, to James McMahon).

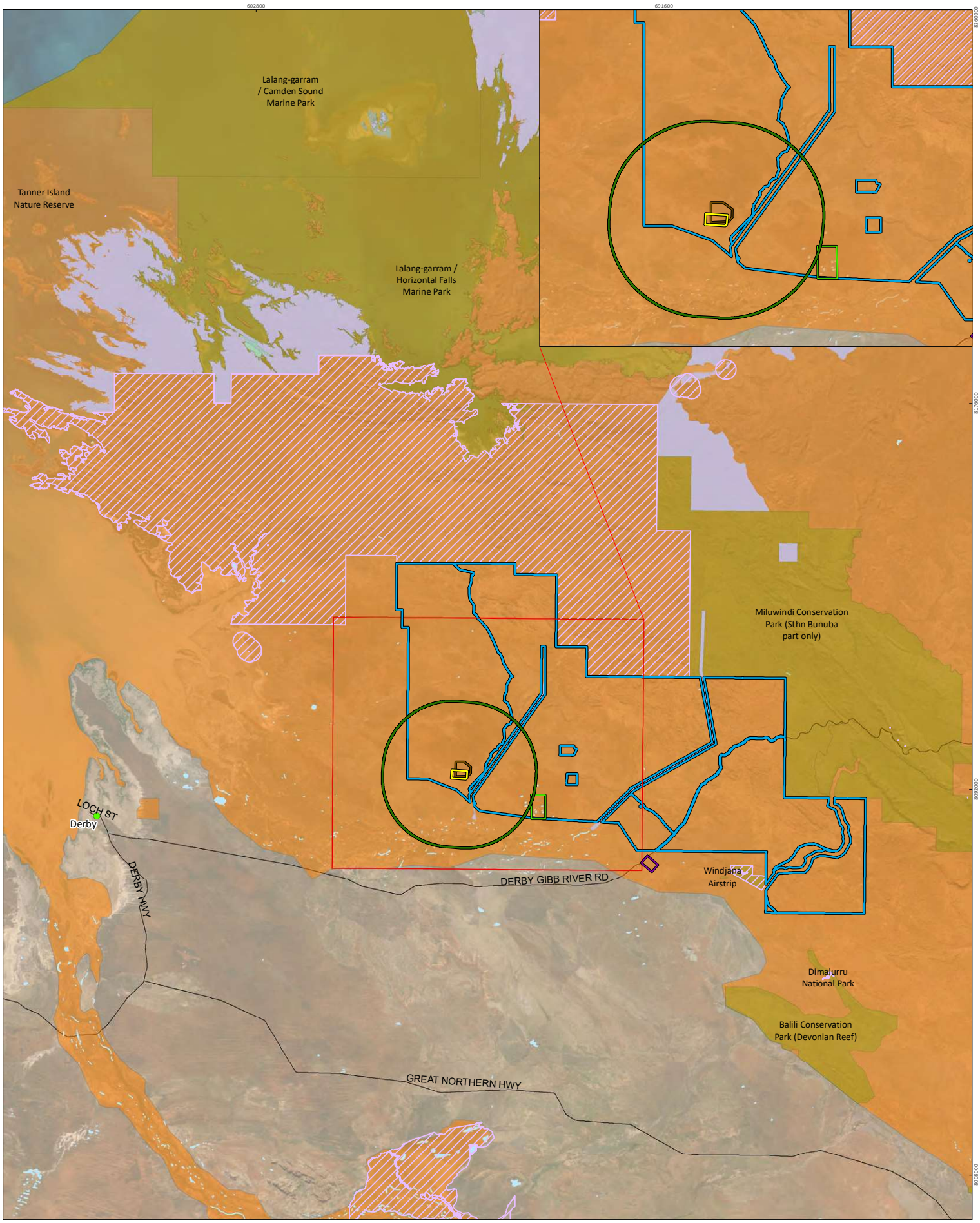
1.2 SCOPE OF WORK

The scope of work was as follows:

- detailed, 2 season flora and vegetation survey in the study area, to
    - define and map vegetation types and condition
    - conduct targeted searches for significant flora (Threatened and Priority) and Threatened and Priority ecological communities (TEC and PECs), where applicable
    - conduct targeted searches for declared pests and weeds of national significance (WoNS)
- high level reconnaissance survey within a 15 km buffer of study area to identify GDV indicator species, including
    - identify riparian vegetation (riverbanks, creeks, floodplains, waterholes)
    - undertake targeted searches for indicator species
    - conduct relevé surveys to describe vegetation.

1.3 STUDY AREA

The detailed study area is approximately 586.5 ha and located within Scrubby Paddock on Napier Downs pastoral lease (LPL N049855; Figure 1-1). The reconnaissance study area for the GDV survey intersects Napier Downs, Meda and Kimberley Downs stations. Napier Downs is situated in the Northern Botanical Province as defined by EPA (2016b).



Australian Capital Equity
Napier Downs Irrigation Project

Project No	1453
Date	1/12/2022
Drawn by	BK
Map author	GW

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Kilometers

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Detailed study area
Reconnaissance study area
Napier Downs Station

Previous study areas
Option 1
Option 2
Option 3

Environmentally sensitive areas
Lake
DBCA managed land
Indigenous Protected Areas
West Kimberley National Heritage Place

Figure 1-1

Project location and study area

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2 LEGISLATIVE CONTEXT

The protection of flora and fauna in WA is principally governed by 3 acts:

- Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
- State *Biodiversity Conservation Act 2016* (BC Act)
- State *Environmental Protection Act 1986* (EP Act).

The BC Act came into full effect on 1 January 2019 and replaced the functions of the *Wildlife Conservation Act 1950* (WC Act).

2.1 COMMONWEALTH

The EPBC Act is administered by the Federal Department of Agriculture, Water and the Environment (DAWE). The EPBC Act provides for the listing of Threatened flora and Threatened Ecological Communities (TECs) as matters of National Environmental Significance (NES). Under the EPBC Act, actions that have, or are likely to have, a significant impact on a matter of NES, require approval from the Australian Government Minister for the Environment through a formal referral process.

Conservation categories applicable to Threatened flora species under the EPBC Act are as follows:

- Extinct (EX)[1] – there is no reasonable doubt that the last individual has died
- Extinct in the Wild (EW) – taxa known to survive only in captivity
- Critically Endangered (CR) – taxa facing an extremely high risk of extinction in the wild in the immediate future
- Endangered (EN) – taxa facing a very high risk of extinction in the wild in the near future
- Vulnerable (VU) – taxa facing a high risk of extinction in the wild in the medium-term
- Conservation Dependent (CD)[1] – taxa whose survival depends upon ongoing conservation measures; without these measures, a conservation dependent taxon would be classified as Vulnerable, Endangered or Critically Endangered.

Ecological communities are defined as 'naturally occurring biological assemblages that occur in a particular type of habitat' (English & Blyth 1997). There are 3 categories under which ecological communities can be listed as TECs under the EPBC Act: Critically Endangered, Endangered and Vulnerable.

2.2 STATE

2.2.1 Threatened and Priority species

In WA, the BC Act provides for the listing of Threatened flora species (Government of Western Australia 2018a, b)[2] in the following categories:

- Critically Endangered (CR) – species facing an extremely high risk of extinction in the wild in the immediate future[3]

[1] Species listed as Extinct and Conservation Dependent are not matters of NES and therefore do not trigger the EPBC Act.

[2] The *Wildlife Conservation (Specially Protected Fauna) Notice 2018* and the *Wildlife Conservation (Rare Flora) Notice 2018* have been transitioned under regulations 170, 171 and 172 of the *Biodiversity Conservation Regulations 2018* to be the lists of Threatened, Extinct and Specially Protected species under Part 2 of the BC Act.

[3] As determined in accordance with criteria set out in the ministerial guidelines.

- Endangered (EN) – species facing a very high risk of extinction in the wild in the near future[3]
- Vulnerable (VU) – species facing a high risk of extinction in the wild in the medium term future[3].

Species may also be listed as specially protected (SP) under the BC Act in one or more of the following categories:

- species of special conservation interest (conservation dependent fauna, CD) – species with a naturally low population, restricted natural range, of special interest to science, or subject to or recovering from a significant population decline or reduction in natural range
- migratory species (Mig.), including birds subject to international agreement
- species otherwise in need of special protection (OS).

The Department of Biodiversity, Conservation and Attractions (DBCA) administers the BC Act and also maintains a non-statutory list of Priority flora. Priority species are still considered to be of conservation significance – that is they may be Threatened – but cannot be considered for listing under the BC Act until there is adequate understanding of threat levels imposed on them. Species on the Priority flora list are assigned to one of 4 Priority (P) categories, P1 (highest) – P4 (lowest), based on level of knowledge/concern.

2.2.2 Critical habitat

Under the BC Act, habitat is eligible for listing as critical habitat if it is critical to the survival of a Threatened species or a TEC and its listing is otherwise in accordance with the ministerial guidelines.

2.2.3 Threatened and Priority Ecological Communities

The BC Act provides for the listing of TECs in the following categories:

- Critically Endangered – facing an extremely high risk of becoming eligible for listing as a collapsed ecological community in the immediate future[3]
- Endangered – facing a very high risk of becoming eligible for listing as a collapsed ecological community in the near future[3]
- Vulnerable – facing a high risk of becoming eligible for listing as a collapsed ecological community in the medium-term future[3].

An ecological community may be listed as a collapsed ecological community under the BC Act if there is no reasonable doubt that the last occurrence of the ecological community has collapsed, or the ecological community has been so extensively modified throughout its range that no occurrence of it is likely to recover its species composition and/or structure.

The DBCA also maintains a non-statutory list of Priority Ecological Communities (PECs), which may become TECs in the future; however, do not currently meet survey criteria or that are not adequately defined. PECs are assigned to one of 5 categories depending on their priority for survey or definition, with Priority 1 of highest concern and Priority 5 of lowest concern.

2.2.4 Other significant flora, vegetation and fauna

Under the EPA's environmental factor guidelines, flora and vegetation may be considered significant for a range of reasons other than listing as a Threatened or Priority species or ecological community.

In addition to listing as Threatened or Priority, EPA (2016a) identifies the following:

- flora may be significant for
    - local endemism or association with a restricted habitat type (e.g., surface water or groundwater dependent ecosystems)

  - new species or anomalous features that indicate a potential new species
  - representing the range of a species (particularly at the extremes of range, recently discovered range extensions, or isolated outliers of the main range)
  - being unusual species, including restricted subspecies, varieties or naturally occurring hybrids
  - having relictual status, being representative of taxonomic groups that no longer occur widely in the broader landscape
- vegetation may be significant for:
  - having restricted distribution
  - subject to a degree of historical impact from threatening processes
  - having a role as a refuge
  - providing an important function required to maintain ecological integrity of a significant ecosystem.

Provided in the guide for assessment of applications to clear native vegetation (DER 2014) is a scale for assessing the bioregional conservation status of ecological vegetation classes (Table 2-1).

Table 2-1 Bioregional conservation status of ecological vegetation classes

Conservation status	Description
Presumed extinct	Probably no longer present in the bioregion
Endangered*	Less than 10% of pre-European extent remains
Vulnerable*	10-30% of pre-European extent exists
Depleted*	More than 30% and up to 50% pre-European extent exists
Least concern	More than 50% of pre-European extent exists and subject to little or no degradation over a majority of this area

*or a combination of depletion, loss of quality, current threats and rarity gives a comparable status.

2.2.5 Environmentally Sensitive Areas

Under section 51B of the EP Act the Minister for Environment may declare by notice either a specified area of the State or a class of areas of the State to be ESAs. ESAs are declared in the *Environmental Protection (Environmentally Sensitive Areas) Notice 2005*, which was gazetted on 8 April 2005 (Government of Western Australia 2005).

ESAs are areas where the vegetation has high conservation value. Several types of areas are declared ESAs including:

- the area covered by vegetation within 50 metres (m) of Threatened flora, to the extent to which the vegetation is continuous with the vegetation in which the Threatened flora is located
- the area covered by a TEC
- a defined wetland (Ramsar wetlands, conservation category wetlands and nationally important wetlands) and the area within 50 m of the wetland.

2.2.6 Introduced flora

Introduced flora (weeds) pose threats to biodiversity and natural values by successfully out-competing native species for available nutrients, water, space and sunlight; reducing the natural structural and biological diversity by smothering native plants or preventing them from growing back after clearing, fire or other disturbance; replacing the native plants that animals use for shelter, food and nesting;

and altering fire regimes, often making fires hotter and more destructive (Australian Weeds Committee 2007).

Management of some weed species is required under Commonwealth or State frameworks. Key classifications for significant introduced flora that are relevant to this report are:

- Declared Pest – the Biosecurity and Agriculture Management Act 2007 (BAM Act), Section 22 makes provision for a plant taxon to be listed as a Declared Pest organism in parts of, or the entire State. Under the Biosecurity and Agriculture Management Regulations 2013 Declared Pests are assigned to one of 3 control categories that dictate the level of management required (DPIRD 2019).
- Weed of National Significance (WoNS) – high impact, established introduced flora causing major economic, environmental, social and/or cultural impacts in a number of states/territories, and which have strong potential for further spread (Australian Weeds Committee 2012). Management is required in accordance with Department of Primary Industries and Regional Development (DPIRD) guidelines for particular WoNS.

Throughout this report, introduced flora species are indicated with an asterisk (*).

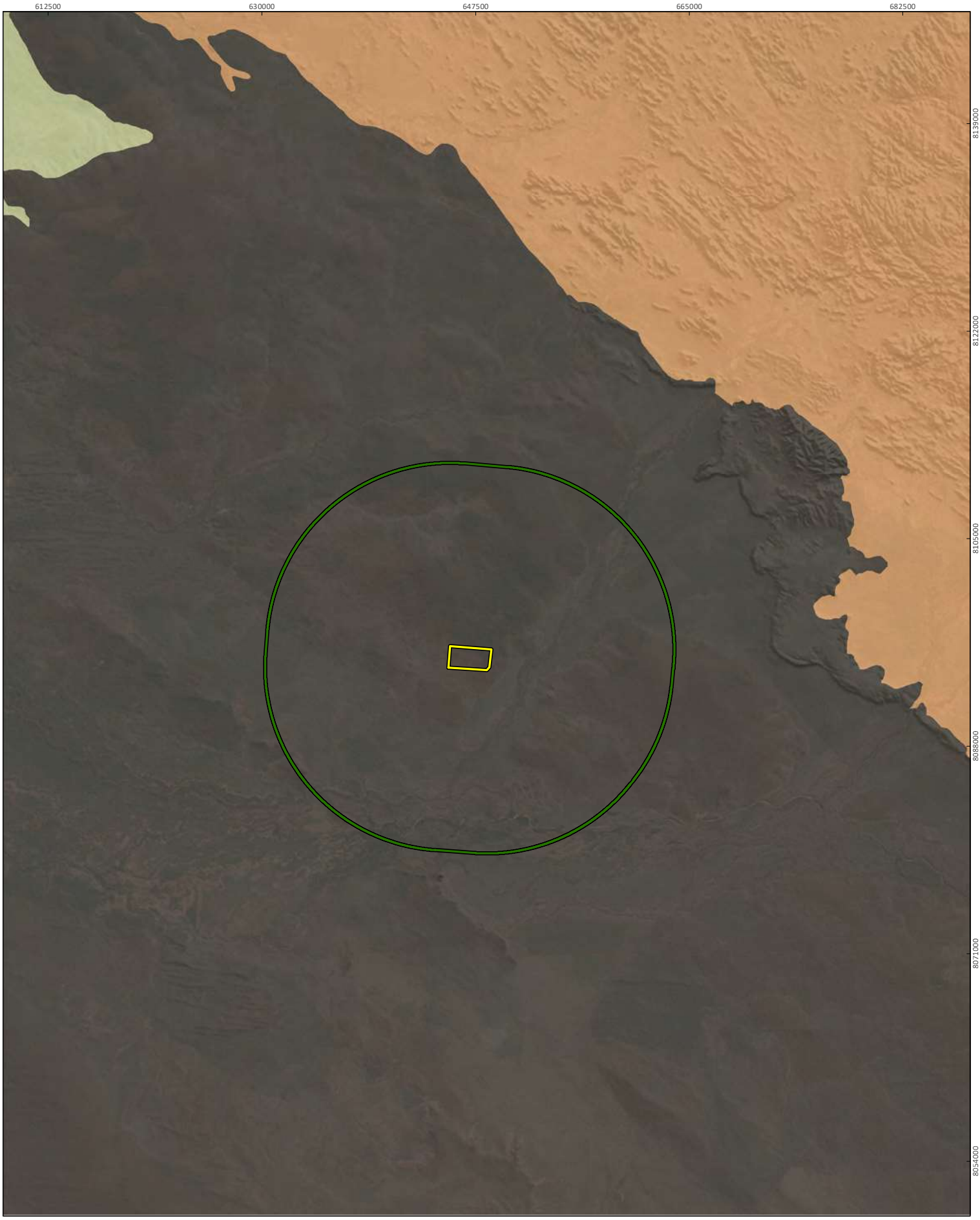
3 EXISTING ENVIRONMENT

3.1 INTERIM BIOGEOGRAPHIC REGIONALISATION OF AUSTRALIA

The detailed and reconnaissance study areas are located entirely within Fitzroy Trough (DL1) subregion of the Dampierland bioregion (Figure 3-1). The Fitzroy Trough subregion is comprised of 4 basic components, described as (Graham 2001b):

- 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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Kilometers

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Detailed study area
Reconnaissance study area

Region, subregion

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

Figure 3-1

Study area in relation to IBRA bioregions and subregions

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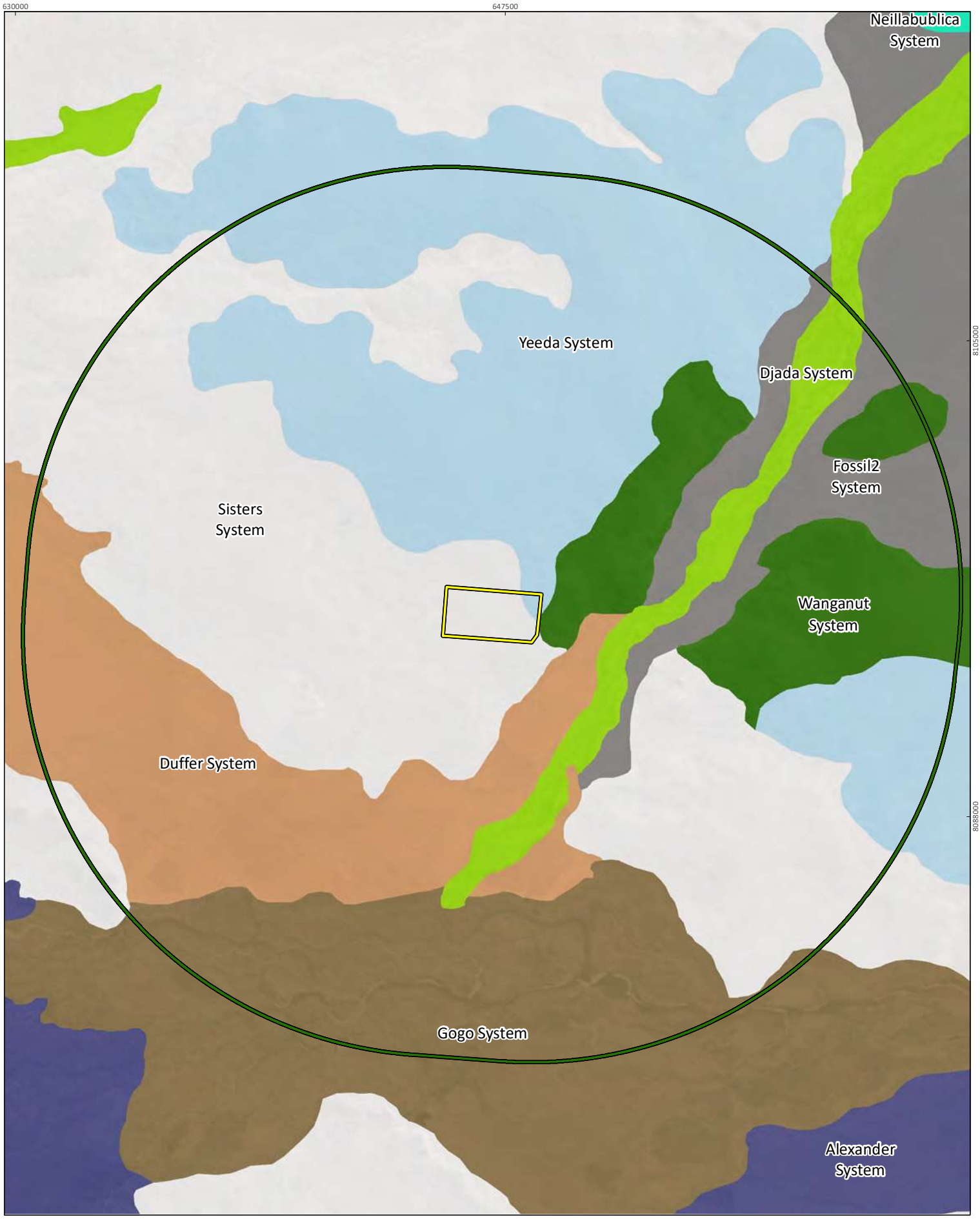
3.2 LAND SYSTEMS AND SURFACE GEOLOGY

DPIRD undertakes land system mapping for WA using a nesting soil-landscape mapping hierarchy (Schoknecht & Payne 2011). Under this hierarchy, land systems are defined as areas with recurring patterns of landforms, soils, vegetation and drainage (Payne & Leighton 2004). The detailed study area intersects 3 land systems but fall predominantly within one of these, the Sisters System (Table 3-1; Figure 3-2).

