Brand Highway Passing Lanes

Survey for Listed Threatened and Priority Flora Taxa

MAIN ROADS WESTERN AUSTRALIA

DECEMBER 2017

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Brand Highway Passing Lanes Survey for Listed Threatened and Priority Flora Taxa

Prepared for: Main Roads Western Australia

Job Number: MR17-57

Report Number: MR17-57-01

Cover Photograph: *Arnocrinum gracillimum* (P2)

DOCUMENT REVISION AND STATUS

Revision	Status	Originator	Internal Reviewer	Internal Review Date	Client Reviewer	Client Review Date
A	Draft Report	AS/DC	CG	16/12/2017		

DISCLAIMER

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EXECUTIVE SUMMARY

Main Roads Western Australia (Main Roads) is proposing to undertake the construction of a series of passing lanes for the Brand Highway, north of Perth between Granville and Mimegarra (the Project) which will require clearing of native vegetation. Main Roads commissioned Woodman Environmental Consulting Pty Ltd (Woodman Environmental) to undertake survey for significant flora to support the approvals process for the Project.

The field survey was conducted from the 6th – 10th of November 2017, with vegetation located within the entire Survey Area grid searched for significant flora. A total of 22 significant flora taxa were recorded within the Survey Area, all of which were DBCA-listed Priority taxa. No Threatened flora taxa were recorded during the survey. The majority of these taxa are relatively widespread, and known from a reasonable number of populations across their range. Four significant taxa, being *Catacolea enodis* (P2), *Desmocladus microcarpus* (P2), *Lyginia excelsa* (P1) and *Tetratheca angulata* (P3), are considered to be of higher significance, either because they have a relatively restricted range, and/or are known from relatively few (less than 10) populations. However, all of these taxa were recorded outside the Survey Area, and it is expected that there are additional locations of these taxa in the immediate vicinity of the Survey Area.

A total of 11 significant flora taxa known from the vicinity of the Survey Area could not be surveyed for due to survey timing not coinciding with the flowering period (for taxa which flowering material is essential for identification and/or detection of the taxon). An assessment of likelihood of presence of these taxa identified a total of six of these DBCA listed priority taxa which could possibly occur in the Survey Area including *Acacia cummingiana* (P3), *Diuris recurva* (P4), *Drosera marchantii* subsp. *prophylla* (P3), *Thysanotus vernalis* (P3), *Thelymitra apiculata* (P4) and *Thelymitra pulcherrima* (P2). No additional significant taxa are considered likely to occur in the Survey Area.

1. INTRODUCTION

1.1 Project Overview

Main Roads Western Australia (Main Roads) is proposing to undertake the construction of a series of passing lanes for the Brand Highway, between Granville and Mimegarra (the Project) north of Perth in Western Australia (Figure 1). These proposed works will require clearing of native vegetation.

GHD Pty Ltd (GHD) undertook biological assessments for the Project in September 2014 and September/October 2015 (GHD 2016a, b) to assist in project design provide information for the environmental assessment and approvals process. Targeted survey for significant flora taxa was not undertaken over all the areas Main Roads is currently proposing to be clear.

Main Roads commissioned Woodman Environmental Consulting Pty Ltd (Woodman Environmental) to undertake survey for significant flora to support the approvals process for the Project.

1.2 Aim and Objectives

The aim of the survey was to accurately determine the extent (in terms of location and area) of significant flora taxa within the Survey Area. Main Roads provided a targeted flora taxa list for the survey (as presented below), however the survey was also to encompass any other significant flora taxa that may be located in the Survey Areas;