Table 3-1 Land systems and extent in the detailed study area

Land system	Description	Area (ha)	% of study area
Sisters System	Low sandy plateaux and lower slopes supporting pindan woodlands with *Acacia*'s and eucalypts and curly spinifex-ribbon grass, and valley plains supporting mixed woodlands with ribbon grass.	537.0	91.6
Wanganut System	Sandplains and linear dunes supporting pindan woodlands with *Acacia*'s and bloodwoods and curly spinifex- ribbon grass, and broad low-lying swales supporting bloodwood-grey box woodlands with curly spinifex-ribbon grass.	0.7	0.1
Yeeda System	Red sandplains supporting pindan vegetation with dense *Acacia* shrubs, scattered bloodwood and grey box trees and curly spinifex and ribbon grass.	48.8	8.3
	Total	**586.5**	**100**

According to the Surface Geology of Australia 1:1,000,000 scale, Western Australia database (Stewart et al. 2008), the detailed study area intersects a single geological formation (Figure 3-3); Sand plain 38499 (Czs), which is 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'.



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Kilometers

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Detailed study area
Reconnaissance study area

Land system

- Alexander System
- Djada System
- Duffer System
- Fossil2 System
- Gogo System
- Neillabublica System
- Sisters System
- Wanganut System
- Yeeda System

Figure 3-2

Land systems in the study area

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Kilometers

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Detailed study area

Reconnaissance study area

Surface geology

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

Figure 3-3

Surface geology in the study area

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3.3 CLIMATE AND WEATHER

The climate of the Fitzroy Trough subregion is described as dry hot tropical and semi-arid with summer rainfall. The average annual rainfall is between 500 – 800 mm (Graham 2001a).

The nearest Bureau of Meteorology (BoM) weather station with comprehensive data collection and recent historic climate data is Derby Airport (no. 003032), Latitude: 17.39°S Longitude 123.68°E), located 77 km west of the detailed study area.

Derby Airport records the highest mean maximum monthly temperature (38.3°C) in November (lowest in June, 30.8°C) and the lowest minimum mean monthly temperature (14.6°C) in July (highest in December, 26.3°C; Figure 3-4). Mean annual rainfall is 704.4 mm with January and February recording the highest monthly mean (207.0 and 197.7 mm respectively; Figure 3-4).

Daily mean temperatures at Derby Airport preceding the surveys were consistently higher than the long-term averages in the months prior to both surveys, with below average maximum temperatures not recorded after June 2020 (Figure 3-4). Records from Derby Airport show that rainfall from November 2020 to March 2021 was well above average; however, only 7.4 mm of rainfall was recorded in the 6 months preceding the first survey (Figure 3-4). More substantial rainfall was recorded in the 3 months prior to the second survey (315.2 mm), which was much lower than the long-term average of 535.2 mm.

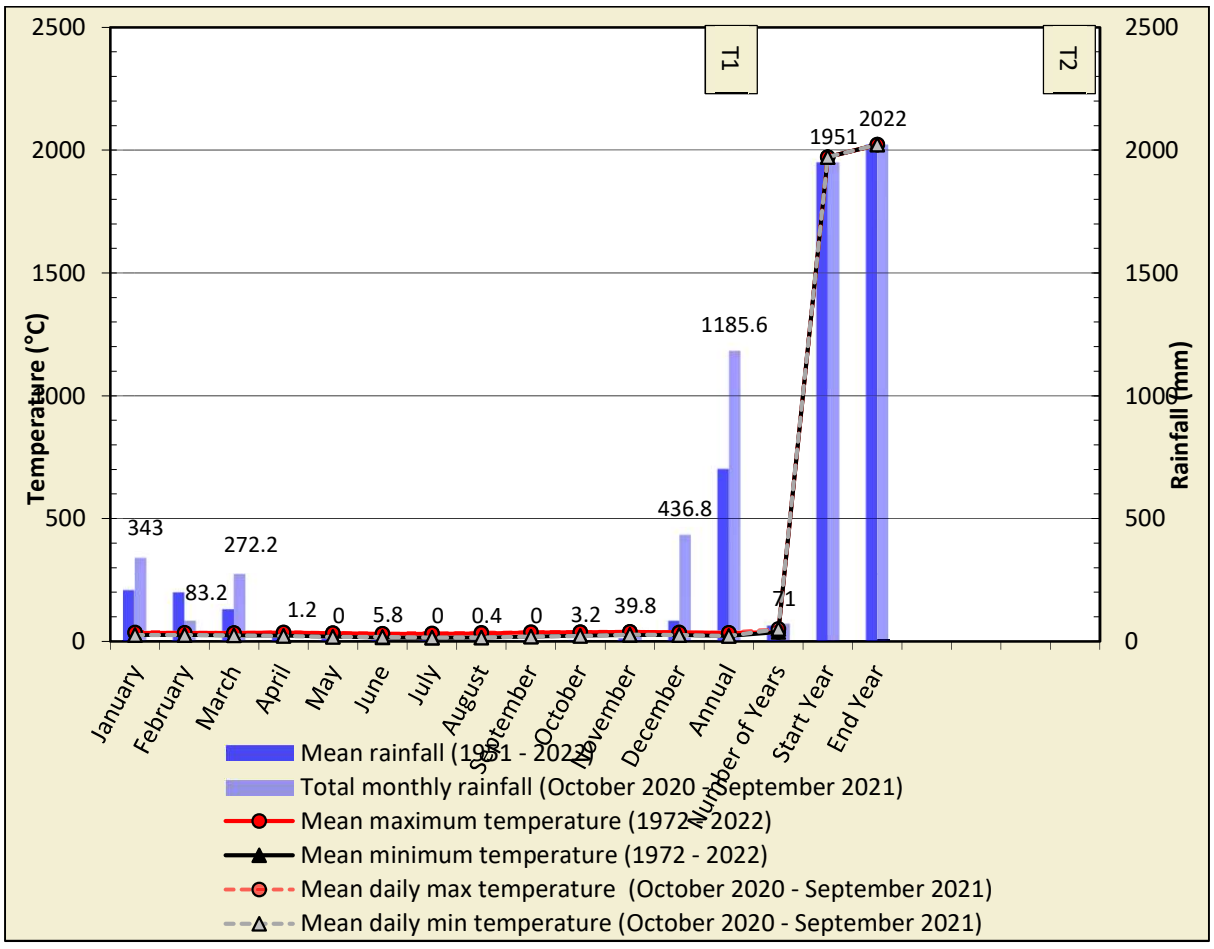


Figure 3-4 **Annual climate and weather data for Derby Airport (no. 003032) and mean monthly data for the 12 months preceding the survey (BoM 2022)**

3.4 LAND USE

The dominant land uses in the Fitzroy Trough subregion are native pasture grazing, conservation reserves and unallocated crown land (Graham 2001a). The detailed study area occurs entirely within the Napier Downs pastoral lease.

3.5 NATIONAL HERITAGE PLACES, CONSERVATION RESERVES AND ENVIRONMENTALLY SENSITIVE AREAS

The study areas are 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 1-1). The listing is vast in extent, covering 949.9 km^2 of the Kimberley region, and is recognised as nationally significant under several criteria (DoEE 2019a).

The study areas are situated over the King Leopold Orogen geological province; they 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, with the buffer located approximately 23 km east of the detailed study area.

The study areas are not situated within any conservation reserves or Environmentally Sensitive Areas (ESAs); however, Wilinggin an Indigenous Protected Area (IPA) is located partially within the reconnaissance study area, 2.6 km to the east of the detailed study area (Figure 1-1). The closest conservation reserve, King Leopold Ranges Conservation Park, is situated 58 km northeast and the closest ESA is 33.5 km northeast (Figure 1-1).

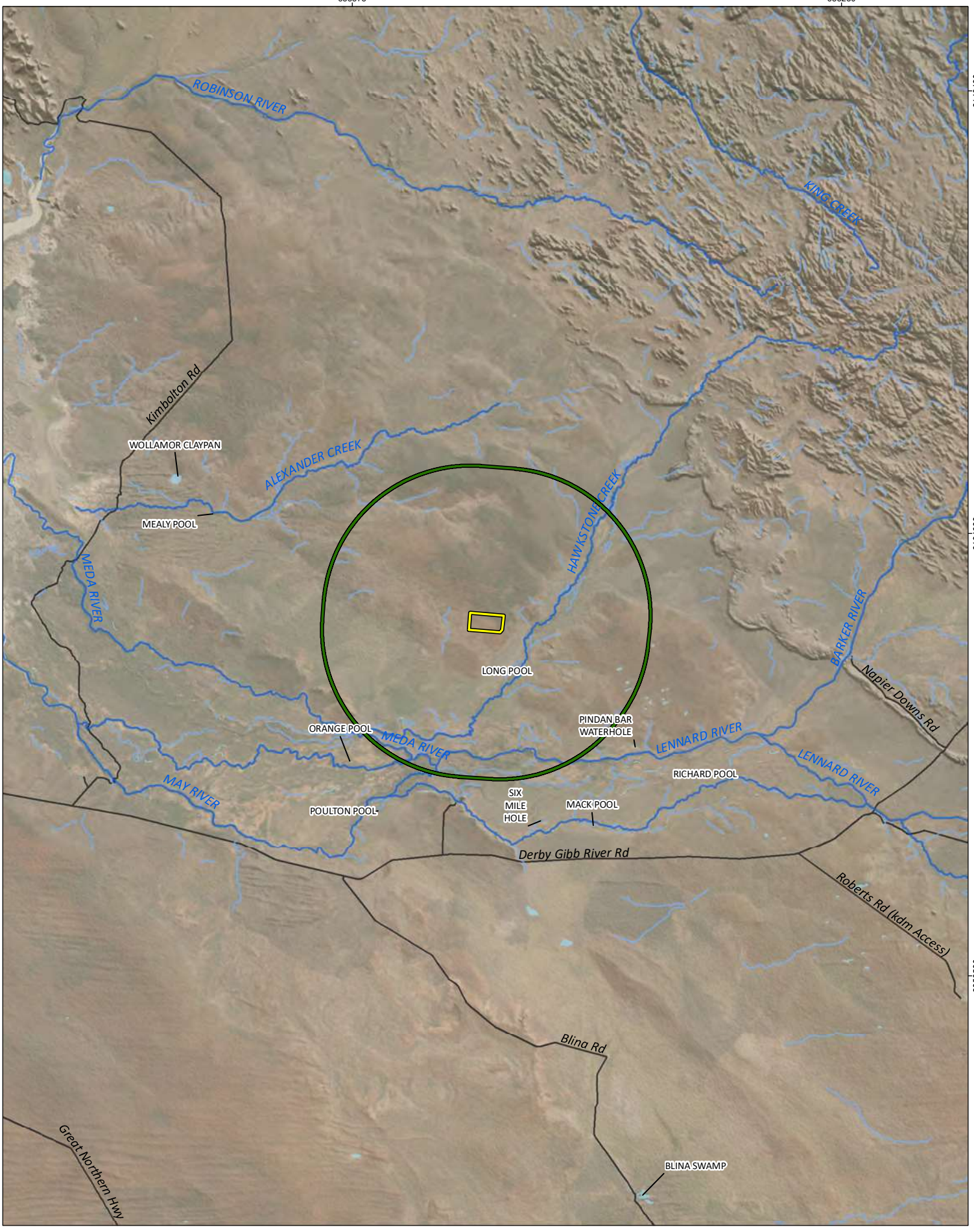
3.6 SURFACE AND GROUNDWATER VALUES

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

There are no Ramsar or other significant wetlands within the detailed study area. No perennial wetlands are present in the detailed study area.

The target aquifer for the Project is the Grant Group (Figure 3-6). The Grant Group aquifer 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.

Two groundwater springs are present in the reconnaissance study area or wider the desktop search extent. The closest to the detailed study area is Ngooderoodyne Spring located 10 km to the west. Oodinjil Spring is located 46 km to the northwest (Figure 3-6).



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Project No	1453
Date	1/12/2022
Drawn by	BK
Map author	GW

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- Detailed study area
- Reconnaissance study area
- River
- Minor watercourse

Figure 3-5

Surface water values

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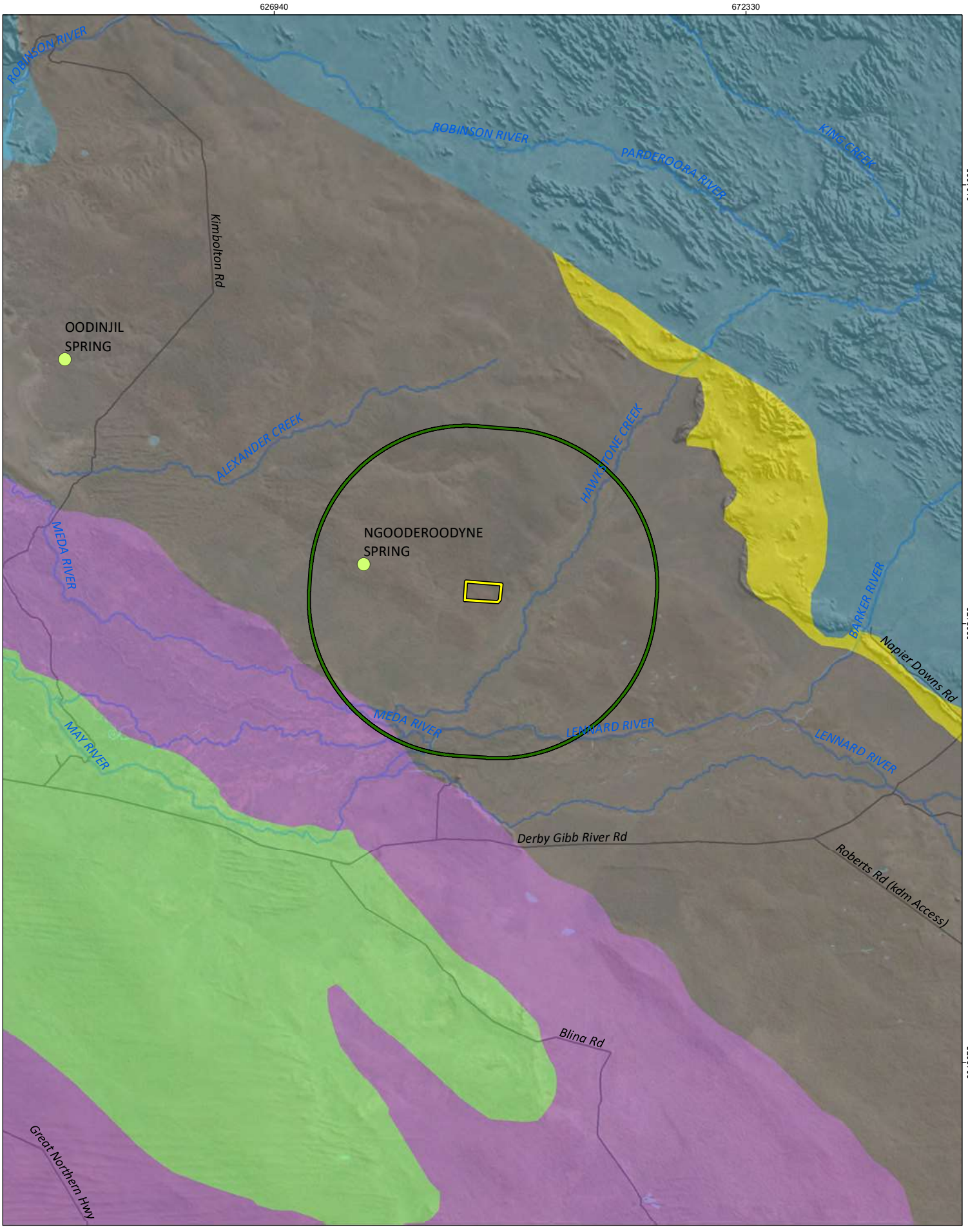

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- Detailed study area
- Reconnaissance study area

WRIMS aquifers

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

- River
- Spring

Figure 3-6

Groundwater values

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4 METHODS

The detailed survey was conducted in accordance with relevant survey guidelines and guidance, including:

- *EPA Environmental Factor Guideline: Flora and vegetation* (EPA 2016a)
- *EPA Technical Guidance: Flora and vegetation surveys for Environmental Impact Assessment* (EPA 2016b).

The results of the previous desktop assessments (Phoenix 2019, 2020) were used to inform this survey. The detailed study area lies reasonably central to the 40 km buffer applied for database searches conducted for the Phoenix (2019) desktop assessment. Accordingly, the results of the database searches were applicable to the detailed study area.

The detailed study area for the field survey differed to that of the Phoenix (2020) desktop assessment, comprising a smaller section of the Option 3 area and slightly offset to the south (Figure 1-1). The desktop assessment from Phoenix (2020) was subsequently updated for the current study area and these are the results presented in this report.

4.1 DESKTOP REVIEW

Database searches and a literature review were undertaken to identify and prepare a list of significant flora and vegetation that may occur within the detailed study area, including:

- Threatened flora and TECs listed as MNES under the EPBC Act
- Threatened flora and TEC listed under the BC Act
- Priority flora and PECs listed by DBCA
- Groundwater dependent ecosystems.

The following database searches were undertaken:

- EPBC Act Protected Matters Search Tool (DoEE 2019b)
- DBCA/WA Museum (WAM) NatureMap database (DBCA 2019a)
- DBCA and WA Herbarium Threatened and Priority Flora database (DBCA 2019b)
- DBCA Threatened and Priority Ecological Communities database (DBCA 2019b)
- Groundwater dependent ecosystem atlas (BoM 2019).

The search extent for the database searches was a centre point for both Option 1 and Option 2 areas with a 40 km buffer. Given the remoteness of the study areas and shift in study area, Florabase (WA Herbarium 1998) was interrogated to determine whether any Threatened flora were recorded for the Fitzroy Trough IBRA subregion, subsequently extending the desktop search area for Threatened flora.

A preliminary assessment of the likelihood of occurrence of each species was undertaken for the significant flora identified in the desktop assessment. Based on habitats likely present in the detailed study area, flowering periods, disturbance within the detailed study area and/or proximity of the closest records, taxa were assigned a rank reflecting their likelihood of occurring.

A review of land systems, soils and vegetation associations was undertaken to define potential vegetation units in the detailed study area. The potential for occurrence of the significant flora and vegetation in the detailed study area identified in the database searches was then assessed. The assessment was based on reviewed information relating to habitat preference (soils, landforms, elevation and vegetation associations) and locality records from the database searches.

The flora assessments assigned each taxon to one of 4 ratings:

- recorded – desktop record of species within detailed study area
- likely – detailed study area within known range of species; suitable habitat likely to be present and/or records within 5 km
- possible – detailed study area within known range of species; potential habitat may be present, no records within 5 km
- unlikely – detailed study area outside known range of species, no records within 5 km and suitable habitat unlikely to be present.

4.2 DETAILED SURVEY

4.2.1 Survey timing

Field survey dates are provided in Table 4-1.

Table 4-1 Survey dates

Survey type	Season	Dates
Flora and vegetation detailed survey, phase 1	Spring	22-27 October 2021
Flora and vegetation detailed survey, phase 2	Autumn	27-31 May 2022
Reconnaissance survey groundwater dependent vegetation	Spring/Autumn	23 October 2021 30 May 2022

4.2.2 Field methods

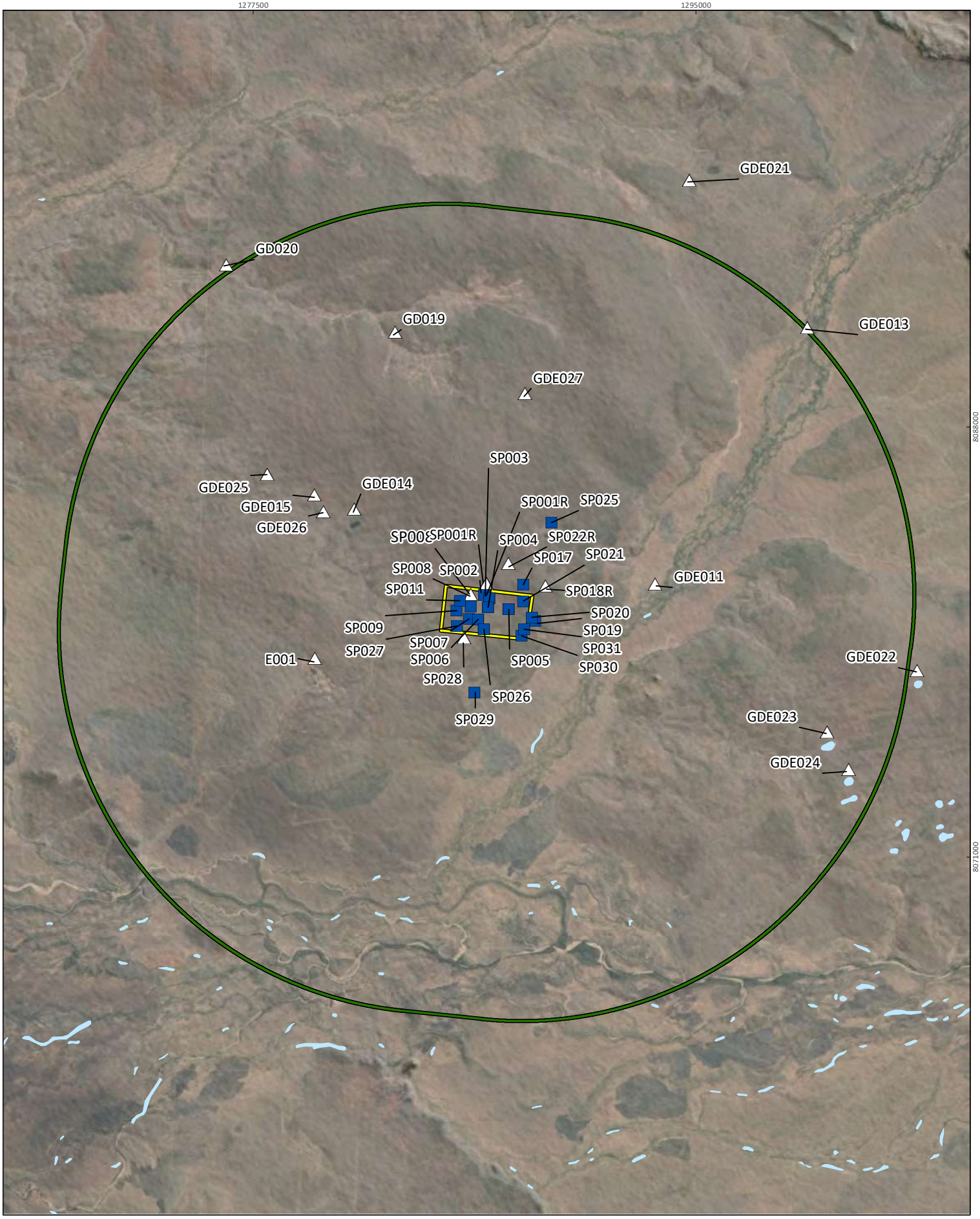
Field methods for the flora and vegetation survey of the detailed study area included:

- surveying of quadrats and relevés (see 4.2.2.1)
- targeted flora searches (4.2.2.2)
- vegetation type and condition mapping (4.2.2.3, 4.2.2.4).