- *Drakaea elastica* (T)
- *Eucalyptus absita* (T)
- *Paracaleana dixonii* (T)
- *Ptychosema pusillum* (T)
- *Lyginia excelsa* (P1)
- *Arnocrinum gracillimum* (P2)
- *Catacolea enodis* (P2)
- *Chordifex reseminans* (P2)
- *Desmocladus microcarpus* (P2)
- *Allocasuarina ramosissima* (P3)
- *Banksia dallanneyi* subsp. *pollosta* (P3)
- *Beaufortia bicolor* (P3)
- *Drosera marchantii* subsp. *prophylla* (P3)
- *Grevillea makinsonii* (P3)
- *Guichenotia alba* (P3)
- *Haemodorum loratum* (P3)
- *Phlebocarya pilosissima* subsp. *pilosissima* (P3)
- *Diuris recurva* (P4)
- *Eucalyptus macrocarpa* subsp. *elachantha* (P4)
- *Grevillea saccata* (P4)

The overall objectives of the assessment were to:

- Identify and record the locations of flora taxa that occur within the Survey Area that are one of the following (hereafter referred to as significant flora taxa):
  - Listed Threatened Species under the *Environment Protection and Biodiversity Conservation Act* 1999 (Commonwealth) (EPBC Act);
  - Threatened Flora under the *Wildlife Conservation Act* 1950 (WA) (WC Act);
  - Priority Flora taxa as classified by the Western Australian Department of Parks and Wildlife (DPaW); and
  - Other significant flora taxa as defined by EPA (2016).

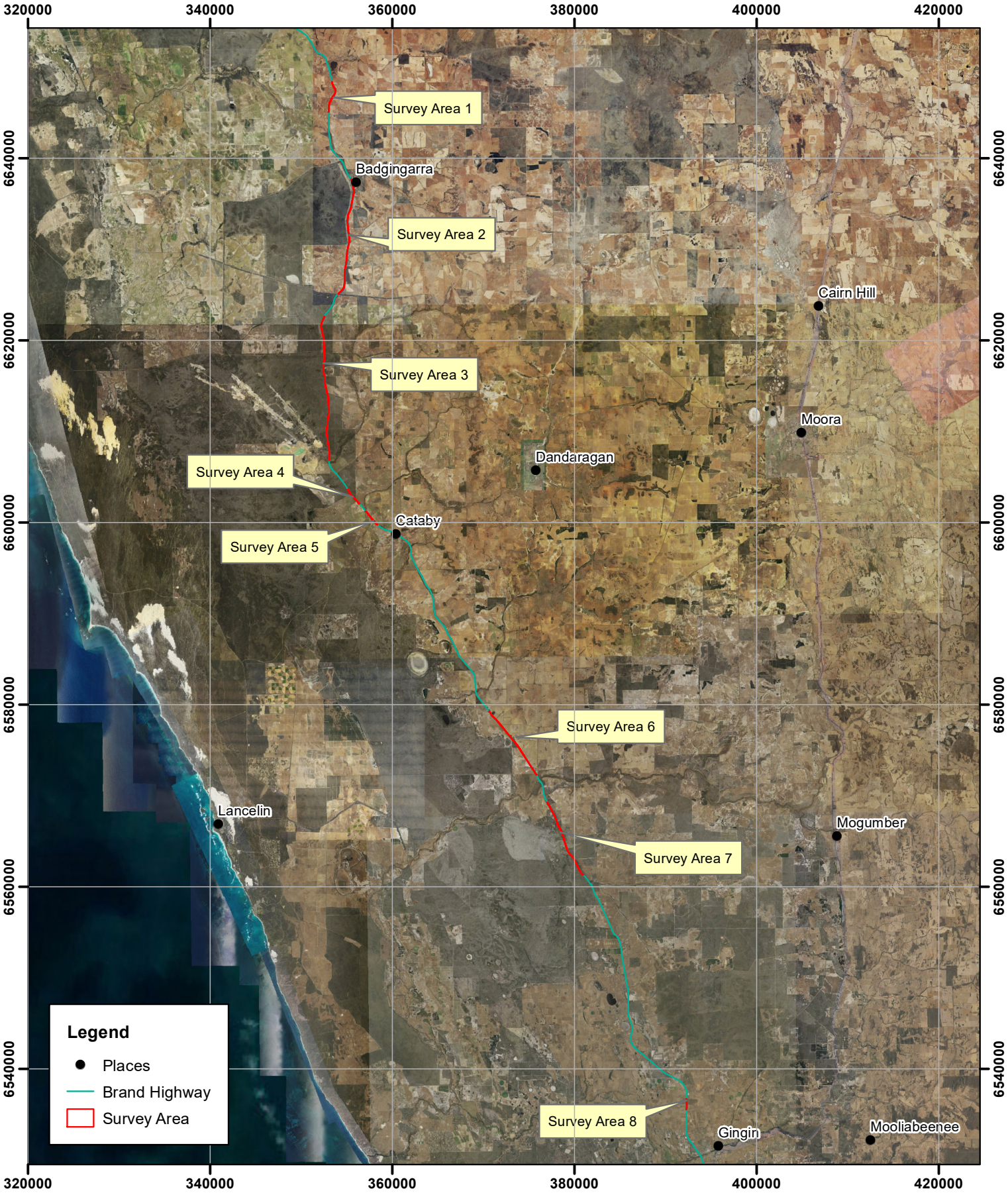
The survey and reporting works comply with the following documents:

- *Environmental Protection (Clearing of Native Vegetation) Regulations* 2004;
- *Environmental Factor Guideline – Flora and Vegetation* (EPA 2016);
- *Technical Guide - Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA (2016).

1.3 Survey Area

The Survey Area is located in the Midwest Region of Western Australia occurring in the Geraldton Sandplains and Swan Coastal Plain IBRA regions. The Survey Area consists of 13 polygons which have been designated into eight areas (Survey Areas 1 – 8), with the most northern area being Survey Area 1 and the most southern area being Survey Area 8 (Figure 1). The Survey Area occurs:

- Between the vicinity of Cataby northward to Badgingarra;
- Immediately north of the intersection of Red Gully Road and the Brand Highway heading northwards to the intersection of Nammegarra Road and the Brand Highway; and
- In the vicinity of Wallering Road.



Survey Area Location	Author: Alison Saligari	N
	WEC Ref: MR17-57-01	
WOODMAN ENVIRONMENTAL	Filename: MR17-57-01-f01.mxd	**Figure**
	Scale: 1:550,000 (A4)	1
	Projection: GDA 1994 MGA Zone 50	
This map should only be used in conjunction with WEC report MR17-57-01.	Revision: A - 24 November 2017	

2. BACKGROUND

2.1 Climate

The Survey Area is located within the Geraldton Sandplains and Swan Coastal Plain IBRA regions in the South-West Province (Beard 1990). The climate of this area is classified as Mediterranean, with winter rain and a dry summer (Beard 1990). Figure 2 displays long term mean monthly rainfall for 3 meteorological stations in the vicinity of Survey Areas 1 - 8 including Badgingarra (data from 1962 – 2017), Lake Nammen (data from 1971 – 2017) and Gingin (data from 1889 – 2017) (Bureau of Meteorology 2017).

Mean monthly rainfall generally peaks from late autumn to early spring (May – September), with the highest rainfall on average received in July for the 3 stations. The rainfall pattern in 2017 was unusual compared with the long-term monthly averages, with much higher rainfall experienced in January and February, followed by lower rainfall in April – June and higher rainfall in August – September (Figure 2). The rainfall received from May to September 2017 was below the long term average across these months for Badgingarra, Lake Nammen and Gingin with a total of 70.5 mm, 62.1 mm and 217.8 mm below the long term average recorded for the 3 stations respectively (Bureau of Meteorology 2017).