Prior to the commencement of the field survey, data including satellite imagery, survey boundary, and pre-selected vegetation quadrats were loaded onto electronic field devices. The field survey involved assessing and mapping vegetation boundaries, conducting quadrat and relevé sampling and collecting opportunistic flora specimens. GPS locations of vegetation and condition boundaries, survey sites and flora specimen data were recorded digitally.

4.2.2.1 Quadrats and relevés

Quadrat locations were selected to ensure that an accurate representation of the major vegetation types within the detailed study area were sampled adequately. Two methods were used for the selection of quadrat placement within the detailed study area. Preliminary quadrat locations were pre-selected using aerial photography, with selection based on apparent changes in the vegetation visible in the aerial imagery. Final quadrat placement was determined in the field while ground-truthing the detailed study area on foot. Some preliminary quadrats were moved to locations which better represented vegetation types and some quadrats were changed to relevés, where only dominant vegetation was recorded for the purposes of accurate vegetation mapping. In total, 14 quadrats and one relevé were surveyed across the detailed study area (Figure 4-1; Appendix 1).



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Quadrat sampling dimensions were 50 m x 50 m in accordance with EPA guidance for the Northern Botanical Province. The following information was recorded for each quadrat (Appendix 2):

- location – the geographic coordinates of all 4 corners of the quadrat in WGS84 projection
- description of vegetation – a broad description utilising the structural formation and height classes based on National Vegetation Information System (ESCAVI 2003) and in accordance with EPA (2016b) (Appendix 3)
- habitat – a brief description of landform and habitat
- geology – a broad description of surface soil type and rock type
- disturbance history – a description of any observed disturbance including an estimate of time since last fire, weed invasions, soil disturbance, human activity and fauna activity
- vegetation condition – using the condition scale in EPA (2016b) for the Northern Botanical Province
- height and percentage foliage cover (PFC) – a visual estimate of cover of total vegetation cover, cover of shrubs and trees >2 m tall, cover of shrubs <2 m, total grass cover and total herb cover
- photograph – a colour photograph of the vegetation within each quadrat in a south-easterly direction from the north-west corner of the quadrat
- flora species list – comprehensive list of all flora species recorded within the quadrat.

To ensure accurate taxonomic identification of flora species present within the detailed study area, collections were made of each specimen at least once and each collection was pressed and documented for identification using the WA Herbarium resources.

For each species identified, records on FloraBase and the Australasian Virtual Herbarium were consulted to provide information on known ranges to determine whether the detailed study area represented a range extension for the species.

Relevés were sampled within vegetation units where dominant species, soils and topography were representative of vegetation surveyed in quadrats. Information collected in relevés was the same as for quadrats with the exception that:

- only a single geographic coordinate was recorded
- only prominent flora species were recorded.

4.2.2.2 Targeted flora searches

Targeted searches were undertaken for significant flora (Threatened and Priority) identified from the desktop assessment, Declared Pests and WoNS. Following presentation of desktop results to DWER it was advised that an additional 4 significant species be considered to potentially occur in the detailed study area that were also targeted in the searches:

- *Euploca geocharis* (P1)
- *Corchorus fitzroyensis* (P3)
- *Dendrolobium cheelii* (P3)
- *Stylidium costulatum* (P3).

Remnant vegetation was traversed by foot in meandering transects with the searches focused on habitats considered likely to support significant flora, in addition to previously recorded locations of significant plants or populations near the detailed study area.

If a flora species was considered to potentially be a significant species (i.e. similar floristic characteristics and occurring within suitable habitat) the following information was collected:

- GPS coordinates, including population boundary where applicable

- description of the habitat and floristic community in which the potential significant species was located
- population size estimate (i.e. estimated number of individual plants) where applicable
- specimen collection for taxonomic identification and lodgement at the WA Herbarium
- photograph of live plant in situ and description of important details, such as flower colour, height of individual or average height of population.

Following the field survey, the likelihood of occurrence assessment for significant flora identified from the desktop study was reviewed and assigned to one of 4 ratings:

- recorded – species recorded within the detailed study area by previous or current survey
- likely – detailed study area within known range of species; suitable habitat present, records within 5 km, and may not have been detectible during survey (e.g. survey conducted outside flowering period, annual plant survey conducted outside likely period of occurrence, small herbaceous plant in dense vegetation)
- possible – study area within known range of species; potential habitat within the detailed study area and may not have been detectible during survey (e.g. survey conducted outside flowering period, annual plant survey conducted outside likely period of occurrence, small herbaceous plant in dense vegetation), or entire area of habitat not thoroughly searched
- unlikely – detailed study area outside known range of species and/or no suitable habitat present and/or suitable/potential habitat present but detailed study area considered adequately searched for the species.

4.2.2.3 Vegetation type mapping

Vegetation mapping was undertaken at a scale of 1:10,000 using NVIS sub-association level (L5) for structural descriptions (ESCAVI 2003). The vegetation descriptions from quadrats and relevés from the survey were grouped according to similarity of community structure (i.e. canopy levels), species composition and combination of species and the prevalent community structure (i.e. woodland, shrubland, etc.). The vegetation boundaries were mapped utilising ArcGIS ESRI imagery and from vegetation boundaries recorded on GPS during the field survey.

To support delineation of vegetation types, a cluster analysis was conducted based on species presence in each quadrat. The fusion strategy for the site classification was flexible UPGMA with a beta value of -0.1 and Bray Curtis association measure in the software package PATN (Belbin 2003). A dendrogram was produced to illustrate the similarities between the vegetation units identified. Statistically distinct vegetation units (the floristic group) classified the vegetation at a local scale. Local scale vegetation units were described at NVIS Level V – Association (ESCAVI 2003). The term 'vegetation type' was used for local scale vegetation units in accordance with EPA technical guidance (EPA 2016b).

4.2.2.4 Vegetation condition mapping

The condition of vegetation was mapped across the detailed study area based on the appropriate condition scale for the Northern Botanical Province (Trudgen 1988 in EPA 2016b) (Table 4-2). The vegetation condition ratings relate to vegetation structure, the level of disturbance and weed cover at each structural layer and the ability of the vegetation unit to regenerate. Vegetation condition ranges from Excellent being the highest rating to Completely Degraded as the lowest.

Table 4-2 Vegetation condition rating scale (EPA 2016b)

Condition rating	Description
Excellent	Pristine or nearly so, no obvious signs of damage caused by human activities since European settlement.
Very Good	Some relatively slight signs of damage caused by human activities since European settlement. For example, some signs of damage to tree trunks caused by repeated fire, the presence of some relatively non-aggressive weeds, or occasional vehicle tracks.
Good	More obvious signs of damage caused by human activity since European settlement, including some obvious impact on the vegetation structure such as that caused by low levels of grazing or slightly aggressive weeds.
Poor	Still retains basic vegetation structure or ability to regenerate it after very obvious impacts of human activities since European settlement, such as grazing, partial clearing, frequent fires or aggressive weeds.
Degraded	Severely impacted by grazing, very frequent fires, clearing or a combination of these activities. Scope for some regeneration but not to a state approaching good condition without intensive management. Usually with a number of weed species present including very aggressive species.
Completely Degraded	Areas that are completely or almost completely without native species in the structure of their vegetation; i.e. areas that are cleared or 'parkland cleared' with their flora comprising weed or crop species with isolated native trees or shrubs.

4.2.3 Analysis of survey completeness

A species accumulation curve based on accumulated species versus number of sites surveyed was used to evaluate the level of adequacy of the survey effort. The species accumulation curve was generated by inputting the site-species matrix into Phoenix's proprietary spreadsheet.

4.3 RECONNAISSANCE SURVEY

The reconnaissance survey for GDV indicator species involved flying by helicopter to preselected areas representing riverbanks, creeks and waterholes apparent from aerial imagery. In addition, several small lakes known to the local pilot were visited. At each location the following was conducted:

- targeted searches for indicator species (Table 4-3)
- collection of specimens of indicator species
- relevé surveys to describe vegetation.

A total of 14 relevés were sampled in the reconnaissance study area (Appendix 1).

Table 4-3 GDV indicator species provided by Robyn Loomes of DWER

Form	Species	Comments
Tree	*Barringtonia acutangula*	Tolerates seasonal inundation
	Melaleuca argentea	Tolerates seasonal inundation
	Melaleuca leucadendra	
	Eucalyptus camaldulensis	Tolerates seasonal inundation
	Eucalyptus microtheca	
	Lophostemon grandiflorus	Tolerates seasonal inundation, water level range -2.18 to -3.87 mbgl
	Terminalia platyphylla	
	Melaleuca viridiflora	
	Corymbia bella	Fringing species, water level range -1.47 to -2.76 mbgl
	Melaleuca alsophila (Salt water paperbark)	Tolerates inundation, water level range -1.03 to -2.45 mbgl
Shrub	*Pandanus spirialis*	Tolerates seasonal inundation, water level range -1.00 to -2.49 mbgl
	Pandanus aquaticus	
	Flugge virosa	
	Diospyros humilis	water level range -3.11 to -3.61 mbgl
	Grewia brevifolia	
	Planchonia careya	
Rush/sedge	*Typha domingensis*	Tolerates inundation
	Schoenoplectus subulatus	Tolerates seasonal inundation
Aquatic	*Nymphaea violacea*	
	Nymphoidies beaglensis	

4.4 SURVEY PERSONNEL

The personnel involved in the surveys are listed in Table 4-4. All survey work was carried out under relevant licences issued by DBCA under the BC Act (Table 4-4).

Table 4-4 Survey personnel

Name	Permit	Qualifications	Role/s
Dr Grant Wells	FB2000227	PhD (Botany)	Project manager, fieldwork, taxonomy, reporting
Dr David Leach	NA	PhD (Plant Biology), BAppSci (Hons) (Conservation and Park Management)	Data analysis
Dr Andrew Perkins	NA	BSc. (Hons) (Biological Sciences); PhD (Botany)	Taxonomy
Calum Woods	NA	BSc (Wildlife & Conservation Biology); Ma (Conservation Biology)	Mapping, Data management and analysis
Martin Henson	FB62000110	BEnvSci (Hons)	Fieldwork, logistics
Tim Morald	FB62000317	BSc (Applied Science)	Fieldwork, logistics, taxonomy
Brigitte Kovar	NA	BSc (Ex. Sci.)	GIS spatial data, figure production

5 RESULTS

5.1 DESKTOP REVIEW

5.1.1 Flora assemblage

The NatureMap search (DBCA 2018) *s*howed a total of 910 species recorded in the vicinity of the detailed study area, 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 were the Malvaceae (38), Myrtaceae (15) and Amaranthaceae (15).

5.1.2 Significant flora

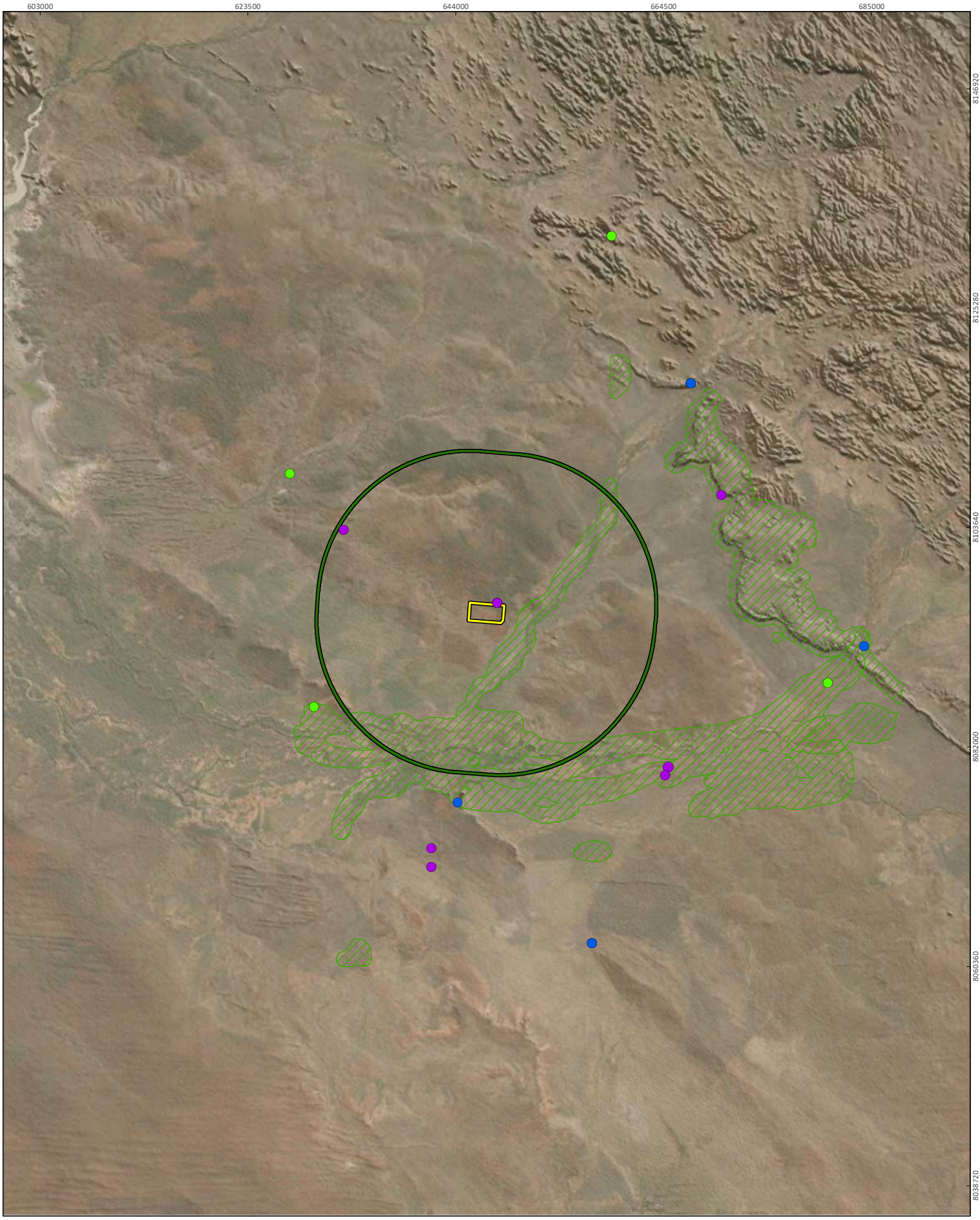
The search of Florabase (WA Herbarium 1998) determined that there were no Threatened flora recorded for the Fitzroy Trough IBRA subregion. Twelve significant flora species were identified in the database searches. In addition, the 4 species recommended for survey by DWER were included making a total of 16 considered in the assessment, all Priority flora (Table 5-1; Figure 5-1). One very old record (1967) of *Stylidium pindanicum* (P3) occurred in close proximity (~250 m) to the detailed study area and it was therefore considered likely to occur (Figure 5-1). Of the remaining species, 8 were assessed as possibly occurring in the detailed study area, and 7 as unlikely (Table 5-1).

Table 5-1 Significant flora identified in the desktop assessment

Species	Cons. status	Nearest record to detailed study area	Description and habitat (WA Herbarium 1998)	LOO[1] in detailed study area	Criteria
Acacia monticola x *tumida* var. *kulparn*	P3	22.7 km S	Shrub to 2 m, grey bark fissured to reveal reddish stems. Coastal cliffs and dunes, sand in shrubland over grassland	Possible	Closest record 22.7 km S of detailed study area. Habitat appears suitable
Alysicarpus suffructicosus	P2	21.1 km NW	Erect compact shrub to 0.3 m. Sandy clay, creek crossing.	Unlikely	Closest record 21.1 km NE of detailed study area. Habitat not suitable.
Blumea pungens	P2	32.6 km E	Erect herb 0.6-1.5 m. Riverine, hillslopes, gorges. Sand over sandstone.	Unlikely	Closest record 32.6 km E of detailed study area. Habitat not suitable.
Clerodendrum inerme	P1	18.0 km S	Erect dense tree or multi-stemmed shrub to 4m. Coastal swales, cleft sandstone rocks, grey loam on hillslope.	Unlikely	Closest record 18.0 km SW of detailed study area. Habitat not suitable.
Corchorus fitzroyensis	P3	NA	Low sprawling rounded subshrub, 0.3 m tall by 0.5 m wide. Open woodland of *Corymbia* and *Eucalyptus* over open to dense grassland, tree savanna on alluvial and colluvial flats, floodplains and riverine woodlands in sandy, sandy clay, clay loam soils.	Possible	Habitat appears suitable.
Decaisnina biangulata	P3	24.0 km ENE	Hemiparasitic aerial shrub on *Lophostemon*, *Syzygium*, *Tristania*, *Terminalia*.	Possible	Closest record 24.0 km NW of detailed study area. Habitat appears suitable.
Dendrolobium cheelii	P3	NA	Erect, multi-stemmed shrub 0.15-0.6 m high. In *Eucalyptus* and *Terminalia* open woodland in grey-brown clay-loam. On top of waterfall above creek. Open forest of *Eucalyptus* spp. in deep red clay on edge of swamp and in open woodland in loam.	Possible	Habitat appears suitable.
Euploca aenigmata (formerly *Heliotropium aenigmatum*)	P1	35.7 km E	Ascending or spreading herb 0.15-0.6 m. sandy drainage course off sandstone rubble, Barker River, Artesian range.	Unlikely	Closest record 35.7 km NE of detailed study area. Habitat not suitable.

Species	Cons. status	Nearest record to detailed study area	Description and habitat (WA Herbarium 1998)	LOO[1] in detailed study area	Criteria
Euploca geocharis	P1	NA	Erect open shrub to 40 cm tall. Very open woodland with *Sehima nervosum*, *Petalostigma pubescens*, *Aristida ?inaequiglumis*, *Bauhinia cunninghamii*, *Vachellia suberosa*, and *Dichanthium sericeum* subsp. *polystachyum* on a flat in grey clay. Open tussock grassland. River frontage, black alluvial soil.	Unlikely	Habitat (soil types) not suitable.
Euploca parviantrum (formerly *Heliotropium parviantrum*)	P1	32.8 km SSE	Erect annual, herb, to 0.15 m high. Flats, plains, rocky slopes. Sandy soils.	Possible	Closest record 32.8 km ENE of detailed study area. Habitat appears suitable.
Gomphrena cucullata	P3	21.8 km SE	Spreading or erect annual herb to 0.25 m. Open floodplains. Red sandy loam, clayey sand.	Possible	Closest record 21.8 km SE of detailed study area. Habitat appears suitable.
Ipomoea johnsoniana	P1	28.6 km NE	Dense shrub to 1 m, twining stems. Known only from a single location on sandy flats on top of a Devonian limestone range.	Unlikely	Closest record 28.6 km NE of detailed study area. Habitat not suitable.
Schoenoplectiella humillima	P2	17.4 km WSW	Sedge to 5 cm. Seepages, pools, red-brown clay.	Possible	Closest record 17.4 km SW of detailed study area. Habitat appears suitable.
Stylidium costulatum	P3	NA	Erect tufted annual herb to 0.1-0.2 m tall. Open *Eucalyptus* and *Corymbia* woodlands and pindan vegetation frequently in riparian vegetation and seasonally wet areas in sand, clayey-sand soils	Possible	Habitat appears suitable.
Stylidium pindanicum	P3	238 m N	Annual herb to 30 cm, leaves basally rosetted. Damp, sandy soils, clay flats.	Likely	Record in close proximity to detailed study area. Habitat appears suitable.
Tephrosia rosea var. Napier Range (C.R. Dunlop 7760 & B.K. Simon)	P3	14.4 km WNW	Silver leafed perennial herb to 0.5 m. Valley floors, skeletal soils.	Unlikely	Closest record 14.4 km NW of detailed study area. Habitat unsuitable.

[1] Likelihood of occurrence.



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Detailed study area

Reconnaissance study area

TEC/PEC

Status

P1

P2

P3

Figure 5-1

Desktop records of significant flora and vegetation

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5.1.3 Introduced flora

The desktop review identified records of 18 introduced species within the desktop search extent. None of these are a Declared Pest or WoNS (Table 5-2).

Table 5-2 Desktop records of significant weeds

Family	Species	WoNS	Declared Pest
Asteraceae	**Bidens pilosa* var. *pilosa*	N	N
Poaceae	**Cenchrus ciliaris*	N	N
Poaceae	**Cenchrus echinatus*	N	N
Poaceae	**Cynodon 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

5.1.4 Vegetation associations

Regional scale vegetation mapping by Shepherd *et al.* (2002) mapped a single vegetation association in the entirety of the detailed study area (Figure 5-1), association 754, Fitzroy Sandplains. Association 754 has 100% or nearly so of its pre-European extent remaining and is classified as of Least Concern (Table 5-3). The vegetation association is not well represented in DBCA managed lands.

Table 5-3 State-wide extent of Pre-European vegetation associations present in the detailed study area (Government of Western Australia 2019)

Assoc.	Description	Bioregion	Bioregion	Bioregion	Current DBCA managed lands (ha)	Status	Area (ha)
		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*	195,333.2	195,333.2	100	172.3	Least concern	586.5

644000

Vegetation association

- 60: Grasslands, tall bunch grass savanna woodland, grey box & cabbage gum over ribbon grass
- 61: Grasslands, tall bunch grass savanna woodland, coolabah over ribbon grass (Crysopogon spp.)
- 64: Grasslands, tall bunch grass savanna low tree; baobabs (Adansonia gregorii) , bauhinia & beefwood (Grevillea striata over ribbon grass)
- 706: Grasslands, tall bunch grass savanna, mitchell & ribbon/blue grass
- 726: Grasslands, tall bunch grass savanna low tree; baobabs, bauhinia & beefwood over mitchell & ribbon/blue grass on black soil
- 737: Shrublands, pindan; Acacia tumida shrubland with scattered low bloodwood & Eucalyptus setosa over curly spinifex
- 743: Grasslands, tall bunch grass savanna sparse low tree; Acacia suberosa & bauhinia over ribbon/blue grass on black soil
- 754: Shrublands, pindan; Acacia tumida shrubland with woolybutt (Eucalyptus miniata) & cabbage gum (E. grandiflora) medium woodland over ribbon grass & curly spinifex (Triodia pungens)
- 755: Shrublands, pindan; Acacia tumida & A. oimpressa shrubland with scattered low bloodwood & Eucalyptus setosa over ribbon & curly spinifex
- 757: Shrublands, pindan; Acacia tumida & A. oimpressa shrubland with scattered low bloodwood & Eucalyptus setosa over ribbon & curly spinifex
- 759: Grasslands, tall bunch grass savanna woodland, coolabah over ribbon/blue grass (Botriochloa spp.)
- 840: Grasslands, tall bunch grass savanna, ribbon/blue grass

8103640

8082000

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Detailed study area

Reconnaissance study area

Figure 5-2

Vegetation associations of the study area

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5.1.5 Significant vegetation

A total of 6 PECs occur within the desktop search extent (Figure 5-1; Table 5-4). The closest buffer zone, of the Kimberley Vegetation Association 759 PEC, occurs approximately 1.3 km to the east of the detailed study area, within the reconnaissance study area. The PEC is associated with the riparian and floodplain zones of the Lennard River and Hawkstone Creek. The detailed study area does not intersect the buffer zones of the PECs.

Table 5-4 Threatened and Priority Ecological Communities within the desktop search extent

Community ID	Community name	Cons. status	Buffer (km)	Proximity to detailed study area
Gogo Land System	Gogo Land System	Priority 3	0.5	25 km south
Leopold Land System	Leopold Land System	Priority 3	0.5	30.5 km south-east
Napier Range	Monsoon vine thickets and Camaenid land snails of limestone ranges (Napier Range)	Priority 1	0.5	21.7 km east
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
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
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

5.2 FIELD SURVEY

5.2.1 Flora assemblage

A total of 104 flora taxa representing 40 families and 78 genera identified to species level were recorded in the detailed study area (Appendix 4). Within the detailed study area, species richness ranged from 19 - 36 species between quadrats (Appendix 5). No introduced species were recorded, and the assemblage included 76 perennial species, and 28 annual or short-lived species. The most prominent families recorded were Fabaceae (15 spp.), Myrtaceae (10 spp.), Poaceae (9 spp.) and Malvaceae (8 spp.). A species accumulation curve by sites confirms that the survey adequately captured the flora richness of the detailed study area at the time the survey was conducted (Figure 5-3).

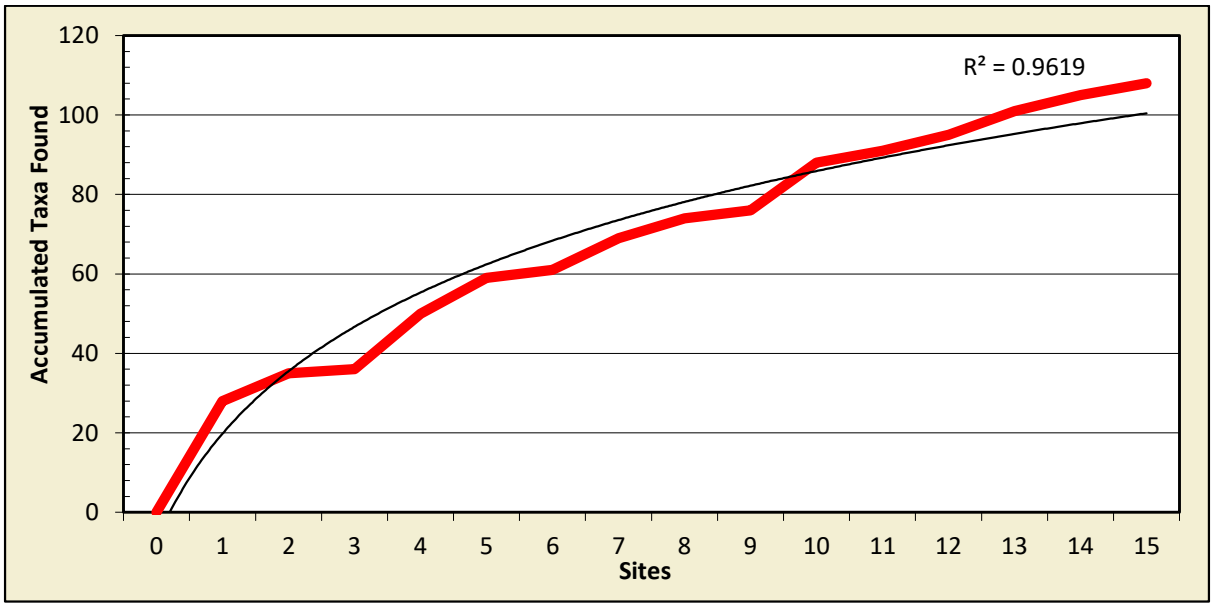


Figure 5-3 Species accumulation curve of sites surveyed for the detailed survey

A total of 67 flora taxa representing 31 families and 55 genera were identified to species level from the reconnaissance survey for GDV indicator species (Appendix 6). Of these, 38.8% had also been recorded during the detailed flora and vegetation survey. The most prominent families recorded were Myrtaceae (9 spp.), Fabaceae (8 spp.), Poaceae (8 spp.) and Cyperaceae (7 spp.).

5.2.2 Significant flora

No Threatened flora were recorded during the field survey. Two Priority flora, *Lophostemon grandiflorus* subsp. *grandiflorus* (P3) and *Goodenia sepalosa* var. *glandulosa* (P3) were recorded (Table 5-5; Figure 5-4).

The records of *Lophostemon grandiflorus* subsp. *grandiflorus* (P3) represent an infill of the known distribution of this species. The species was also recorded at 7 further locations during the GDV reconnaissance survey associated with riparian vegetation surrounding small lakes and in vegetation in seasonally wet depressions.

A significant (212.6 km south-west) range extension was recorded for *Phyllanthus* sp. B Kimberley Flora (T.E.H. Aplin et al. 809) (Figure 5-4) and therefore this record is considered significant for the species (refer to section 2.2.4).

A specimen of all significant flora was lodged with the WA Herbarium and a Threatened and Priority flora report form submitted to DBCA (WA Herb accession number 9729).

The likelihood of occurrence assessment (section 4.2.2.2) for the remaining significant species identified in the desktop review, did not change from the initial assessment (section 0), with one species considered likely to occur and 8 as possibly occurring (Table 5-6). Given that 2 significant flora were recorded in the detailed study area that were not identified in the desktop assessment, all species for which suitable habitat occurred in the detailed study area were considered to possibly or likely occur despite the majority of records occurring further than 5 km from the detailed study area. Seven species were considered unlikely to occur based on a lack of suitable habitat.

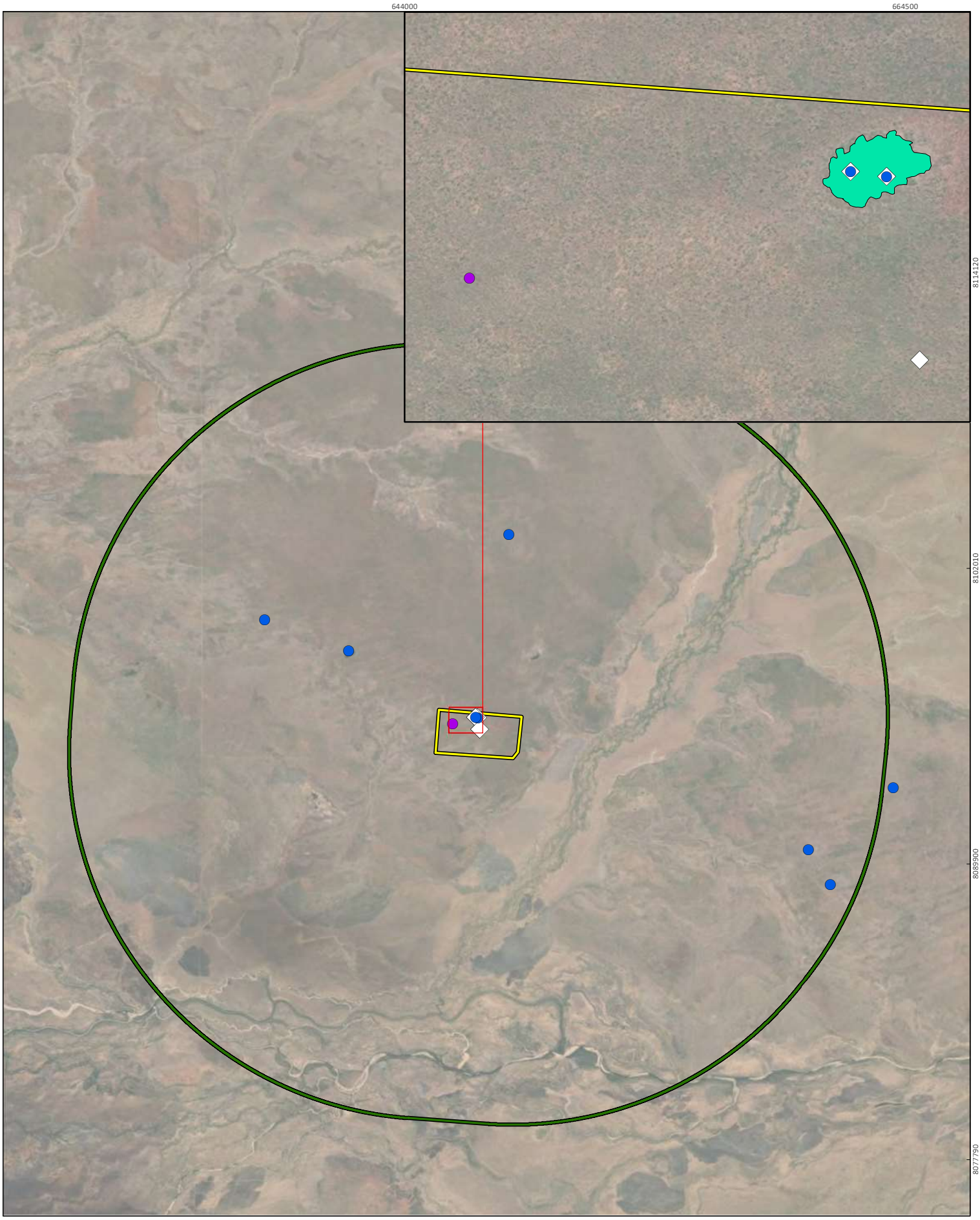
Table 5-5 Details of significant flora recorded during the field survey

Species	Status	Distribution and ecology	Survey records	Photograph
Lophostemon grandiflorus subsp. *grandiflorus*	P3	Occurs in the Dampierland and Victoria Bonaparte bioregions (WA Herbarium 1998). There are 10 records of this species in WA Herbarium (1998) Habitat descriptions include semi-deciduous vine thicket in a drainage basin in grey brown sand, *Melaleuca dealbata*, *Lophostemon grandiflorus* subsp. *grandiflorus* low woodland over *Acacia colei* var. *colei*, *Tephrosia rosea* var. *clementii* shrubland over *Abutilon otocarpum* low open shrubland in a drainage basin in salmon coloured sandy loam, coastal vine thicket, large *Melaleuca* and *Grewia* vine thicket in low area behind coastal dunes, on swamp, wet seepage area. Population sizes for the Florabase records are limited to a single cultivated tree, and a comment that the *Lophostemon* was dominant in a vine thicket.	The species was recorded at a single location in the detailed study area where it was a dominant overstorey species in a tall shrubland that surrounded a seasonally wet depression. Also recorded at 7 locations in the reconnaissance study area.	

Species	Status	Distribution and ecology	Survey records	Photograph
				

Species	Status	Distribution and ecology	Survey records	Photograph
Goodenia sepalosa var. *glandulosa*	P3	Occurs in the Dampierland, Northern Kimberley and Victoria Bonaparte bioregions (WA Herbarium 1998). There are 15 records of this species in WA Herbarium (1998). Habitat descriptions include herb/sedge land in damp sandy loam along edge of minor drainage channel, *Corymbia* woodland over tall *Acacia* shrubland on the crest of a rise in brown loam, *Corymbia* woodland over tall *Acacia* shrubland on a plain in reddish brown sandy loam, Pindan woodland mid slope in red sand. Population sizes recorded were limited to single plants, records of less than 1% cover and a comment of being uncommon.	The species was recorded at a single quadrat site in the detailed study area where it was present in low numbers under isolated *Corymbia* trees over a tall shrubland of *Acacia tumida* var. *tumida*, *Petalostigma pubescens* and *Grevillea refracta* subsp. *refracta*.	
Phyllanthus sp. B Kimberley Flora (T.E.H. Aplin et al. 809)	RE* (327.7 km south-west)	Currently only recorded in the Northern Kimberley bioregion (WA Herbarium 1998). There is only one confirmed record of this species in WA Herbarium (1998), though an unconfirmed record is present 212.6 km north-west. The habitat description lists *Eucalyptus miniata* and *E. tetrodonta* woodland; however, the unconfirmed record lists vegetation associated with at least seasonally wet soil.	The species was recorded in 3 quadrats of the detailed survey, 2 of which were associated with a seasonally wet depression and the third with *Eucalyptus miniata* woodland.	

*Range extension.



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Map author	GW

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Detailed study area
Reconnaissance study area

Priority flora

Lophostemon grandiflorus subsp. *grandiflorus* population boundary

Name, status

Goodenia sepalosa var. glandulosa, P3 (DBCA list)
Lophostemon grandiflorus subsp. grandiflorus, P3 (DBCA list)

Range extension species

Phyllanthus sp. B Kimberley flora

Figure 5-4

Significant flora records from the field survey

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Table 5-6 Likelihood of occurrence for significant flora identified in the desktop review

Species	Status	Likelihood of occurrence in detailed study area	Vegetation types for recorded, likely, possible species
Acacia monticola x *tumida* var. *kulparn*	P3	Possible, suitable habitat present	AttSs
Alysicarpus suffructicosus	P2	Unlikely, lack of suitable habitat	
Blumea pungens	P2	Unlikely, lack of suitable habitat	
Clerodendrum inerme	P1	Unlikely, lack of suitable habitat	
Corchorus fitzroyensis	P3	Possible, suitable habitat present	AttSs, EmDhaSs
Decaisnina biangulata	P3	Possible, suitable host species recorded in detailed study area, not all of the study area could be searched	AttSs, EmDhaSs, MccLggCr, MvPsp.
Dendrolobium cheelii	P3	Possible, suitable habitat present	AttSs, EmDhaSs
Euploca aenigmata (formerly *Heliotropium aenigmatum*)	P1	Unlikely, lack of suitable habitat	
Euploca geocharis	P1	Unlikely, lack of suitable habitat	
Euploca parviantrum (formerly *Heliotropium parviantrum*)	P1	Possible, suitable habitat present	AttSs, EmDhaSs
Gomphrena cucullata	P3	Possible, suitable habitat present	EmDhaSs
Ipomoea johnsoniana	P1	Possible, suitable habitat present	AttSs, EmDhaSs
Schoenoplectiella humillima	P2	Possible, suitable habitat present	MccLggCr, McPsp.
Stylidium costulatum	P3	Possible, suitable habitat present	MccLggCr, McPsp.
Stylidium pindanicum	P3	Likely, suitable habitat present, records in very close proximity to detailed study area	AttSs, MccLggCr, Mvsp.
Tephrosia rosea var. Napier Range (C.R. Dunlop 7760 & B.K. Simon)	P3	Unlikely, lack of suitable habitat	

5.2.3 Introduced flora

No introduced flora species were recorded during the survey.

5.2.4 Unidentified flora

Two specimens collected during the detailed survey and 3 specimens collected during the reconnaissance survey could not be identified to species level (Table 5-7), all as a result of insufficient taxonomic characters, as plants were sterile (lacking reproductive structures) or reproductive structures were too old/dry or damaged to be useful. None of the specimens are considered to represent any significant species identified in the desktop assessment.

Table 5-7 Unidentified taxa recorded during the field survey

Taxon	Comments	Survey
Euphorbia sp.	Insufficient taxonomic characters due to sterility	Detailed
Terminalia sp.	Insufficient taxonomic characters due to sterility	Detailed
Eleocharis sp.	Insufficient taxonomic characters due to sterility, may represent *Eleocharis dulcis*	Reconnaissance
Fimbristylis ?*microcarya*	Insufficient taxonomic characters as the reproductive characters were not intact, however likely represents *Fimbristylis microcarya*	Reconnaissance
Synostemon sp.	Insufficient taxonomic characters due to sterility	Reconnaissance

5.2.5 GDV indicator species

At least one of the GDV indicator species (Table 4-3) was recorded at each of the sites in the reconnaissance survey (Table 5-8; Appendix 2). In addition, species closely related to GDV indicator species, i.e. *Nymphoides quadriloba*, *N. indica* (*N. beaglensis*) and *Melaleuca cajuputi* subsp. *cajuputi* (*M. viridiflora*), were also recorded.

The sites included seasonally wet depressions, small lakes and riparian vegetation of 2 creek systems including Hawkstone Creek (Figure 4-1). Riparian vegetation of the creek systems comprised mid *Eucalyptus camaldulensis* subsp. *obtusa* and/or *Corymbia* spp. woodlands over tall mixed open shrublands frequently with *Acacia* and *Melaleuca* spp. over mixed grasses and sedges (Appendix 2). Vegetation of the seasonally wet depressions and riparian vegetation of the lakes comprised tall shrublands of *Melaleuca* spp. and *Lophostemon grandiflorus* subsp. *grandiflorus* occasionally with isolated mid *Corymbia* spp. over mixed grasses and sedges.

Table 5-8 GDV indicator species recorded at the reconnaissance survey sites

Site code	Species
GD018	*Typha domingensis*
GD019	*Melaleuca viridiflora*
GD020	*Eucalyptus camaldulensis* subsp. *obtusa* *Pandanus spiralis*
GDE011	*Eucalyptus camaldulensis* subsp. *obtusa* *Planchonia careya*
GDE013	*Eucalyptus camaldulensis* subsp. *obtusa* *Terminalia platyphylla* *Lophostemon grandiflorus* subsp. *riparius*
GDE014	*Lophostemon grandiflorus* subsp. *grandiflorus*
GDE015	*Melaleuca viridiflora* *Nymphoides quadriloba*
GDE021	*Lophostemon grandiflorus* subsp. *grandiflorus* *Nymphoides quadriloba* *Nymphoides indica*
GDE022	*Lophostemon grandiflorus* subsp. *grandiflorus*
GDE023	*Lophostemon grandiflorus* subsp. *grandiflorus* *Melaleuca cajuputi* subsp. *cajuputi* *Nymphoides quadriloba*
GDE024	*Lophostemon grandiflorus* subsp. *grandiflorus* *Melaleuca cajuputi* subsp. *cajuputi* *Nymphoides quadriloba*
GDE025	*Lophostemon grandiflorus* subsp. *grandiflorus* *Melaleuca cajuputi* subsp. *cajuputi*
GDE026	*Melaleuca viridiflora*
GDE027	*Lophostemon grandiflorus* subsp. *grandiflorus* *Melaleuca cajuputi* subsp. *cajuputi* *Nymphoides indica*

5.2.6 Vegetation types

A total of 4 vegetation types were defined for the study area based on the dendrogram (Figure 5-5). They comprised *Melaleuca* woodlands over mixed herbs and grasses, tall *Acacia tumida* var. *tumida* mixed shrubland over *Sorghum* and *Chrysopogon* tussock grassland, and low open *Eucalyptus* woodland over open mixed shrublands and mixed tussock grasses (Table 5-9; Figure 5-6). Vegetation units MvPsp. and MccLggCr represent restricted vegetation types given the confined distribution to a small soak in the northern section of the detailed study area (Table 5-9; Figure 5-6).