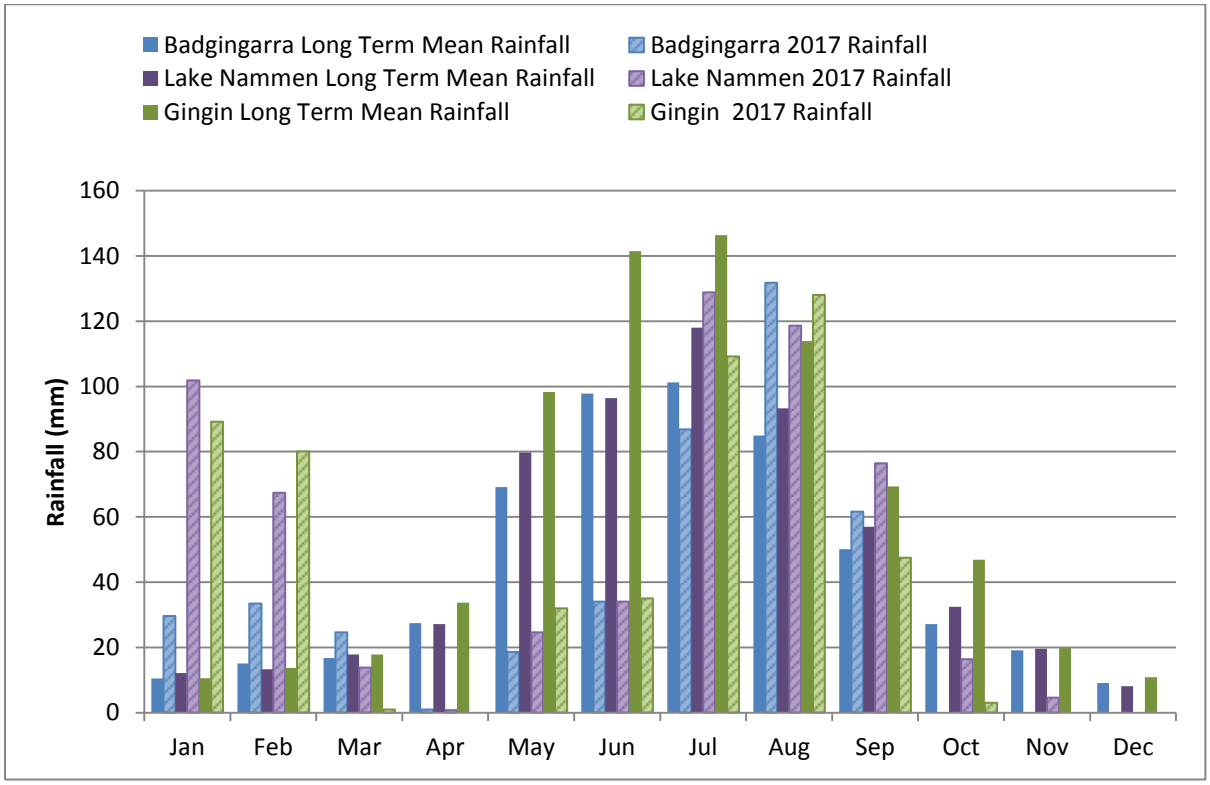


Figure 2: Rainfall (mm) Recorded at Badgingarra, Lake Nammen and Gingin (Bureau of Meteorology 2017)

2.2 Flora

Main Roads conducts annual dataset requests from DBCA's Threatened flora databases, including the Western Australian Herbarium (WA Herb) specimen database and Threatened

and Priority Flora database (TPFL). The search undertaken for the Survey Area included all records within the Survey Area, and within a 10 km buffer of the Survey Area. Table 1 presents the resulting flora taxa from this search, as well as significant flora records from local flora surveys undertaken in the Survey Area on behalf of Main Roads (Astron 2016, GHD 2016a, b and Main Roads 2016).

As per Table 1, a total of 173 significant taxa are known from the vicinity of the Survey Area, including 28 Threatened taxa and 145 DBCA listed priority taxa. Of these, 23 taxa have been previously recorded during surveys for the Project, and occur within or in the immediate vicinity of Survey Area (shaded in yellow). Appendix A presents conservation codes for Western Australia flora (DBCA 2017a).