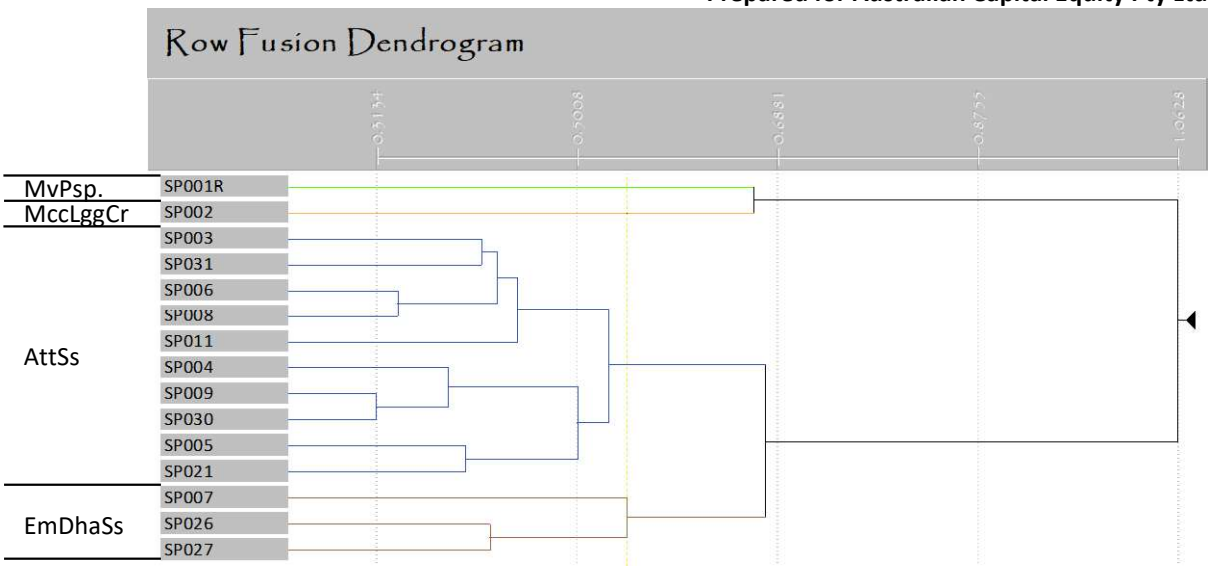

Figure 5-5 Hierarchical clustering (UPGMA) of the flora quadrats of the detailed study area

Table 5-9 Vegetation types, description and extent in the detailed study area

Vegetation type	Site/s	Vegetation description	Extent in detailed study area (ha) and %	Representative photograph
AttSs	SP003, SP004, SP005, SP006, SP008, SP009, SP011, SP021, SP030, SP031	Isolated trees of *Eucalyptus miniata* and *Corymbia greeniana* over a tall shrubland of *Acacia tumida* var. *tumida*, *Grevillea refracta* subsp. *refracta* and *Petalostigma pubescens* over a tall open tussock grassland of *Sorghum stipoideum* and *Chrysopogon latifolius*.	514.2 (87.6%)	
EmDhaSs	SP007, SP026, SP027	Mid to low open woodland of *Eucalyptus miniata*, *Terminalia canescens* and *Corymbia* spp. over a tall open shrubland of *Dodonaea hispidula* var. *arida*, *Petalostigma pubescens* and *Grevillea refracta* subsp. *refracta* over a mixed open tussock grassland of *Sorghum stipoideum*, *Triodia caelestialis* and *Chrysopogon fallax*.	66.2 (11.3%)	

Vegetation type	Site/s	Vegetation description	Extent in detailed study area (ha) and %	Representative photograph
MccLggCr	SP002	Mid open woodland of *Melaleuca cajuputi* subsp. *cajuputi* and *Eucalyptus tectifica* over a low open forest of *Lophostemon grandiflorus* subsp. *grandiflorus* over a low mixed forbland of *Crotalaria ramosissima*, *Indigofera hirsuta* and *Eriocaulon cinereum* with mixed grasses.	3.5 (0.6%)	
MvPsp.	SP001R	Low open forest of resprouting *Melaleuca viridiflora* and *Lophostemon grandiflorus* subsp. *grandiflorus* over low, mixed isolated forbs and grasses including *Phyllanthus* sp. B Kimberley Flora (T.E.G. Aplin et al. 809), *Stemodia lathraia* and *Aristida hygrometrica*.	0.9 (0.2%)	
Cleared	NA	Areas devoid of vegetation	1.7 (0.3%)	NA

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- Detailed study area
- Reconnaissance study area

Vegetation type

- AttSs
- Cleared
- EmDhaSs
- MccLggCr
- MvPsp.

Figure 5-6

Vegetation types recorded in the detailed study area

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5.2.7 Vegetation condition

Remnant vegetation in the detailed study area was recorded to be in Very Good to Excellent condition (Figure 5-7) with the majority (99.1%) in Excellent condition (Table 5-10). MccLggCr was the only vegetation unit to record a condition rating other than Excellent, due to the presence of livestock tracks and evidence of grazing (Table 5-10).

Table 5-10 Vegetation condition – extent of each condition rating in detailed study area

Condition rating	Area (ha)	% of detailed study area	Vegetation types
Excellent	581.3	99.1	AttSs, EmDhaSs, MvPsp.
Very Good	3.5	0.6	MccLggCr
Good	-	-	-
Poor	-	-	-
Degraded	-	-	-
Completely Degraded	-	-	-
Cleared	1.7	0.3	-

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Detailed study area
Reconnaissance study area

Vegetation condition

Excellent
Very good
Completely degraded

Figure 5-7

Vegetation condition in the study area

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5.2.8 Significant vegetation

No TEC or PEC are present in the detailed study area. In total, 3 vegetation types were considered to have local significance (Table 5-11). MccLggCr and MvPsp. represent restricted vegetation communities (3.5 and 0.9 ha, respectively) that occur within a small soak to the north of the detailed study area. Both vegetation types also are confirmed habitat for *Lophostemon grandiflorus* subsp. *grandiflorus* (P3; Figure 5-6). AttSs, while widespread in the detailed study area, is considered locally significant as confirmed habitat for *Goodenia sepalosa* var. *glandulosa* (P3).

Table 5-11 Significant vegetation types in the detailed study area

Vegetation type	Significance	Level of significance
AttSs	Represents habitat for the Priority flora *Goodenia sepalosa* var. *glandulosa* (P3)	Locally significant
MccLggCr	Represents both a restricted vegetation community and habitat for the Priority flora *Lophostemon grandiflorus* subsp. *grandiflorus* (P3)	Locally significant
MvPsp.	Represents both a restricted vegetation community and habitat for the Priority flora *Lophostemon grandiflorus* subsp. *grandiflorus* (P3)	Locally significant

5.3 SURVEY LIMITATIONS

The limitations of the flora and vegetation survey have been considered in accordance with EPA (2016b, c) (Table 5-12).

Table 5-12 Consideration of potential survey limitations

Limitations	Comments
Availability of contextual information at a regional and local scale	Limited contextual information was available at both the regional and local scale.
Competency/experience of the team carrying out the survey	Field surveys were led by botanists both with over 20 years' experience conducting surveys in Western Australia and both have conducted numerous surveys in the Kimberley bioregion.
Scope and completeness	The intensity of the survey was sufficient for a detailed survey of the study area and the reconnaissance survey attained the objective of identifying GDV indicator species at regional water bodies.
Proportion of flora recorded and/or collected, any identification issues	The species accumulation curve has determined that a high proportion of the flora was recorded and there were only a few specimens that could not be identified to species level, none of which resembled potentially significant flora.
Access within the study area	There was limited vehicle access within the study area necessitating accessing survey locations on foot. High plant density, particularly dense stands of *Sorghum* grasses restricted capacity to conduct targeted searches. Access to the reconnaissance survey sites was by helicopter facilitating survey at a sufficient number of sites and different water bodies to determine the presence of GDV indicator species. Access to some areas, e.g., Lennard river

Limitations	Comments
	was restricted as neighbouring pastoralists were mustering at the time of the surveys.
Timing, rainfall, season	Both surveys were conducted in the supplementary survey period for the Northern botanical province, no survey was conducted during the Primary survey period (January to March) as the study area is not accessible at this time due to flooded creeks and high likelihood of vehicle bogging. The second survey was conducted in May following high rainfall some months earlier and was conducted at the earliest opportunity when the study area was accessible by vehicle.
Disturbance that may have affected the results of the survey	There was no disturbance that would have affected the results of the survey.

6 DISCUSSION

6.1 FLORA ASSEMBLAGE

The number of taxa recorded for the detailed study area represented a small proportion (11.5%) of the recorded flora identified in the desktop assessment to occur in the vicinity. This reflects the substantially larger area of the desktop assessment and the fact that the detailed study area was predominantly covered by just 2 vegetation types.

The flora assemblage in the detailed study area was representative of that determined in the desktop assessment with the Poaceae, Fabaceae, Myrtaceae and Malvaceae prominent in both instances.

6.2 SIGNIFICANT FLORA

A total of 8 new populations for *Lophostemon grandiflorus* subsp. *grandiflorus* were recorded during the surveys including one large population in the detailed study area. These populations represent the first records of the species for the Fitzroy Trough subregion. The ten records for the species on FloraBase (WA Herbarium 1998) represent 6 populations and subsequently the 8 new populations recorded during the surveys represent more than half of the known populations of the species. There are no records of the species in the conservation estate.

The records from the field survey indicate that *Lophostemon grandiflorus* subsp. *grandiflorus* is relatively abundant in the area and it is likely there are further populations of the species in the broader vicinity of the detailed study area. Previous records (WA Herbarium 1998) and all those recorded in the current survey have been associated with drainage basins and swamps.

Goodenia sepalosa var. *glandulosa* has previously been recorded in the Fitzroy Trough subregion and in similar habitat, Pindan vegetation. The 15 records for the species on Florabase (WA Herbarium 1998) each represent a different population and subsequently the current record increases the known populations to 16. There are 2 records of the species in the Yampi Private Nature Reserve.

Records of *Goodenia sepalosa* var. *glandulosa* (WA Herbarium 1998) indicate typically small populations. As the identity of the species in the current survey was determined post-field, the number of individuals present was not recorded. A foliage cover of 0.1% was recorded indicating the species was present in low numbers.

The records for *Phyllanthus* sp. B Kimberley Flora (T.E.H. Aplin et al. 809) are the first for the Fitzroy Trough subregion and the Dampierland bioregion with the single confirmed previous record for the species occurring in the Mitchell subregion of the Northern Kimberley bioregion (WA Herbarium 1998). The habitat in which the species was recorded in the current survey match those of the previous confirmed and unconfirmed record for the species.

There is no information regarding population sizes for the previous records of *Phyllanthus* sp. B Kimberley Flora (T.E.H. Aplin et al. 809) (WA Herbarium 1998). Two records from the current survey were associated with the seasonally wet swamp and the *Lophostemon grandiflorus* subsp. *grandiflorus* shrubland, where cover values of 0.5% and 0.1% were recorded, indicating the species was present in this area in substantial numbers.

Stylidium pindanicum (P3) was considered likely to occur in the detailed study area as there is suitable habitat and a previous record in very close proximity. This small annual herb has been recorded flowering from May to August (WA Herbarium 1998) and it is possible it was not flowering during the May 2022 survey and therefore not readily detectable. The entire detailed study area represents suitable habitat for this species and a large amount of suitable habitat also occurs in the surrounding landscape. *Stylidium pindanicum* has been recorded in 3 bioregions, with a record indicating a population of 100's of individuals and comments on the species being common.

Schoenoplectiella humillima (P2) and *Stylidium costulatum* (P3) were considered to possibly occur in the detailed study area with the MvPsp. and MccLggCr vegetation types representing suitable habitat. *Schoenoplectiella humillima* is a small grass like sedge to 5 cm tall and may not have been readily detectable at the time of the surveys. *Stylidium costulatum* is a small herb recorded flowering from April to August (WA Herbarium 1998) and it is possible it was not flowering during the May 2022 survey and therefore not readily detectable.

A further 6 species, *Acacia monticola* x *tumida* var. *kulparn* (P3), *Corchorus fitzroyensis* (P3), *Decaisnina biangulata* (P3), *Dendrolobium cheelii* (P3), *Euploca parviantrum* (P1) and *Gomphrena cucullata* (P3) were considered to possibly occur in the detailed study area as a large proportion of the detailed study area represents suitable habitat for the species and the entire area was not systematically searched.

It is considered unlikely that any Threatened flora would occur in the detailed study area, as no Threatened flora are recorded for the Fitzroy Tough subregion (WA Herbarium 1998) and only one species *Pandanus spiralis* var. *flammeus*, has been recorded for the Dampierland bioregion. No suitable habitat for *Pandanus spiralis* var. *flammeus* occurs in the detailed study area.

6.3 INTRODUCED FLORA

Despite being an active pastoral lease, no introduced flora were recorded in the detailed study area. Subsequently, no introduced plants requiring management were recorded in the detailed study area.

6.4 GDV INDICATOR SPECIES

GDV indicator species were identified at each of the water bodies surveyed in the reconnaissance study area. No sites were surveyed on the Lennard River due to restrictions of flying the helicopter in the area, as neighbouring pastoralists were mustering cattle. It is considered highly likely that GDV indicator species would occur in the riparian vegetation of the Lennard River given their presence along smaller drainage lines such as Hawkstone creek.

6.5 VEGETATION

The 2 prominent vegetation types AttSs and EmDhaSs which comprised 98.9% of the detailed study area are representative of the pre-European vegetation association 754 mapped for the detailed study area, that has a current extent of 195,333.24 ha and is classed as least concern. This indicates that a considerable area of similar vegetation occurs outside of the detailed study area.

None of the vegetation types of the detailed study area were considered to represent any of the PECs identified in the desktop assessment and no mapped locations of any significant vegetation intersected the detailed study area.

AttSs was considered locally significant as habitat for the significant flora *Goodenia sepalosa* var. *glandulosa.* As this vegetation type is representative of the broader vegetation association this indicates a large amount of suitable habitat for this species outside of the detailed study area.

The MvPsp. And MccLggCr vegetation types were considered locally significant as:

- they were habitat for significant flora, *Lophostemon grandiflorus* subsp. *grandiflorus* (P3), and *Phyllanthus* sp. B Kimberley Flora (T.E.H. Aplin et al. 809)
- *Lophostemon grandiflorus* subsp. *grandiflorus* was prominent in the upper canopy
- they comprised a novel range of species not seen elsewhere in the detailed study area
- had a restricted, <1% combined, distribution in the detailed study area.

The reconnaissance survey for GDV indicator species identified several further seasonally wet depressions/swamps and lakes with similar *Lophostemon grandiflorus* subsp. *grandiflorus* shrublands outside of the detailed study area.

The majority of the detailed study area was recorded to be in excellent condition with disturbances limited to livestock tracks. Grazing was evident in the small area rated vegetation to be in very good condition. The lack of weed species recorded during the survey provides a further indication that there has been little evident disturbance to the natural vegetation in the detailed study area.

6.6 CONCLUSION

It is highly unlikely that the detailed study area contains either a listed Threatened flora, TEC or PEC. Three significant flora recorded during the survey comprised of 2 P3 species (*Lophostemon grandiflorus* subsp. g*randiflorus* and *Goodenia sepalosa* var. *glandulosa*, and new record and range extension for *Phyllanthus* sp. B Kimberley Flora (T.E.H. Aplin et al. 809), previously only known from one confirmed record.

Vegetation types MvPsp. and MccLggCr represent the most significant botanical value in the detailed study area as habitat for 2 significant species, a novel combination of species and a restricted distribution. The remainder of the detailed study area contains vegetation representative of vegetation that covers a broad distribution outside of the detailed study area.

At 14 survey locations, vegetation associated with creeks, seasonal lakes and seasonally wet areaswere identified in the reconnaissance study area to contain GDV indicator species.

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Appendix 1 Survey site locations

Site name	Site type	Latitude	Longitude
GD018	Relevé	-17.245929	124.320222
GD019	Relevé	-17.12936	124.345341
GD020	Relevé	-17.107827	124.282112
GDE011	Relevé	-17.215146	124.444814
GDE013	Relevé	-17.122185	124.497108
GDE014	Relevé	-17.192697	124.332632
GDE015	Relevé	-17.188102	124.317905
GDE021	Relevé	-17.071712	124.451633
GDE022	Relevé	-17.242046	124.542663
GDE023	Relevé	-17.26514	124.510218
GDE024	Relevé	-17.2781	124.518742
GDE025	Relevé	-17.181595	124.30022
GDE026	Relevé	-17.19401	124.321427
GDE027	Relevé	-17.149405	124.394091
SP001R	Relevé	-17.217213	124.382521
SP002	Quadrat	-17.217093	124.381693
SP003	Quadrat	-17.218192	124.383667
SP004	Quadrat	-17.221437	124.383281
SP005	Quadrat	-17.221974	124.390897
SP006	Quadrat	-17.225878	124.379777
SP007	Quadrat	-17.225903	124.376408
SP008	Quadrat	-17.221357	124.376957
SP009	Quadrat	-17.223065	124.371696
SP011	Quadrat	-17.21954	124.372916
SP021	Quadrat	-17.218792	124.39618
SP026	Quadrat	-17.229373	124.382142
SP027	Quadrat	-17.228482	124.372145
SP030	Quadrat	-17.231167	124.396049
SP031	Quadrat	-17.228848	124.396819

Appendix 2 Flora survey site descriptions

Site details			
Site	**GD018**	**Position (WGS84)**	-17.245929, 124.320222
Slope	negligible	**Topography**	plain
Soil colour	grey, black	**Soil texture**	clay
Rock cover (%)	0	**Rock type**	none

Observation details - visit 1 (23 Oct 2021)			
Sample description	Tall *Typha domingensis* and *Eleocharis* sp. sedgeland.		
Habitat	waterhole		
Disturbance	grazing-high		
Vegetation condition	Very Good	**Fire age**	not evident
Total veg. cover (%)	95	**Tree cover (%)**	0
Shrub cover (%)	2	**Grass cover (%**	95
Herb cover (%)	0		

Sample and effort summary				
Sample method	**Visit**	**Sample date**	**Dimensions**	**Observer**
Relevé	1	23-Oct-2021	unbounded	Tim Morald

Species (9)	Status	Visit 1		Visit 2	
		Cover (%)	Height (m)	Cover (%)	Height (m)
Typha domingensis		95	2		
Eleocharis sp.		2	1		
Acrostichum speciosum		0.2	2		
Ludwigia octovalvis		0.1	1.8		
Fuirena ciliaris		0.1	0.3		
Ceratopteris thalictroides		0.1	0.3		
Fimbristylis littoralis		0.1	0.15		
Calandrinia uniflora		0.1	0.15		
Uvedalia linearis var. *lutea*		0.1	0.1		

Site details			
Site	**GD019**	**Position (WGS84)**	-17.12936, 124.345341
Slope	negligible	**Topography**	creek
Soil colour	whitish	**Soil texture**	sand
Rock cover (%)	2	**Rock type**	ferrous - ironstone, sandstone

Observation details - visit 1 (23 Oct 2021)			
Sample description	Mid open *Corymbia dendromerinx* and *C. polycarpa* woodland over tall *Acacia tumida* var. *tumida, Cochlospermum fraseri* and *Melaleuca viridiflora* shrubland over mid *Eriachne aristidea*, *Heteropogon contortus* and *Sorghum stipoideum* grassland.		
Habitat	riparian zone		
Disturbance	grazing-low		
Vegetation condition	Excellent	**Fire age**	long-unburnt (>10 years)
Total veg. cover (%)	20	**Tree cover (%)**	10
Shrub cover (%)	2	**Grass cover (%**	10
Herb cover (%)	0.1		

Sample and effort summary				
Sample method	**Visit**	**Sample date**	**Dimensions**	**Observer**
Relevé	1	23-Oct-2021	unbounded	Tim Morald

Species (27)	Status	Visit 1		Visit 2	
		Cover (%)	Height (m)	Cover (%)	Height (m)
Eriachne aristidea		10	1		
Heteropogon contortus		5	0.8		
Corymbia dendromerinx		3	10		
Corymbia polycarpa		2	10		
Cochlospermum fraseri		2	8		
Melaleuca viridiflora		2	6		
Acacia tumida var. *tumida*		2	5		
Waltheria indica		0.5	1		
Acacia tumida var. *tumida*		0.2	6		
Sorghum stipoideum		0.2	1.8		
Opilia amentacea		0.1	5		
Acacia monticola		0.1	5		
Hakea arborescens		0.1	4		
Santalum lanceolatum		0.1	1.8		
Acacia neurocarpa		0.1	1.8		
Calytrix exstipulata		0.1	1		
Goodenia sp.		0.1	1		
Synostemon sp.		0.1	1		
Trichodesma zeylanicum var. *zeylanicum*		0.1	1		
Cyperus holoschoenus		0.1	1		
Rostellularia adscendens var. *clementii*		0.1	0.8		
Corchorus sidoides subsp. *sidoides*		0.1	0.4		
Pterocaulon paradoxum		0.1	0.3		
Bacopa floribunda		0.1	0.3		
Streptoglossa odora		0.1	0.3		
Abildgaardia oxystachya		0.1	0.2		
Canscora diffusa		0.1	0.1		

Site details			
Site	**GD020**	**Position (WGS84)**	-17.107827, 124.282112
Slope	negligible	**Topography**	creek
Soil colour	whitish	**Soil texture**	gravel / alluvial, sand
Rock cover (%)	50	**Rock type**	ferrous - ironstone

Observation details - visit 1 (23 Oct 2021)			
Sample description	Mid *Eucalyptus camaldulensis* subsp. *obtusa* woodland over tall sparse *Acacia tumida* var. *tumida, Pandanus sprialis* and *Melaleuca viridifolia* shrubland over isolated mid *Eriachne aristidea*, *Eragrostis fallax* and *E. speciosa* grasses.		
Habitat	riparian zone		
Disturbance	grazing-low		
Vegetation condition	Excellent	**Fire age**	long-unburnt (>10 years)
Total veg. cover (%)	30	**Tree cover (%)**	20
Shrub cover (%)	0.1	**Grass cover (%**	10
Herb cover (%)	0.1		

Sample and effort summary				
Sample method	**Visit**	**Sample date**	**Dimensions**	**Observer**
Relevé	1	23-Oct-2021	unbounded	Tim Morald

Species (16)	Status	Visit 1		Visit 2	
		Cover (%)	Height (m)	Cover (%)	Height (m)
Eucalyptus camaldulensis subsp. *obtusa*		15	10		
Acacia tumida var. *tumida*		2	5		
Eriachne aristidea		2	0.6		
Eragrostis speciosa		2	0.5		
Pandanus spiralis		1	5		
Eragrostis fallax		1	1		
Melaleuca viridiflora		0.5	5		
Lysiphyllum cunninghamii		0.1	6		
Grevillea agrifolia subsp. *agrifolia*		0.1	1.8		
Petalostigma pubescens		0.1	1.5		
Acacia neurocarpa		0.1	1.2		
Microstachys chamaelea		0.1	1		
Trichodesma zeylanicum var. *zeylanicum*		0.1	1		
Calytrix exstipulata		0.1	1		
Acacia tumida var. *tumida*		0.1	1		
Nelsonia campestris		0.1	0.2		

Site details			
Site	**GDE011**	**Position (WGS84)**	-17.215146, 124.444814
Slope	negligible	**Topography**	riparian zone
Soil colour	grey, whitish	**Soil texture**	sand, sandy loam
Rock cover (%)	0	**Rock type**	None

Observation details - visit 1 (30 May 2022)			
Sample description	Mid *Eucalyptus camaldulensis* subsp. *obtusa*, *Planchonia careya* and *Terminalia carpentariae* woodland over mid to tall sparse *Ficus aculeata* var. *aculeata*, *Acacia colei* and *Brachychiton diversifolius* shrubland over tall closed *Heteopogon contortus* and *Mnesithea rottbellioides* grassland.		
Habitat	woodland		
Disturbance	none evident		
Vegetation condition	Excellent	**Fire age**	
Total veg. cover (%)	0	**Tree cover (%)**	
Shrub cover (%)		**Grass cover (%**	
Herb cover (%)			

Sample and effort summary				
Sample method	**Visit**	**Sample date**	**Dimensions**	**Observer**
Relevé	1	30-May-2022	unbounded	Grant Wells

Species (6)	Status	Visit 1		Visit 2	
		Cover (%)	Height (m)	Cover (%)	Height (m)
Heteropogon contortus		50	1.2		
Eucalyptus camaldulensis subsp. *obtusa*		25	22		
Mnesithea rottboellioides		20	2.2		
Planchonia careya		3	15		
Terminalia carpentariae		2	20		
Ficus aculeata var. *aculeata*		1	1.8		

Site details			
Site	**GDE013**	**Position (WGS84)**	-17.122185, 124.497108
Slope	gentle	**Topography**	river
Soil colour	white	**Soil texture**	sand
Rock cover (%)	0	**Rock type**	

Observation details - visit 1 (30 May 2022)			
Sample description	Mid *Eucalyptus camaldulensis* subsp. *obtusa*, *Lophostemon grandiflorus* subsp. *riparius* and Pterminalia *platyphylla* woodland tall open *Acacia colei*, *Dodonaea platyptera*. and *Lysiphyllum cunninghamii* shrubland over tall *Arundinella nepalensis* grassland.		
Habitat	woodland		
Disturbance	grazing-medium, livestock tracks		
Vegetation condition	Very Good	**Fire age**	
Total veg. cover (%)	0	**Tree cover (%)**	
Shrub cover (%)		**Grass cover (%**	
Herb cover (%)			

Sample and effort summary				
Sample method	**Visit**	**Sample date**	**Dimensions**	**Observer**
Relevé	1	30-May-2022	unbounded	Grant Wells

Species (5)	Status	Visit 1		Visit 2	
		Cover (%)	Height (m)	Cover (%)	Height (m)
Arundinella nepalensis		40	1.2		
Eucalyptus camaldulensis subsp. *obtusa*		15	25		
Terminalia platyphylla		8	20		
Dodonaea platyptera		3	5		
Lophostemon grandiflorus subsp. *riparius*		2	20		

Site details			
Site	**GDE014**	**Position (WGS84)**	-17.192697, 124.332632
Slope	negligible	**Topography**	riparian zone
Soil colour	grey, whitish	**Soil texture**	sand
Rock cover (%)	0	**Rock type**	

Observation details - visit 1 (30 May 2022)			
Sample description	Tall *Lophostemon grandiflorus* subsp. *grandiflorus* shrubland over isolated low *Indigofera hirsutus* shrubs over low open *Eragrostis fallax* grassland.		
Habitat	shrubland		
Disturbance	evidence of feral animals, grazing-medium, livestock tracks		
Vegetation condition	Very Good	**Fire age**	
Total veg. cover (%)	0	**Tree cover (%)**	
Shrub cover (%)		**Grass cover (%**	
Herb cover (%)			

Sample and effort summary				
Sample method	**Visit**	**Sample date**	**Dimensions**	**Observer**
Relevé	1	30-May-2022	unbounded	Grant Wells

Species (3)	Status	Visit 1		Visit 2	
		Cover (%)	Height (m)	Cover (%)	Height (m)
Lophostemon grandiflorus subsp. *grandiflorus*	P3 (DBCA list)	45	5		
Eragrostis fallax		4	0.2		
Indigofera hirsuta		1	0.3		

Site details			
Site	**GDE015**	**Position (WGS84)**	-17.188102, 124.317905
Slope	gentle	**Topography**	riparian zone
Soil colour	grey, whitish	**Soil texture**	sandy loam
Rock cover (%)	0	**Rock type**	

Observation details - visit 1 (30 May 2022)	
Sample description	Tall open *Melaleuca viridiflora* shrubland over *Fimbristylis* ?*microcarya* sedge land with *Byblis rorida*, *Drosera serpens* and *Nymphoides quadriloba* forbs.

Habitat	shrubland		
Disturbance	grazing-medium, livestock tracks		
Vegetation condition	Very Good	**Fire age**	
Total veg. cover (%)	0	**Tree cover (%)**	
Shrub cover (%)		**Grass cover (%**	
Herb cover (%)			

Sample and effort summary				
Sample method	**Visit**	**Sample date**	**Dimensions**	**Observer**
Relevé	1	30-May-2022	unbounded	Grant Wells

Species (5)	Status	Visit 1		Visit 2	
		Cover (%)	Height (m)	Cover (%)	Height (m)
Fimbristylis ?microcarya		40	0.2		
Melaleuca viridiflora		25	2.5		
Drosera serpens		0.1	0.25		
Byblis rorida		0.1	0.15		
Nymphoides quadriloba		0.1	0.1		

Site details			
Site	**GDE021**	**Position (WGS84)**	-17.071712, 124.451633
Slope	gentle	**Topography**	riparian zone
Soil colour	grey, whitish	**Soil texture**	sand
Rock cover (%)	0	**Rock type**	

Observation details - visit 1 (30 May 2022)	
Sample description	Isolated mid *Corymbia polycarpa* trees over tall *Lophostemon grandiflorus* subsp. *grandiflorus* shrubland over *Eragrostis fallax* grassland and *Cyperus macrostachyos* sledge land with *Nymphoides quadriloba* and *N. indica* forbs.

Habitat	shrubland		
Disturbance	evidence of feral animals, grazing-medium, livestock tracks		
Vegetation condition	Very Good	**Fire age**	
Total veg. cover (%)	0	**Tree cover (%)**	
Shrub cover (%)		**Grass cover (%**	
Herb cover (%)			

Sample and effort summary				
Sample method	**Visit**	**Sample date**	**Dimensions**	**Observer**
Relevé	1	30-May-2022	unbounded	Grant Wells

Species (7)	Status	Visit 1		Visit 2	
		Cover (%)	Height (m)	Cover (%)	Height (m)
Eragrostis fallax		50	0.2		
Lophostemon grandiflorus subsp. *grandiflorus*	P3 (DBCA list)	15	3.5		
Corymbia polycarpa		5	15		
Cyperus macrostachyos		3	0.4		
Nymphoides quadriloba		0.1	0.1		
Nymphoides indica		0.1	0.1		
Alternanthera angustifolia		0.1	0.05		

Site details			
Site	**GDE022**	**Position (WGS84)**	-17.242046, 124.542663
Slope	gentle	**Topography**	depression
Soil colour	grey, whitish	**Soil texture**	sand, sandy loam
Rock cover (%)	0	**Rock type**	None

Observation details - visit 1 (30 May 2022)			
Sample description	Isolated mid *Corymbia opaca* trees over tall *Lophostemon grandiflorus* subsp. *grandiflorus* shrubland over *Marsilea hirsuts* and *Alternanthera angustifolia* forbland.		
Habitat	shrubland		
Disturbance	grazing-medium, livestock tracks		
Vegetation condition	Very Good	**Fire age**	
Total veg. cover (%)	0	**Tree cover (%)**	
Shrub cover (%)		**Grass cover (%**	
Herb cover (%)			

Sample and effort summary				
Sample method	**Visit**	**Sample date**	**Dimensions**	**Observer**
Relevé	1	30-May-2022	unbounded	Grant Wells

Species (4)	Status	Visit 1		Visit 2	
		Cover (%)	Height (m)	Cover (%)	Height (m)
Lophostemon grandiflorus subsp. *grandiflorus*	P3 (DBCA list)	20	6		
Alternanthera angustifolia		3	0.1		
Corymbia opaca		2	12		
Marsilea hirsuta		1	0.05		

Site details			
Site	**GDE023**	**Position (WGS84)**	-17.26514, 124.510218
Slope	gentle	**Topography**	depression
Soil colour	black, white	**Soil texture**	sand
Rock cover (%)	0	**Rock type**	

Observation details - visit 1 (30 May 2022)			
Sample description	Low open *Melaleuca cajuputi* subsp. *cajuputi* woodland over tall *Lophostemon grandiflorus* subsp. *grandiflorus* shrubland over *Eragrostis fallax* grassland with *Nymphoides quadriloba* forbs.		
Habitat	open woodland		
Disturbance	grazing-high, livestock tracks		
Vegetation condition	Good	**Fire age**	
Total veg. cover (%)	0	**Tree cover (%)**	
Shrub cover (%)		**Grass cover (%**	
Herb cover (%)			

Sample and effort summary				
Sample method	**Visit**	**Sample date**	**Dimensions**	**Observer**
Relevé	1	30-May-2022	unbounded	Grant Wells

Species (5)	Status	Visit 1		Visit 2	
		Cover (%)	Height (m)	Cover (%)	Height (m)
Eragrostis fallax		80	0.2		
Lophostemon grandiflorus subsp. *grandiflorus*	P3 (DBCA list)	15	6		
Aeschynomene indica		5	0.8		
Melaleuca cajuputi subsp. *cajuputi*		2	8		
Nymphoides quadriloba		0.1	0.02		

Site details			
Site	**GDE024**	**Position (WGS84)**	-17.2781, 124.518742
Slope	gentle	**Topography**	depression
Soil colour	grey, whitish	**Soil texture**	sand, sandy loam
Rock cover (%)	0	**Rock type**	None

Observation details - visit 1 (30 May 2022)			
Sample description	Low open *Melaleuca cajuputi* subsp. *cajuputi* woodland over tall *Lophostemon grandiflorus* subsp. *grandiflorus* shrubland over *Heteropogon contortus* grassland with *Nymphoides quadriloba* forbs.		
Habitat	open woodland		
Disturbance	grazing-high, livestock tracks		
Vegetation condition	Good	**Fire age**	
Total veg. cover (%)	0	**Tree cover (%)**	
Shrub cover (%)		**Grass cover (%**	
Herb cover (%)			

Sample and effort summary				
Sample method	**Visit**	**Sample date**	**Dimensions**	**Observer**
Relevé	1	30-May-2022	unbounded	Grant Wells

Species (5)	Status	Visit 1		Visit 2	
		Cover (%)	Height (m)	Cover (%)	Height (m)
Heteropogon contortus		20	1		
Lophostemon grandiflorus subsp. *grandiflorus*	P3 (DBCA list)	15	6		
Melaleuca cajuputi subsp. *cajuputi*		5	8		
Sesbania cannabina		2	1		
Nymphoides quadriloba		0.1	0.02		

Site details			
Site	**GDE025**	**Position (WGS84)**	-17.181595, 124.30022
Slope	gentle	**Topography**	riparian zone
Soil colour	grey, whitish	**Soil texture**	sand
Rock cover (%)	0	**Rock type**	

Observation details - visit 1 (30 May 2022)			
Sample description	Isolated mid *Corymbia polycarpa* and *Melaleuca cajuputi* subsp. *cajuputi* trees over *Lophostemon grandiflorus* subsp. *grandiflorus* shrubland over *Fimbristylis caespitosa* sedges and *Chrysopogon latifolius* grasses over *Marsilea hirsuta, Alternanthera angustifolia* and *Calotis breviseta* forbs.		
Habitat	shrubland		
Disturbance	grazing-medium, livestock tracks		
Vegetation condition	Very Good	**Fire age**	
Total veg. cover (%)	0	**Tree cover (%)**	
Shrub cover (%)		**Grass cover (%**	
Herb cover (%)			

Sample and effort summary				
Sample method	**Visit**	**Sample date**	**Dimensions**	**Observer**
Relevé	1	30-May-2022	unbounded	Grant Wells

Species (9)	Status	Visit 1		Visit 2	
		Cover (%)	Height (m)	Cover (%)	Height (m)
Chrysopogon latifolius		40	1		
Lophostemon grandiflorus subsp. *grandiflorus*	P3 (DBCA list)	20	8		
Melaleuca cajuputi subsp. *cajuputi*		10	12		
Corymbia polycarpa		2	12		
Indigofera hirsuta		0.2	0.5		
Fimbristylis caespitosa		0.2	0.4		
Alternanthera angustifolia		0.2	0.2		
Calotis breviseta		0.1	0.15		
Marsilea hirsuta		0.1	0.05		

Site details			
Site	**GDE026**	**Position (WGS84)**	-17.19401, 124.321427
Slope	gentle	**Topography**	depression
Soil colour	grey, whitish	**Soil texture**	sandy loam
Rock cover (%)	0	**Rock type**	

Observation details - visit 1 (30 May 2022)			
Sample description	Isolated *Corymbia opaca* trees over tall open *Acacia colei* and *Melaleuca viridiflora* shrubland over Poaceae sp. closed grassland.		
Habitat	shrubland		
Disturbance	grazing-medium, livestock tracks		
Vegetation condition	Very Good	**Fire age**	
Total veg. cover (%)	0	**Tree cover (%)**	
Shrub cover (%)		**Grass cover (%**	
Herb cover (%)			

Sample and effort summary				
Sample method	**Visit**	**Sample date**	**Dimensions**	**Observer**
Relevé	1	30-May-2022	unbounded	Grant Wells

Species (3)	Status	Visit 1		Visit 2	
		Cover (%)	Height (m)	Cover (%)	Height (m)
Melaleuca viridiflora		15	7		
Acacia colei		15	6		
Drosera serpens		0.1	0.25		

Site details			
Site	**GDE027**	**Position (WGS84)**	-17.149405, 124.394091
Slope	negligible	**Topography**	riparian zone
Soil colour	black	**Soil texture**	sand, sandy loam
Rock cover (%)	0	**Rock type**	None

Observation details - visit 1 (30 May 2022)			
Sample description	Low *Melaleuca cajuputi* subsp. *cajuputi* and *Corymbia polycarpa* woodland over tall open *Lophostemon grandiflorus* subsp. *grandiflorus* shrubland over *Fuirena ciliaris*, *Eleocharis brassii* and *Eragrostis fallax* sedge/grassland.		
Habitat	woodland		
Disturbance	grazing-medium, livestock tracks		
Vegetation condition	Very Good	**Fire age**	
Total veg. cover (%)	0	**Tree cover (%)**	
Shrub cover (%)		**Grass cover (%**	
Herb cover (%)			

Sample and effort summary				
Sample method	**Visit**	**Sample date**	**Dimensions**	**Observer**
Relevé	1	30-May-2022	unbounded	Grant Wells

Species (9)	Status	Visit 1		Visit 2	
		Cover (%)	Height (m)	Cover (%)	Height (m)
Eragrostis fallax		70	0.2		
Lophostemon grandiflorus subsp. *grandiflorus*	P3 (DBCA list)	10	12		
Melaleuca cajuputi subsp. *cajuputi*		5	10		
Corymbia polycarpa		2	12		
Eleocharis brassii		0.5	0.6		
Alternanthera angustifolia		0.4	0.2		
Marsilea hirsuta		0.2	0.1		
Fuirena ciliaris		0.1	0.15		
Nymphoides indica		0.1	0.05		

Site details			
Site	**SP001R**	**Position (WGS84)**	-17.217213, 124.382521
Slope	negligible	**Topography**	depression
Soil colour	grey	**Soil texture**	sandy clay, clay
Rock cover (%)	0	**Rock type**	none

Observation details - visit 1 (25 Oct 2021)	
Sample description	Low *Melaleuca viridiflora* woodland over isolated clumps of tall *Lophostemon grandiflrous* subsp. *grandiflorus* and *Melaleuca cajuputi* subsp. *cajuputi* shrubs over isolated low *Microstachys chamaelea*.

Habitat	woodland		
Disturbance	livestock tracks		
Vegetation condition	Excellent	**Fire age**	
Total veg. cover (%)	70	**Tree cover (%)**	70
Shrub cover (%)	0	**Grass cover (%**	40
Herb cover (%)			

Sample and effort summary				
Sample method	**Visit**	**Sample date**	**Dimensions**	**Observer**
Relevé	1	25-Oct-2021	unbounded	Martin Henson
Relevé	2	28-May-2022	unbounded	Grant Wells

Species (20)	Status	Visit 1		Visit 2	
		Cover (%)	Height (m)	Cover (%)	Height (m)
Melaleuca viridiflora		80	6		
Crotalaria ramosissima		1	0.2		
Lophostemon grandiflorus subsp. *grandiflorus*	P3 (DBCA list)	0.5	4		
Stemodia lathraia		0.2	0.3		
Melaleuca cajuputi subsp. *cajuputi*		0.1	4		
Sorghum stipoideum		0.1	1		
Grevillea agrifolia subsp. *agrifolia*		0.1	1		
Eragrostis exigua		0.1	1		
Waltheria indica		0.1	1		
Ludwigia perennis		0.1	1		
Microstachys chamaelea		0.1	0.3		
Tephrosia rosea var. *clementii*		0.1	0.3		
Corchorus sidoides subsp. *sidoides*		0.1	0.3		
Centrolepis exserta		0.1	0.05		
Phyllanthus sp. B Kimberley Flora (T.E.H. Aplin et al. 809)	Range extension			0.5	0.2
Zornia muelleriana subsp. *congesta*				0.1	0.1
Triodia caelestialis				0.1	0.2
Aristida hygrometrica				0.1	0.6
Eragrostis speciosa				0.1	0.3
Bulbostylis barbata				0.1	0.1

Site details			
Site	**SP002**	**Position (WGS84)**	-17.217093, 124.381693
Slope	negligible	**Topography**	depression
Soil colour	grey	**Soil texture**	sandy clay, clay
Rock cover (%)	0	**Rock type**	none

Observation details - visit 1 (25 Oct 2021)			
Sample description	Mid open *Eucalyptus tectifica*and *Melaleuca cajuputi* subsp. *cajaputi* woodland over tall *Lophostemon grandiflorus* subsp. *grandiflorus* shrubland over low sparse *Indigofera hirsuta*, *Crotalaria ramosissima* and *Waltheria indica* shrubland.		
Habitat	shrubland		
Disturbance	livestock tracks		
Vegetation condition	Excellent	**Fire age**	
Total veg. cover (%)	40	**Tree cover (%)**	40
Shrub cover (%)	0.1	**Grass cover (%**	0.1
Herb cover (%)			

Sample and effort summary				
Sample method	**Visit**	**Sample date**	**Dimensions**	**Observer**
Quadrat	1	25-Oct-2021	unbounded	Martin Henson
Quadrat	2	28-May-2022	unbounded	Grant Wells

Species (23)	Status	Visit 1		Visit 2	
		Cover (%)	Height (m)	Cover (%)	Height (m)
Lophostemon grandiflorus subsp. *grandiflorus*	P3 (DBCA list)	40	4		
Melaleuca cajuputi subsp. *cajuputi*		3	10		
Eucalyptus tectifica		2	20		
Eriocaulon cinereum		1	0.05		
Ludwigia perennis		0.2	1.1		
Acacia tumida var. *tumida*		0.1	1.5		
Ehretia saligna var. *saligna*		0.1	1.5		
Eriachne obtusa		0.1	0.4		
Bergia trimera		0.1	0.3		
Cyperus holoschoenus		0.1	0.3		
Ammannia multiflora		0.1	0.25		
Centrolepis exserta		0.1	0.05		
Phyllanthus sp. B Kimberley Flora (T.E.H. Aplin et al. 809)	Range extension			0.1	0.25
Pterocaulon paradoxum				0.1	0.4
Indigofera hirsuta				2	0.5
Waltheria indica				0.1	0.5
Zornia muelleriana subsp. *congesta*				0.1	0.1
Bulbostylis barbata				0.1	0.1
Euploca ovalifolia				0.1	0.4
Arivela viscosa				0.1	0.3
Aristida hygrometrica				0.1	0.6
Grewia pindanica				0.1	1.2
Crotalaria ramosissima				2	0.3

Site details			
Site	**SP003**	**Position (WGS84)**	-17.218192, 124.383667
Slope	negligible	**Topography**	plain
Soil colour	red-orange	**Soil texture**	loamy sand
Rock cover (%)	0	**Rock type**	none

Observation details - visit 1 (25 Oct 2021)			
Sample description	Tall *Grevillea agrifolia* subsp. *agrifolia*, *G. refracta* subsp. *refracta* and *Petalostigma pubescens* shrubland over mid open *Dodonaea hispidula* var. *arida*, *Waltheria indicia* and *Ehretia saligna* var. *saligna* shrubland over mid *Sorghum stipoideum* grassland.		
Habitat	shrubland		
Disturbance	livestock tracks		
Vegetation condition	Excellent	**Fire age**	long-unburnt (>10 years)
Total veg. cover (%)	80	**Tree cover (%)**	70
Shrub cover (%)	2	**Grass cover (%**	50
Herb cover (%)			

Sample and effort summary				
Sample method	**Visit**	**Sample date**	**Dimensions**	**Observer**
Quadrat	1	25-Oct-2021	unbounded	Martin Henson
Quadrat	2	28-May-2022	unbounded	Grant Wells

Species (26)	Status	Visit 1		Visit 2	
		Cover (%)	Height (m)	Cover (%)	Height (m)
Grevillea agrifolia subsp. *agrifolia*		20	5		
Petalostigma pubescens		20	5		
Dodonaea hispidula var. *arida*		10	2		
Grevillea refracta subsp. *refracta*		5	4		
Acacia tumida var. *tumida*		2.2	3		
Waltheria indica		1	1		
Ehretia saligna var. *saligna*		0.2	1.5		
Pterocaulon paradoxum		0.2	0.6		
Triodia caelestialis		0.2	0.3		
Eucalyptus miniata		0.1	10		
Corymbia greeniana		0.1	8		
Calytrix exstipulata		0.1	1		
Aristida hygrometrica		0.1	0.5		
Microstachys chamaelea		0.1	0.3		
Hypoestes floribunda		0.1	0.3		
Spermacoce occidentalis		0.1	0.2		
Sorghum stipoideum				20	1
Eriachne ciliata				0.1	0.2
Sersalisia sericea				0.1	1.5
Goodenia panduriformis				0.1	0.8
Cathetus virgatus				0.1	0.3
Polymeria ambigua				0.1	0.2
Brachychiton diversifolius				0.1	7
Bonamia pannosa				0.1	0.5
Lysiphyllum cunninghamii				0.1	2
Corchorus sidoides subsp. *sidoides*				0.1	0.4

Site details			
Site	**SP004**	**Position (WGS84)**	-17.221437, 124.383281
Slope	negligible	**Topography**	plain
Soil colour	red-orange	**Soil texture**	loamy sand
Rock cover (%)	0	**Rock type**	none