Table 1: Significant Flora Taxa Known from the Vicinity of the Survey Area

Taxon	Status	Source
Acacia cummingiana	P3	WA Herb
Acacia denticulosa	Threatened	WA Herb
Acacia drummondii subsp. *affinis*	P3	TPFL, WA Herb
Acacia epacantha	P3	WA Herb
Acacia flabellifolia	P3	WA Herb
Acacia forrestiana	Threatened	WA Herb
Acacia plicata	P3	WA Herb
Acacia pulchella var. reflexa acuminate bracteole variant (R.J. Cumming 882)	P3	TPFL, WA Herb
Acacia retrorsa	P2	WA Herb
Acacia splendens	Threatened	TPFL, WA Herb
Acacia wilsonii	Threatened	WA Herb
Allocasuarina grevilleoides	P3	WA Herb
Allocasuarina ramosissima	P3	GHD (2016a), TPFL, WA Herb
Amanita carneiphylla	P3	WA Herb
Andersonia gracilis	Threatened	TPFL, WA Herb
Anigozanthos humilis subsp. Badgingarra (S.D. Hopper 7114)	P2	TPFL, WA Herb
Anigozanthos humilis subsp. *chrysanthus*	P4	TPFL, WA Herb
Anigozanthos viridis subsp. *terraspectans*	Threatened	TPFL, WA Herb
Arnocrinum gracillimum	P2	TPFL, WA Herb
Asterolasia drummondii	P4	TPFL, WA Herb
Asterolasia grandiflora	P4	WA Herb
Babingtonia delicata	P1	TPFL, WA Herb
Babingtonia urbana	P3	WA Herb
Baeckea sp. Dandaragan (G. Paczkowska s.n. PERTH 08245606)	P1	WA Herb
Banksia chamaephyton	P4	WA Herb
Banksia dallanneyi subsp. *pollosta*	P3	GHD (2016b), TPFL, WA Herb
Banksia elegans	P4	WA Herb
Banksia kippistiana var. *paenepeccata*	P3	WA Herb,
Banksia mimica	Threatened	TPFL, WA Herb
Banksia nobilis subsp. *fragrans*	P3	WA Herb

Taxon	Status	Source
Banksia prionophylla	P1	TPFL, WA Herb
Banksia pteridifolia subsp. *vernalis*	P3	WA Herb
Banksia serratuloides subsp. *perissa*	Threatened	TPFL, WA Herb
Banksia splendida subsp. *macrocarpa*	P3	WA Herb
Banksia subulata	P3	WA Herb
Beaufortia bicolor	P3	TPFL, WA Herb
Beaufortia eriocephala	P3	TPFL, WA Herb
Beyeria gardneri	P3	WA Herb
Blennospora doliiformis	P3	TPFL, WA Herb
Boronia tenuis	P4	TPFL
Caladenia speciosa	P4	WA Herb
Calectasia palustris	P2	WA Herb
Calytrix chrysantha	P4	TPFL, WA Herb
Calytrix ecalycata subsp. *brevis*	P3	WA Herb
Catacolea enodis	P2	WA Herb
Chamelaucium sp. Cataby (G.J. Keighery 11009)	Threatened	TPFL, WA Herb
Chordifex chaunocoleus	P4	TPFL, WA Herb
Chordifex reseminans	P2	GHD (2016b), TPFL, WA Herb
Comesperma rhadinocarpum	P2	TPFL, WA Herb
Conospermum scaposum	P3	WA Herb
Conostephium magnum	P4	GHD (2016a, b), Main Roads (2016), WA Herb
Cristonia biloba subsp. *pubescens*	P2	WA Herb
Cyanicula ixioides subsp. *ixioides*	P4	WA Herb
Dampiera tephrea	P2	TPFL, WA Herb
Darwinia acerosa	Threatened	WA Herb
Darwinia carnea	Threatened	WA Herb
Desmocladus biformis	P3	WA Herb
Desmocladus elongatus	P4	GHD (2016a, b), WA Herb
Desmocladus microcarpus	P2	TPFL, WA Herb
Desmocladus nodatus	P3	WA Herb
Dillwynia dillwynioides	P3	TPFL, WA Herb
Diuris drummondii	Threatened	TPFL, WA Herb
Diuris ?recurva	P4	GHD (2016b)
Drakaea elastica	Threatened	TPFL, WA Herb
Drosera allantostigma	P1	WA Herb
Drosera marchantii subsp. *prophylla*	P3	TPFL, WA Herb
Drosera occidentalis subsp. *occidentalis*	P4	TPFL
Eleocharis keigheryi	Threatened	TPFL, WA Herb
Eucalyptus abdita	P2	WA Herb
Eucalyptus absita	Threatened	TPFL, WA Herb
Eucalyptus absita x *loxophleba*	P1	TPFL, WA Herb
Eucalyptus crispata	Threatened	TPFL, WA Herb
Eucalyptus exilis	P4	TPFL, WA Herb
Eucalyptus lateritica	Threatened	TPFL, WA Herb
Eucalyptus leprophloia	Threatened	TPFL, WA Herb
Eucalyptus macrocarpa subsp. *elachantha*	P4	GHD (2016a), TPFL, WA Herb
Eucalyptus pendens	P4	TPFL, WA Herb
Eucalyptus suberea	Threatened	TPFL, WA Herb
Eucalyptus x carnabyi	P4	TPFL, WA Herb

Taxon	Status	Source
Gastrolobium nudum	P2	WA Herb
Gompholobium gairdnerianum	P3	WA Herb
Goodenia xanthotricha	P2	WA Herb
Grevillea calliantha	Threatened	TPFL, WA Herb
Grevillea drummondii	P4	TPFL, WA Herb
Grevillea evanescens	P1	TPFL, WA Herb
Grevillea florida	P3	TPFL, WA Herb
Grevillea leptopoda	P3	WA Herb
Grevillea makinsonii	P3	GHD 2016a
Grevillea rudis	P4	GHD (2016a, b), WA Herb,
Grevillea saccata	P4	GHD (2016b), TPFL, WA Herb
Grevillea synapheae subsp. A Flora of Australia (S.D. Hopper 6333)	P1	TPFL, WA Herb
Grevillea synapheae subsp. *minyulo*	P1	GHD (2016b), TPFL, WA Herb
Grevillea thyrsoides subsp. *thyrsoides*	P3	WA Herb
Grevillea uniformis	P3	WA Herb
Guichenotia alba	P3	GHD (2016b), WA Herb
Haemodorum loratum	P3	Astron (2016), TPFL, WA Herb
Hakea longiflora	P3	WA Herb
Hakea megalosperma	Threatened	TPFL, WA Herb
Hakea neurophylla	P4	WA Herb
Hensmania stoniella	P3	WA Herb
Hibbertia glomerata subsp. *ginginensis*	P2	TPFL, WA Herb
Hibbertia helianthemoides *	P4	GHD (2016b), TPFL
Hopkinsia anoectocolea	P3	WA Herb
Hypocalymma gardneri	P3	Main Roads, WA Herb
Hypocalymma serrulatum	P3	GHD (2016a), TPFL, WA Herb
Hypocalymma sp. Cataby (G.J. Keighery 5151)	P2	TPFL, WA Herb
Hypocalymma sp. Dandaragan (C.A. Gardner 9014)	P1	WA Herb
Hypocalymma tetrapterum	P3	TPFL, WA Herb
Hypolaena robusta	P4	GHD (2016a), WA Herb
Isopogon drummondii	P3	WA Herb
Isopogon panduratus subsp. *palustris*	P3	WA Herb
Isotropis cuneifolia subsp. *glabra*	P2	TPFL, WA Herb
Jacksonia anthoclada	P3	TPFL, WA Herb
Jacksonia carduacea	P3	WA Herb
Jacksonia rubra	P2	WA Herb
Lasiopetalum sp. Hill River (T.N. Stoate 5)	P1	WA Herb
Lasiopetalum venustum	P3	WA Herb
Lepidobolus quadratus	P3	WA Herb
Lepyrodia curvescens	P2	WA Herb
Leucopogon plumuliflorus	P2	WA Herb
Leucopogon sp. Badgingarra (R. Davis 421)	P2	WA Herb
Leucopogon sp. Yanchep (M. Hislop 1986)	P3	WA Herb
Leucopogon squarrosus subsp. *trigynus*	P2	WA Herb
Lyginia excelsa	P1	GHD (2016b), WA Herb
Macarthuria keigheryi	Threatened	TPFL, WA Herb
Onychosepalum microcarpum	P3	GHD (2016a)
Paracaleana dixonii	Threatened	TPFL, WA Herb
Patersonia spirifolia	Threatened	WA Herb