Observation details - visit 1 (24 Oct 2021)			
Sample description	Mid *Eucalyptus miniata* woodland over tall *Acacia tumida* var. *tumida*, *Ehretia saligna* var. *saligna* and *Grevillea refracta* subsp. *refracta* shrubland over low open *Chrysopogon latifolius* grassland.		
Habitat			
Disturbance	none evident		
Vegetation condition	Excellent	**Fire age**	long-unburnt (>10 years)
Total veg. cover (%)	80	**Tree cover (%)**	40
Shrub cover (%)	10	**Grass cover (%**	60
Herb cover (%)			

Sample and effort summary				
Sample method	**Visit**	**Sample date**	**Dimensions**	**Observer**
Quadrat	1	24-Oct-2021	unbounded	Martin Henson
Quadrat	2	29-May-2022	unbounded	Grant Wells

Species (23)	Status	Visit 1		Visit 2	
		Cover (%)	Height (m)	Cover (%)	Height (m)
Eucalyptus miniata		10	12		
Acacia tumida var. *tumida*		10	5		
Ehretia saligna var. *saligna*		5	3		
Grevillea refracta subsp. *refracta*		4	6		
Corymbia greeniana		3	5		
Dodonaea hispidula var. *arida*		3	1.5		
Acacia dunnii		1	5		
Petalostigma pubescens		1	5		
Corchorus sidoides subsp. *sidoides*		1	1.2		
Pterocaulon paradoxum		1	0.8		
Bonamia pannosa		0.2	0.25		
Calytrix exstipulata		0.1	1.1		
Phyllanthus sp. B Kimberley Flora (T.E.H. Aplin et al. 809)		0.1	0.4		
Microstachys chamaelea		0.1	0.3		
Hypoestes floribunda		0.1	0.3		
Sersalisia sericea				0.1	2
Cathetus virgatus				0.1	0.3
Chrysopogon latifolius				15	0.2
Scleria brownii				0.1	0.2
Eriachne obtusa				0.1	0.1
Polymeria ambigua				0.1	0.2
Sorghum stipoideum				5	1.5
Phyllanthus sp. B Kimberley Flora (T.E.H. Aplin et al. 809)	Range extension			0.1	0.2

Site details			
Site	**SP005**	**Position (WGS84)**	-17.221974, 124.390897
Slope	negligible	**Topography**	plain
Soil colour	red-orange	**Soil texture**	loamy sand
Rock cover (%)	0	**Rock type**	none

Observation details - visit 1 (23 Oct 2021)			
Sample description	Isolated low *Corymbia greeniana* trees over tall *Acacia tumida* var. *tumida*, *Terminalia canescens and Grevillea refracta* subsp. *refracta* shrubland over tall *Sorghum stipoideum* grassland.		
Habitat	shrubland		
Disturbance	none evident		
Vegetation condition	Excellent	**Fire age**	long-unburnt (>10 years)
Total veg. cover (%)	80	**Tree cover (%)**	70
Shrub cover (%)	1	**Grass cover (%**	30
Herb cover (%)			

Sample and effort summary				
Sample method	**Visit**	**Sample date**	**Dimensions**	**Observer**
Quadrat	1	23-Oct-2021	unbounded	Martin Henson
Quadrat	2	28-May-2022	unbounded	Grant Wells

Species (29)	Status	Visit 1		Visit 2	
		Cover (%)	Height (m)	Cover (%)	Height (m)
Sorghum stipoideum		40	1.2		
Acacia tumida var. *tumida*		20	3		
Dodonaea hispidula var. *arida*		20	1.8		
Terminalia canescens		15	3		
Grevillea refracta subsp. *refracta*		10	3		
Waltheria indica		3	1.2		
Acacia dunnii		2	5		
Corymbia greeniana		0.5	5		
Pterocaulon paradoxum		0.5	1		
Gymnema erectum		0.5	1		
Lysiphyllum cunninghamii		0.1	3		
Leichhardtia viridiflora subsp. *tropica*		0.1	3		
Flueggea virosa subsp. *melanthesoides*		0.1	2.5		
Ehretia saligna var. *saligna*		0.1	2		
Sida hackettiana		0.1	0.6		
Microstachys chamaelea		0.1	0.5		
Corchorus sidoides subsp. *sidoides*		0.1	0.3		
Gymnema pleiadenium		0.1	0.2		
Evolvulus alsinoides var. *decumbens*		0.1	0.15		
Eriachne obtusa				0.1	0.5
Dolichandrone occidentalis				0.1	3
Scleria brownii				0.1	0.2
Polymeria ambigua				0.1	0.1
Cathetus virgatus				0.1	0.2
Cajanus marmoratus				0.1	0.02
Bonamia pannosa				0.1	
Aristida hygrometrica				0.1	0.5
Trianthema pilosa				0.1	0.01
Chrysopogon latifolius				10	0.2

Site details			
Site	**SP006**	**Position (WGS84)**	-17.225878, 124.379777
Slope	negligible	**Topography**	plain
Soil colour	red-orange	**Soil texture**	loamy sand
Rock cover (%)	0	**Rock type**	none

Observation details - visit 1 (26 Oct 2021)			
Sample description	Low *Petalostigma pubescens*, *Corymbia cadophora* and *C. greeniana* woodland over tall *Acacia tumida* var. *tumida*, *Grevillea refracta* subsp. *refracta* and *Cochlospermum fraseri* shrubland over tall sparse *Sorghum stipoideum* grassland.		
Habitat	open woodland		
Disturbance	livestock tracks		
Vegetation condition	Excellent	**Fire age**	long-unburnt (>10 years)
Total veg. cover (%)	80	**Tree cover (%)**	60
Shrub cover (%)	5	**Grass cover (%**	60
Herb cover (%)			

Sample and effort summary				
Sample method	**Visit**	**Sample date**	**Dimensions**	**Observer**
Quadrat	1	26-Oct-2021	unbounded	Martin Henson
Quadrat	2	28-May-2022	unbounded	Grant Wells

Species (27)	Status	Visit 1		Visit 2	
		Cover (%)	Height (m)	Cover (%)	Height (m)
Petalostigma pubescens		40	6		
Grevillea refracta subsp. *refracta*		10	3		
Acacia tumida var. *tumida*		6	4		
Sorghum stipoideum		5	1		
Corymbia cadophora		1	9		
Cochlospermum fraseri		1	6		
Acacia dunnii		1	5		
Terminalia canescens		1	4		
Corymbia greeniana		0.2	7		
Wrightia saligna		0.2	5		
Microstachys chamaelea		0.2	0.5		
Ehretia saligna var. *saligna*		0.1	1.5		
Pterocaulon paradoxum		0.1	0.5		
Chrysopogon latifolius				0.2	15
Evolvulus alsinoides var. *decumbens*				0.1	0.2
Calytrix exstipulata				0.5	1.5
Corchorus sidoides subsp. *sidoides*				0.1	0.4
Buchnera linearis				0.1	0.15
Cathetus virgatus				0.1	0.4
Dodonaea hispidula var. *arida*				1	1
Euphorbia schultzii var. *comans*				0.1	0.2
Evolvulus alsinoides var. *villosicalyx*				0.1	0.15
Heteropogon contortus				0.1	0.6
Polymeria ambigua				0.1	0.1
Stemodia lythrifolia				0.2	0.6
Triodia caelestialis				0.1	0.2
Eriachne ciliata				0.1	0.4

Site details			
Site	**SP007**	**Position (WGS84)**	-17.225903, 124.376408
Slope	negligible	**Topography**	plain
Soil colour	brown, whitish	**Soil texture**	sandy loam
Rock cover (%)	0	**Rock type**	none

Observation details - visit 1 (26 Oct 2021)			
Sample description	Mid open *Eucalyptus miniata* and *Corymbia greenianja* woodland over tall open *Calytrix exstipulata*, *Petalostigma pubescens* and *Acacia tumida* var. *tumida* shrubland over tall *Sorghum stipoideum* grassland.		
Habitat	open woodland		
Disturbance	none evident		
Vegetation condition	Excellent	**Fire age**	not evident
Total veg. cover (%)	75	**Tree cover (%)**	40
Shrub cover (%)	10	**Grass cover (%**	60
Herb cover (%)			

Sample and effort summary				
Sample method	**Visit**	**Sample date**	**Dimensions**	**Observer**
Quadrat	1	26-Oct-2021	unbounded	Martin Henson
Quadrat	2	28-May-2022	unbounded	Martin Henson

Species (19)	Status	Visit 1		Visit 2	
		Cover (%)	Height (m)	Cover (%)	Height (m)
Sorghum stipoideum		55	1		
Eucalyptus miniata		5	15		
Calytrix exstipulata		5	4		
Triodia caelestialis		5	0.15		
Petalostigma pubescens		3	4		
Corymbia greeniana		2	10		
Acacia tumida var. *tumida*		2	6		
Terminalia canescens		2	6		
Grevillea refracta subsp. *refracta*		2	5		
Dodonaea hispidula var. *arida*		1	1		
Brachychiton diversifolius		0.1	7		
Persoonia falcata		0.1	5		
Ampelocissus acetosa		0.1	3.5		
Atalaya variifolia		0.1	2.5		
Pterocaulon paradoxum		0.1	0.6		
Microstachys chamaelea		0.1	0.3		
Buchnera asperata		0.1	0.3		
Cassytha filiformis		0.1	0.2		
Chrysopogon latifolius				5	0.2

Site details			
Site	**SP008**	**Position (WGS84)**	-17.221357, 124.376957
Slope	negligible	**Topography**	plain
Soil colour	red-orange	**Soil texture**	loamy sand
Rock cover (%)	0	**Rock type**	none

Observation details - visit 1 (26 Oct 2021)			
Sample description	Mid *Acacia tumida* var. *tumida*, *Corymbia greeniana* and *C. cadophora* woodland over tall *Petalostigma pubescens*, *Ehretia saligna* var. *saligna* and *Acacia dunnii* shrubland over mid *Sorghum stipoideum* grassland.		
Habitat	open woodland		
Disturbance	livestock tracks		
Vegetation condition	Excellent	**Fire age**	
Total veg. cover (%)	70	**Tree cover (%)**	50
Shrub cover (%)	5	**Grass cover (%**	30
Herb cover (%)			

Sample and effort summary				
Sample method	**Visit**	**Sample date**	**Dimensions**	**Observer**
Relevé	1	26-Oct-2021	unbounded	Martin Henson
Quadrat	2	28-May-2022	unbounded	Grant Wells

Species (26)	Status	Visit 1		Visit 2	
		Cover (%)	Height (m)	Cover (%)	Height (m)
Sorghum stipoideum		40	1		
Petalostigma pubescens		30	5		
Acacia tumida var. *tumida*		20	10		
Ehretia saligna var. *saligna*		10	2		
Acacia dunnii		5	7		
Corymbia greeniana		3	10		
Grevillea refracta subsp. *refracta*		2	5		
Dodonaea hispidula var. *arida*		2	1.5		
Corymbia cadophora		1	10		
Corymbia dendromerinx		0.2	9		
Calytrix exstipulata		0.2	1.1		
Pterocaulon paradoxum		0.1	18		
Sersalisia sericea		0.1	3		
Waltheria indica		0.1	1.5		
Crotalaria ramosissima		0.1	0.3		
Triodia caelestialis				0.1	0.2
Bonamia pannosa				0.1	0.3
Brachychiton diversifolius				0.5	4
Chrysopogon latifolius				0.2	20
Corchorus sidoides subsp. *sidoides*				0.1	0.4
Grewia pindanica				0.1	0.8
Scleria brownii				0.1	0.4
Terminalia sp.				0.1	0.7
Terminalia canescens				0.5	4
Flueggea virosa subsp. *melanthesoides*				0.1	3
Cochlospermum fraseri				0.1	4

Site details			
Site	**SP009**	**Position (WGS84)**	-17.223065, 124.371696
Slope	negligible	**Topography**	plain
Soil colour	red-brown	**Soil texture**	sand
Rock cover (%)	0	**Rock type**	None

Observation details - visit 1 (29 May 2022)			
Sample description	Tall open *Acacia tumida* var. *tumida*, *Grevillea refracta* subsp. *refracta* and *Terminalia canescens* shrubland over mid sparse *Dodonaea hispidula* var. *arida*, *Ehretia saligna* var. *saligna* and *Pterocaulon paradoxum* shrubland over open *Sorghum stipodeum* and *Chrysopogon latifolius* grassland.		
Habitat	shrubland		
Disturbance	livestock tracks		
Vegetation condition	Excellent	**Fire age**	old (5-10 years)
Total veg. cover (%)	50	**Tree cover (%)**	30
Shrub cover (%)	8	**Grass cover (%**	20
Herb cover (%)	0.1		

Sample and effort summary				
Sample method	**Visit**	**Sample date**	**Dimensions**	**Observer**
Quadrat	1	29-May-2022	unbounded	Grant Wells

Species (27)	Status	Visit 1		Visit 2	
		Cover (%)	Height (m)	Cover (%)	Height (m)
Acacia tumida var. *tumida*		15	8		
Chrysopogon latifolius		15	0.2		
Ehretia saligna var. *saligna*		6	2.5		
Terminalia canescens		5	8		
Dodonaea hispidula var. *arida*		5	1.8		
Sorghum stipoideum		5	1.5		
Pterocaulon paradoxum		2	1.5		
Eucalyptus miniata		1	12		
Grevillea refracta subsp. *refracta*		1	4		
Corymbia cadophora subsp. *cadophora*		0.1	5		
Brachychiton diversifolius		0.1	4		
Lysiphyllum cunninghamii		0.1	3		
Petalostigma pubescens		0.1	3		
Acacia dunnii		0.1	2		
Flueggea virosa subsp. *melanthesoides*		0.1	2		
Calytrix exstipulata		0.1	1.5		
Acacia colei		0.1	1.5		
Senna notabilis		0.1	1.2		
Sida rohlenae subsp. *occidentalis*		0.1	1		
Waltheria indica		0.1	1		
Aristida hygrometrica		0.1	0.5		
Stemodia lythrifolia		0.1	0.5		
Microstachys chamaelea		0.1	0.5		
Bonamia pannosa		0.1	0.4		
Corchorus sidoides subsp. *sidoides*		0.1	0.4		
Scleria brownii		0.1	0.2		
Polymeria ambigua		0.1	0.05		

Site details			
Site	**SP011**	**Position (WGS84)**	-17.21954, 124.372916
Slope	negligible	**Topography**	plain
Soil colour	red-brown	**Soil texture**	sand
Rock cover (%)	0	**Rock type**	None

Observation details - visit 1 (29 May 2022)	
Sample description	Isolated low *Eucalyptus miniata* and *Corymbia cadophora* subsp. *cadophora*trees over tall *Acacia tumida* var. *tumida* , *Petalostigma pubescens* and *Grevillea refacta* subsp. *refracta* shrubland over sparse *Chrysopogon latifolius* and *Sorghum stipiodeum* grassland.

Habitat	shrubland		
Disturbance	livestock tracks		
Vegetation condition	Excellent	**Fire age**	old (5-10 years)
Total veg. cover (%)	45	**Tree cover (%)**	40
Shrub cover (%)	5	**Grass cover (%**	5
Herb cover (%)	0.1		

Sample and effort summary				
Sample method	**Visit**	**Sample date**	**Dimensions**	**Observer**
Quadrat	1	29-May-2022	unbounded	Grant Wells

Species (25)	Status	Visit 1		Visit 2	
		Cover (%)	Height (m)	Cover (%)	Height (m)
Petalostigma pubescens		25	3		
Grevillea refracta subsp. *refracta*		6	5		
Acacia tumida var. *tumida*		5	12		
Sorghum stipoideum		3	1.5		
Chrysopogon latifolius		2	0.2		
Eucalyptus miniata		1	8		
Corymbia cadophora subsp. *cadophora*		1	6		
Ehretia saligna var. *saligna*		1	2		
Bonamia pannosa		1	0.5		
Grewia pindanica		0.5	0.7		
Pterocaulon paradoxum		0.2	1		
Corymbia opaca		0.1	7		
Cochlospermum fraseri		0.1	4		
Leichhardtia viridiflora subsp. *tropica*		0.1	0.8		
Senna costata		0.1	0.8		
Waltheria indica		0.1	0.7		
Microstachys chamaelea		0.1	0.5		
Hibiscus leptocladus		0.1	0.4		
Corchorus sidoides subsp. *sidoides*		0.1	0.4		
Aristida hygrometrica		0.1	0.4		
Eriachne ciliata		0.1	0.3		
Scleria brownii		0.1	0.2		
Polymeria ambigua		0.1	0.1		
Calandrinia strophiolata		0.1	0.1		
Goodenia sepalosa var. *glandulosa*	P3 (DBCA list)	0.1	0.05		

Site details			
Site	**SP021**	**Position (WGS84)**	-17.218792, 124.39618
Slope	negligible	**Topography**	plain
Soil colour	red-orange	**Soil texture**	loamy sand
Rock cover (%)	0	**Rock type**	none

Observation details - visit 1 (24 Oct 2021)			
Sample description	Mid *acacia dunnii* and *Corymbia greeniana* woodland over tall *Terminalia canescens*, *Lysiphyllum cunninghamii* and *Grevillea refracts* subsp. *refracta* shrubland over tall *Sorghum stipoideum* grassland.		
Habitat	shrubland		
Disturbance	grazing-low		
Vegetation condition	Excellent	**Fire age**	long-unburnt (>10 years)
Total veg. cover (%)	90	**Tree cover (%)**	70
Shrub cover (%)	10	**Grass cover (%**	50
Herb cover (%)			

Sample and effort summary				
Sample method	**Visit**	**Sample date**	**Dimensions**	**Observer**
Quadrat	1	24-Oct-2021	unbounded	Martin Henson

Species (20)	Status	Visit 1		Visit 2	
		Cover (%)	Height (m)	Cover (%)	Height (m)
Sorghum stipoideum		50	1.5		
Acacia dunnii		40	12		
Terminalia canescens		10	6		
Dodonaea hispidula var. *arida*		10	1.5		
Corymbia greeniana		5	10		
Lysiphyllum cunninghamii		5	6		
Grevillea refracta subsp. *refracta*		5	4		
Ehretia saligna var. *saligna*		5	3		
Petalostigma pubescens		3	4		
Waltheria indica		2	1.8		
Hypoestes floribunda		0.5	1		
Flueggea virosa subsp. *melanthesoides*		0.1	3		
Calytrix exstipulata		0.1	3		
Acacia tumida var. *tumida*		0.1	1		
Goodenia panduriformis		0.1	1		
Pterocaulon paradoxum		0.1	0.5		
Microstachys chamaelea		0.1	0.3		
Sida hackettiana		0.1	0.3		
Bonamia pannosa		0.1	0.3		
Leichhardtia viridiflora subsp. *tropica*		0.1			

Site details			
Site	**SP026**	**Position (WGS84)**	-17.229373, 124.382142
Slope	negligible	**Topography**	plain
Soil colour	brown-grey	**Soil texture**	loamy sand, silt
Rock cover (%)	1	**Rock type**	ferrous - ironstone

Observation details - visit 1 (26 Oct 2021)			
Sample description	Mid *Eucalyptus miniata* woodland over tall open *Terminalia canescens*, *Grevillea agrifolia* subsp. *agrifolia* and *Petalostigma pubescens* shrubland over *Triodia caelestialis* and *Sorghum stipoideum* grassland.		
Habitat	open woodland		
Disturbance	none evident		
Vegetation condition	Excellent	**Fire age**	long-unburnt (>10 years)
Total veg. cover (%)	75	**Tree cover (%)**	30
Shrub cover (%)	5	**Grass cover (%**	40
Herb cover (%)			

Sample and effort summary				
Sample method	**Visit**	**Sample date**	**Dimensions**	**Observer**
Quadrat	1	26-Oct-2021	unbounded	Martin Henson
Quadrat	2	28-May-2022	unbounded	Grant Wells

Species (36)	Status	Visit 1		Visit 2	
		Cover (%)	Height (m)	Cover (%)	Height (m)
Triodia caelestialis		25	0.2		
Eucalyptus miniata		10	15		
Terminalia canescens		5	4		
Sorghum stipoideum		5	1		
Grevillea agrifolia subsp. *agrifolia*		2	4		
Grevillea pyramidalis subsp. *pyramidalis*		1	5		
Planchonia careya		1	5		
Petalostigma pubescens		1	4		
Acacia dunnii		1	3		
Grevillea refracta subsp. *refracta*		1	3		
Dodonaea hispidula var. *arida*		1	1.5		
Cassytha filiformis		1			
Acacia tumida var. *tumida*		0.5	4		
Waltheria indica		0.2	1		
Blumea integrifolia		0.2	0.2		
Ehretia saligna var. *saligna*		0.1	1.2		
Calytrix exstipulata		0.1	1		
Microstachys chamaelea		0.1	0.4		
Buchnera asperata		0.1	0.3		
Eriachne ciliata		0.1	0.3		
Rostellularia adscendens var. *clementii*		0.1	0.3		
Euphorbia coghlanii		0.1	0.3		
Spermacoce occidentalis		0.1	0.25		
Corchorus sidoides subsp. *sidoides*				0.1	0.4
Cathetus virgatus				0.1	0.3
Crotalaria medicaginea var. *neglecta*				0.1	0.5
Crotalaria ramosissima				0.1	0.05
Acacia colei				0.1	3
Calandrinia strophiolata				0.1	0.1
Bulbostylis barbata				0.1	0.15
Polycarpaea corymbosa				0.1	0.2
Brachychiton diversifolius				0.1	3
Stemodia lythrifolia				0.1	0.6
Tephrosia leptoclada				0.1	0.4
Tephrosia rosea var. *clementii*				0.1	0.1
Carissa lanceolata				0.1	1

Site details			
Site	**SP027**	**Position (WGS84)**	-17.228482, 124.372145
Slope	negligible	**Topography**	plain
Soil colour	red-orange, whitish	**Soil texture**	sand, sandy loam
Rock cover (%)	0	**Rock type**	None