Taxon	Status	Source
Persoonia filiformis	P2	WA Herb
Persoonia rudis	P3	TPFL, WA Herb
Petrophile biternata	P3	WA Herb
Phlebocarya pilosissima subsp. *pilosissima*	P3	GHD (2016a, b), WA Herb
Platysace ramosissima	P3	TPFL, WA Herb
Podotheca pritzelii	P3	WA Herb
Ptychosema pusillum	Threatened	TPFL, WA Herb
Rhetinocarpha suffruticosa	P1	WA Herb
Rumex drummondii	P4	WA Herb
Schoenus griffinianus	P4	GHD (2016a), Main Roads (2016), TPFL, WA Herb
Schoenus natans	P4	TPFL, WA Herb
Schoenus pennisetis	P3	WA Herb
Spirogardnera rubescens	Threatened	TPFL, WA Herb
Stackhousia sp. Red-blotched corolla (A. Markey 911)	P3	WA Herb
Stenanthemum sublineare	P2	WA Herb
Stylidium aceratum	P3	WA Herb
Stylidium aeonioides	P4	TPFL, WA Herb
Stylidium hymenocraspedum	P3	WA Herb, GHD (2016a, b)
Stylidium inversiflorum	P4	WA Herb
Stylidium longitubum	P4	TPFL, WA Herb
Stylidium nonscandens	P3	WA Herb
Stylidium periscelianthum	P3	WA Herb
Stylidium sp. Moora (J.A. Wege 713)	P2	WA Herb
Stylidium tinkeri	P1	WA Herb
Stylidium torticarpum	P3	WA Herb
Synaphea endothrix	P3	TPFL, WA Herb
Synaphea grandis	P4	WA Herb
Tetratheca angulata	P3	GHD (2016a), WA Herb
Tetratheca hirsuta subsp. *boonanarring*	P2	WA Herb
Thelymitra apiculata	P4	WA Herb
Thelymitra dedmaniarum	Threatened	TPFL, WA Herb
Thelymitra pulcherrima	P2	WA Herb
Thelymitra stellata	Threatened	TPFL
Thysanotus glaucus	P4	TPFL, WA Herb
Thysanotus sp. Badgingarra (E.A. Griffin 2511)	P2	WA Herb
Thysanotus vernalis	P3	WA Herb
Tripterococcus sp. Brachylobus (A.S. George 14234)	P4	TPFL, WA Herb
Verticordia amphigia	P3	WA Herb
Verticordia fragrans	P3	WA Herb
Verticordia huegelii var. *tridens*	P3	WA Herb
Verticordia insignis subsp. *eomagis*	P3	TPFL, WA Herb
Verticordia lindleyi subsp. *lindleyi*	P4	TPFL, WA Herb
Verticordia paludosa	P4	TPFL, WA Herb
Verticordia rutilastra	P3	TPFL, WA Herb
Xanthosia tomentosa	P4	WA Herb

*Note: please see below for further information regarding this taxon

GHD (2016b) recorded *Hibbertia helianthemoides senso lato* (P4) in their study area, and noted that "*Hibbertia helianthemoides senso stricto* occurs in the Stirling Range area and the specimen collected in the Survey area is one of several atypical morphotypes that are currently under study. It is likely that these morphotypes will be recognised as segregate taxa in the future."