Observation details - visit 1 (29 May 2022)			
Sample description	Mid *Eucalyptus miniata* and *Corymbia cadophora* woodland over tall open *Grevillea agrifolia* subsp. *agrifolia*, *G. refracta* subsp. *refracta* and *Terminalia canescens* shrubland over open *Sorghum stipoideum, Chrysopogon latifolius* and *Triodia caelestialis* grassland.		
Habitat	woodland		
Disturbance	evidence of feral animals, livestock tracks		
Vegetation condition	Excellent	**Fire age**	relatively recent (1-5 years)
Total veg. cover (%)	35	**Tree cover (%)**	25
Shrub cover (%)	5	**Grass cover (%**	15
Herb cover (%)	0.1		

Sample and effort summary				
Sample method	**Visit**	**Sample date**	**Dimensions**	**Observer**
Quadrat	1	29-May-2022	unbounded	Grant Wells

Species (28)	Status	Visit 1		Visit 2	
		Cover (%)	Height (m)	Cover (%)	Height (m)
Eucalyptus miniata		15	20		
Triodia caelestialis		10	0.15		
Sorghum stipoideum		7	1.5		
Terminalia canescens		6	5		
Grevillea agrifolia subsp. *agrifolia*		5	3		
Dodonaea hispidula var. *arida*		3	1.2		
Chrysopogon latifolius		3	0.15		
Corymbia cadophora		2	15		
Grevillea refracta subsp. *refracta*		1	4		
Petalostigma pubescens		1	1.8		
Acacia dunnii		0.1	1.6		
Wrightia saligna		0.1	0.5		
Santalum lanceolatum		0.1	0.4		
Vigna lanceolata var. *lanceolata*		0.1	0.4		
Sida hackettiana		0.1	0.35		
Corchorus sidoides subsp. *sidoides*		0.1	0.3		
Polymeria ambigua		0.1	0.3		
Cathetus virgatus		0.1	0.3		
Solanum cunninghamii		0.1	0.25		
Buchnera ramosissima		0.1	0.2		
Crotalaria ramosissima		0.1	0.15		
Goodenia odonnellii		0.1	0.15		
Tephrosia leptoclada		0.1	0.15		
Eriachne ciliata		0.1	0.1		
Euphorbia sp.		0.1	0.1		
Gymnema erectum		0.1	0.1		
Evolvulus alsinoides var. *villosicalyx*		0.1	0.1		
Bergia trimera		0.1	0.02		

Site details			
Site	**SP030**	**Position (WGS84)**	-17.231167, 124.396049
Slope	negligible	**Topography**	plain
Soil colour	red-brown	**Soil texture**	sand
Rock cover (%)	0	**Rock type**	None

Observation details - visit 1 (29 May 2022)			
Sample description	Tall *Acacia tumida* var. *tumida*, *Petalostigma pubescens* and *Terminalia canescens* shrubland over mid sparse *Dodonaea hispidula* var. *arida*, *Pterocaulon paradoxum* and *Grevillea refracta* subsp. *refracta shrubland over Sorghum stipoideum and Chrysopogon latifolius grassland.*		
Habitat	shrubland		
Disturbance	livestock tracks		
Vegetation condition	Excellent	**Fire age**	relatively recent (1-5 years)
Total veg. cover (%)	50	**Tree cover (%)**	30
Shrub cover (%)	5	**Grass cover (%**	30
Herb cover (%)	0.1		

Sample and effort summary				
Sample method	**Visit**	**Sample date**	**Dimensions**	**Observer**
Quadrat	1	29-May-2022	unbounded	Grant Wells

Species (29)	Status	Visit 1		Visit 2	
		Cover (%)	Height (m)	Cover (%)	Height (m)
Acacia tumida var. *tumida*		20	5		
Sorghum stipoideum		20	1.5		
Chrysopogon latifolius		10	0.2		
Terminalia canescens		5	4		
Petalostigma pubescens		5	4		
Dodonaea hispidula var. *arida*		3	1.5		
Corymbia cadophora subsp. *cadophora*		1	10		
Grevillea refracta subsp. *refracta*		1	1.8		
Pterocaulon paradoxum		1	1.3		
Corymbia opaca		0.1	8		
Eucalyptus miniata		0.1	8		
Brachychiton diversifolius		0.1	5		
Carissa lanceolata		0.1	1.5		
Acacia dunnii		0.1	1.2		
Gomphrena flaccida		0.1	1		
Afrohybanthus enneaspermus		0.1	1		
Atalaya hemiglauca		0.1	1		
Crotalaria medicaginea var. *neglecta*		0.1	0.8		
Microstachys chamaelea		0.1	0.5		
Corchorus sidoides subsp. *sidoides*		0.1	0.4		
Bonamia pannosa		0.1	0.4		
Cathetus virgatus		0.1	0.3		
Scleria brownii		0.1	0.2		
Crotalaria ramosissima		0.1	0.2		
Cajanus marmoratus		0.1	0.1		
Indigofera trita		0.1	0.1		
Polymeria ambigua		0.1	0.1		
Trianthema pilosa		0.1	0.01		
Evolvulus alsinoides var. *villosicalyx*		0.1	0.01		

Site details			
Site	**SP031**	**Position (WGS84)**	-17.228848, 124.396819
Slope	negligible	**Topography**	plain
Soil colour	red-brown	**Soil texture**	sand
Rock cover (%)	0	**Rock type**	None

Observation details - visit 1 (29 May 2022)			
Sample description	Tall *Petalostigma pubescens*, *Acacia tumida* var. *tumida* and *A. colei* shrub land over mid open *Dodonaea hispidula* var. *arida*, *Calytrix exstipulata* and *Grevillea refracta* s		
Habitat	shrubland		
Disturbance	livestock tracks, weed infestation		
Vegetation condition	Excellent	**Fire age**	relatively recent (1-5 years)
Total veg. cover (%)	60	**Tree cover (%)**	45
Shrub cover (%)	15	**Grass cover (%**	5
Herb cover (%)	0.1		

Sample and effort summary				
Sample method	**Visit**	**Sample date**	**Dimensions**	**Observer**
Quadrat	1	29-May-2022	unbounded	Grant Wells

Species (27)	Status	Visit 1		Visit 2	
		Cover (%)	Height (m)	Cover (%)	Height (m)
Petalostigma pubescens		30	7		
Dodonaea hispidula var. *arida*		10	1.8		
Acacia tumida var. *tumida*		8	6		
Grevillea refracta subsp. *refracta*		6	2.5		
Acacia colei		5	6		
Calytrix exstipulata		5	1.8		
Sorghum stipoideum		3	1.5		
Chrysopogon latifolius		2	0.2		
Eucalyptus miniata		1	11		
Pterocaulon paradoxum		1	1		
Brachychiton diversifolius		0.5	5		
Ehretia saligna var. *saligna*		0.5	2		
Gymnema pleiadenium		0.1	2		
Senna costata		0.1	1.8		
Cassytha filiformis		0.1	1.5		
Terminalia canescens		0.1	1.5		
Lysiphyllum cunninghamii		0.1	1.3		
Waltheria indica		0.1	1		
Buchnera linearis		0.1	1		
Leichhardtia viridiflora subsp. *tropica*		0.1	0.6		
Corchorus sidoides subsp. *sidoides*		0.1	0.4		
Indigofera trita		0.1	0.3		
Cathetus virgatus		0.1	0.3		
Sida rohlenae subsp. *occidentalis*		0.1	0.25		
Hibiscus meraukensis		0.1	0.2		
Dicliptera armata		0.1	0.2		
Trianthema pilosa		0.1	0.02		

Appendix 3 NVIS hierarchy

Western Australia Current Practice			National Standard		
Hierarchy of terms	**Brief description in WA**	**Indicative scale**	**NVIS Level**	**Description**	**NVIS structural/floristic components required**
Vegetation formation	Structure and growth form – e.g., Forest, Woodland.	1:5 000 000	I	Class	Dominant growth form for the ecologically or structurally dominant stratum.
Vegetation sub-formation	Structural and dominant vegetation layer - Eucalypt Forest, Banksia Woodland	1:2 500 000 I	II	Structural Formation	Dominant growth form, cover and height for the ecologically or structurally dominant stratum.
Vegetation association	Structural form and dominant species – e.g., Medium woodland; York gum (*Eucalyptus loxophleba*) & Wandoo	1:1 000 000 to 1:250 000	III	Broad Floristic Formation	Dominant growth form, cover, height and dominant land cover genus for the uppermost or dominant stratum.
Vegetation complex	Structural and floristic description linked to geomorphology – e.g., Quindalup Complex.	1:250 000 to 1:100 000	IV	Sub-Formation	Dominant growth form, cover, height and dominant genus and Family for the 3 traditional strata. (i.e. Upper, Mid and Ground).
Vegetation type	Floristic definition by strata with structural detail. Often represented with a code and floristic description.	1:100 000 to 1:10 000	V	Association	Dominant growth form, height, cover and up to 3 species for the 3 traditional strata. (i.e. Upper, Mid and Ground).
Plant community	Basic unit of vegetation classification, site specific and highly localised with detailed floristics for each stratum.	1:10 000	VI	Sub-Association	Dominant growth form, height, cover and up to 5 species for all layers/ strata.
Floristic Community Type	Floristic composition definition; e.g., Northern banksia woodlands over herb rich shrublands on the Swan Coastal Plain.	No absolute scale			

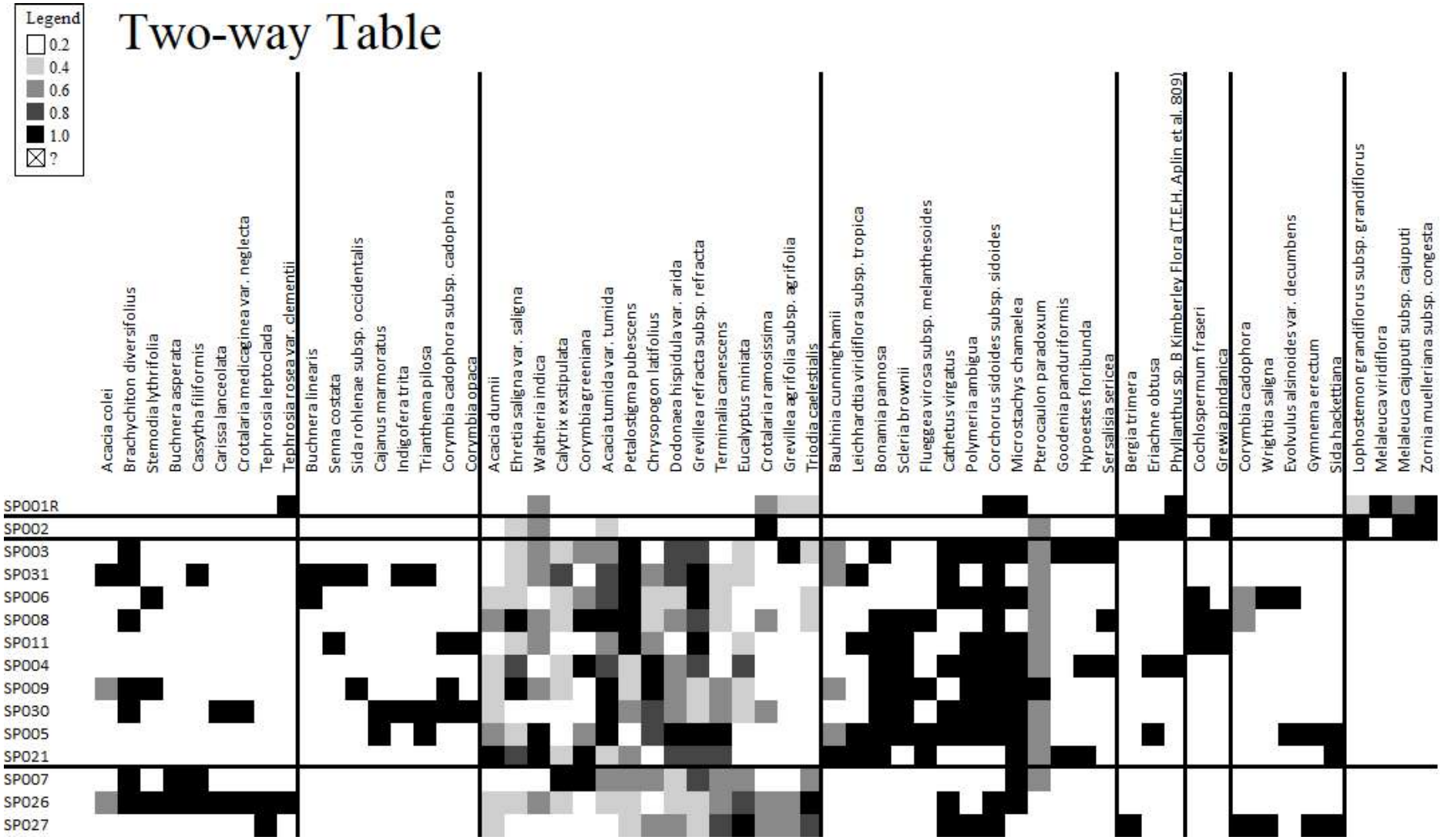
Appendix 4 Flora species inventory for the detailed survey

Family	Species
Acanthaceae	*Dicliptera armata*
Acanthaceae	*Hypoestes floribunda*
Acanthaceae	*Rostellularia adscendens* var. *clementii*
Aizoaceae	*Trianthema pilosa*
Amaranthaceae	*Gomphrena flaccida*
Apocynaceae	*Carissa lanceolata*
Apocynaceae	*Cathetus virgatus*
Apocynaceae	*Wrightia saligna*
Asclepiadaceae	*Gymnema erectum*
Asclepiadaceae	*Gymnema pleiadenium*
Asclepiadaceae	*Leichhardtia viridiflora* subsp. *tropica*
Asteraceae	*Blumea integrifolia*
Asteraceae	*Pterocaulon paradoxum*
Bignoniaceae	*Dolichandrone occidentalis*
Bixaceae	*Cochlospermum fraseri*
Boraginaceae	*Ehretia saligna* var. *saligna*
Boraginaceae	*Euploca ovalifolia*
Caryophyllaceae	*Polycarpaea corymbosa*
Centrolepidaceae	*Centrolepis exserta*
Cleomaceae	*Arivela viscosa*
Combretaceae	*Terminalia canescens*
Convolvulaceae	*Bonamia pannosa*
Convolvulaceae	*Evolvulus alsinoides* var. *decumbens*
Convolvulaceae	*Evolvulus alsinoides* var. *villosicalyx*
Convolvulaceae	*Polymeria ambigua*
Cyperaceae	*Bulbostylis barbata*
Cyperaceae	*Cyperus holoschoenus*
Cyperaceae	*Scleria brownii*
Elatinaceae	*Bergia trimera*
Eriocaulaceae	*Eriocaulon cinereum*
Euphorbiaceae	*Euphorbia coghlanii*
Euphorbiaceae	*Euphorbia schultzii* var. *comans*
Euphorbiaceae	*Microstachys chamaelea*
Fabaceae	*Acacia colei*
Fabaceae	*Acacia dunnii*
Fabaceae	*Acacia tumida* var. *tumida*
Fabaceae	*Bauhinia cunninghamii*
Fabaceae	*Cajanus marmoratus*

Family	Species
Fabaceae	*Crotalaria medicaginea* var. *neglecta*
Fabaceae	*Crotalaria ramosissima*
Fabaceae	*Indigofera hirsuta*
Fabaceae	*Indigofera trita*
Fabaceae	*Senna costata*
Fabaceae	*Senna notabilis*
Fabaceae	*Tephrosia leptoclada*
Fabaceae	*Tephrosia rosea* var. *clementii*
Fabaceae	*Vigna lanceolata* var. *lanceolata*
Fabaceae	*Zornia muelleriana* subsp. *congesta*
Goodeniaceae	*Goodenia odonnellii*
Goodeniaceae	*Goodenia panduriformis*
Goodeniaceae	*Goodenia sepalosa* var. *glandulosa*
Lauraceae	*Cassytha filiformis*
Lecythidaceae	*Planchonia careya*
Lythraceae	*Ammannia multiflora*
Malvaceae	*Brachychiton diversifolius*
Malvaceae	*Corchorus sidoides* subsp. *sidoides*
Malvaceae	*Grewia pindanica*
Malvaceae	*Hibiscus leptocladus*
Malvaceae	*Hibiscus meraukensis*
Malvaceae	*Sida hackettiana*
Malvaceae	*Sida rohlenae* subsp. *occidentalis*
Malvaceae	*Waltheria indica*
Myrtaceae	*Calytrix exstipulata*
Myrtaceae	*Corymbia cadophora* subsp. *cadophora*
Myrtaceae	*Corymbia dendromerinx*
Myrtaceae	*Corymbia greeniana*
Myrtaceae	*Corymbia opaca*
Myrtaceae	*Eucalyptus miniata*
Myrtaceae	*Eucalyptus tectifica*
Myrtaceae	*Lophostemon grandiflorus* subsp. *grandiflorus*
Myrtaceae	*Melaleuca cajuputi* subsp. *cajuputi*
Myrtaceae	*Melaleuca viridiflora*
Onagraceae	*Ludwigia perennis*
Orobanchaceae	*Buchnera asperata*
Orobanchaceae	*Buchnera linearis*
Orobanchaceae	*Buchnera ramosissima*
Phyllanthaceae	*Flueggea virosa* subsp. *melanthesoides*

Family	Species
Phyllanthaceae	*Phyllanthus* sp. B Kimberley Flora (T.E.H. Aplin et al. 809)
Picrodendraceae	*Petalostigma pubescens*
Plantaginaceae	*Stemodia lathraia*
Plantaginaceae	*Stemodia lythrifolia*
Poaceae	*Aristida hygrometrica*
Poaceae	*Chrysopogon latifolius*
Poaceae	*Eragrostis exigua*
Poaceae	*Eragrostis speciosa*
Poaceae	*Eriachne ciliata*
Poaceae	*Eriachne obtusa*
Poaceae	*Heteropogon contortus*
Poaceae	*Sorghum stipoideum*
Poaceae	*Triodia caelestialis*
Portulacaceae	*Calandrinia strophiolata*
Proteaceae	*Grevillea agrifolia* subsp. *agrifolia*
Proteaceae	*Grevillea pyramidalis* subsp. *pyramidalis*
Proteaceae	*Grevillea refracta* subsp. *refracta*
Proteaceae	*Persoonia falcata*
Rubiaceae	*Spermacoce occidentalis*
Santalaceae	*Santalum lanceolatum*
Sapindaceae	*Atalaya hemiglauca*
Sapindaceae	*Atalaya variifolia*
Sapindaceae	*Dodonaea hispidula* var. *arida*
Sapotaceae	*Sersalisia sericea*
Solanaceae	*Solanum cunninghamii*
Violaceae	*Afrohybanthus enneaspermus*
Vitaceae	*Ampelocissus acetosa*

Appendix 5 Flora species by site matrix for detailed survey



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Appendix 6 Flora species inventory for the reconnaissance GDV survey

Family	Species
Acanthaceae	*Nelsonia campestris*
Acanthaceae	*Rostellularia adscendens* var. *clementii*
Amaranthaceae	*Alternanthera angustifolia*
Asteraceae	*Calotis breviseta*
Asteraceae	*Pterocaulon paradoxum*
Asteraceae	*Streptoglossa odora*
Bixaceae	*Cochlospermum fraseri*
Boraginaceae	*Trichodesma zeylanicum* var. *zeylanicum*
Byblidaceae	*Byblis rorida*
Combretaceae	*Terminalia carpentariae*
Combretaceae	*Terminalia platyphylla*
Cyperaceae	*Abildgaardia oxystachya*
Cyperaceae	*Cyperus holoschoenus*
Cyperaceae	*Cyperus macrostachyos*
Cyperaceae	*Eleocharis brassii*
Cyperaceae	*Fimbristylis caespitosa*
Cyperaceae	*Fimbristylis littoralis*
Cyperaceae	*Fuirena ciliaris*
Droseraceae	*Drosera serpens*
Euphorbiaceae	*Microstachys chamaelea*
Fabaceae	*Acacia colei*
Fabaceae	*Acacia monticola*
Fabaceae	*Acacia neurocarpa*
Fabaceae	*Acacia tumida* var. *tumida*
Fabaceae	*Aeschynomene indica*
Fabaceae	*Bauhinia cunninghamii*
Fabaceae	*Indigofera hirsuta*
Fabaceae	*Sesbania cannabina*
Gentianaceae	*Canscora diffusa*
Lecythidaceae	*Planchonia careya*
Malvaceae	*Corchorus sidoides* subsp. *sidoides*
Malvaceae	*Waltheria indica*
Marsileaceae	*Marsilea hirsuta*
Menyanthaceae	*Nymphoides indica*
Menyanthaceae	*Nymphoides quadriloba*
Moraceae	*Ficus aculeata* var. *aculeata*
Myrtaceae	*Calytrix exstipulata*
Myrtaceae	*Corymbia dendromerinx*

Family	Species
Myrtaceae	*Corymbia opaca*
Myrtaceae	*Corymbia polycarpa*
Myrtaceae	*Eucalyptus camaldulensis* subsp. *obtusa*
Myrtaceae	*Lophostemon grandiflorus* subsp. *grandiflorus*
Myrtaceae	*Lophostemon grandiflorus* subsp. *riparius*
Myrtaceae	*Melaleuca cajuputi* subsp. *cajuputi*
Myrtaceae	*Melaleuca viridiflora*
Onagraceae	*Ludwigia octovalvis*
Opiliaceae	*Opilia amentacea*
Pandanaceae	*Pandanus spiralis*
Phrymaceae	*Uvedalia linearis* var. *lutea*
Picrodendraceae	*Petalostigma pubescens*
Plantaginaceae	*Bacopa floribunda*
Poaceae	*Arundinella nepalensis*
Poaceae	*Chrysopogon latifolius*
Poaceae	*Eragrostis fallax*
Poaceae	*Eragrostis speciosa*
Poaceae	*Eriachne aristidea*
Poaceae	*Heteropogon contortus*
Poaceae	*Mnesithea rottboellioides*
Poaceae	*Sorghum stipoideum*
Portulacaceae	*Calandrinia uniflora*
Proteaceae	*Grevillea agrifolia* subsp. *agrifolia*
Proteaceae	*Hakea arborescens*
Pteridaceae	*Acrostichum speciosum*
Pteridaceae	*Ceratopteris thalictroides*
Santalaceae	*Santalum lanceolatum*
Sapindaceae	*Dodonaea platyptera*
Typhaceae	*Typha domingensis*