Hibbertia helianthemoides was also returned from the DBCA TPFL database search. A recent study by Theile and Nge (2017) concluded that *H. helianthemoides* occurs only in the vicinity of the Stirling Range, with all specimens previously ascribed to *H. helianthemoides* collected in the vicinity of the survey area can be referred to a number of other taxa, including *H. sericosepala*, *H. huegelii*, *H. leucocrossa* and *H. desmophylla*, none of which are significant taxa. Based on the photograph presented in GHD (2016b), the taxon collected in their study area is most likely to be *H. sericosepala*. *Hibbertia helianthemoides* was therefore not considered further by this survey.

3. METHODS

3.1 Personnel and Licensing

Table 2 lists the personnel involved in both fieldwork and plant identifications for the survey. The Project Manager (involved in fieldwork and plant identifications) has had extensive previous experience in conducting flora surveys in the vicinity of the Survey Area. All plant material was collected under the scientific licences pursuant to the WC Act Section 23C and Section 23F as listed in Table 2.

Table 2: Personnel and Licensing Information

Personnel	Role	Flora Collecting Permit (WC Act)
David Coultas	Project Manager / Field Manager / Plant Identifications	SL012069 (Section 23C) 119-1617 (Section 23F)
Julia Mattner	Fieldwork	SL012073 (Section 23C)
Marlee Starcevich	Fieldwork	SL012209 (Section 23C)
Samuel Hall	Fieldwork	-

3.2 Field Survey Methods

The field survey was conducted from the 6th – 10th of November, 2017. It is considered that this survey was conducted during the appropriate season (spring), with the majority of taxa in this region (Geraldton Sandplains/ Swan Coastal bioregion) flowering at this time. It is acknowledged however that not all significant flora taxa which may be present in the Survey Area were able to be verified during this survey period (see section 4).

Historical locations of significant flora taxa within the Survey Area were assessed in the field for the relevant taxa, to determine the presence and flowering status of these populations.

Access to the Study Area was achieved by vehicle via Brand Highway. The entire Survey Area was grid searched on foot. The width of vegetation of the Survey Area was generally between 5 m - 10m in width, and occasionally up to 20 m in isolated small sections. Where the vegetation was wide enough, personnel generally walked a single transect through the vegetation and then another on the road shoulder. In some cases the Survey Area was so narrow that only a single transect on the road shoulder was undertaken.

The locations (using GPS) and number of individuals of significant flora at each location were recorded. Where Threatened flora taxa were observed, locations were recorded using DGPS. To assist impact assessment, when Threatened or Priority 1 flora taxa were recorded inside the Survey Area, specific searching to record locations and numbers of individuals outside of the Survey was undertaken if these populations extended outside of the Survey Area. For other significant flora taxa, notes were taken if populations extended outside of the Study Area, with occasional opportunistic records of such significant flora taxa made when clarification of individual numbers was required; however populations outside of the Survey Area were not censed.

All areas traversed in the Survey Area are presented as track logs on Figures 3.1 – 3.19 (presented in Appendix B). Some tracks extend outside the Survey Area to search for flora as outlined above.

3.3 Plant Collection and Identification

Specimens of any unknown taxa that were collected were pressed for later identification at the WA Herbarium. Identifications were undertaken by experienced botanist David Coultas. External experts of particular families or genera were consulted for any specimens considered to be difficult to identify or of taxonomic interest.

Taxon nomenclature generally follows *FloraBase* (Western Australian Herbarium 1998-) with all names checked against the current DPaW Max database to ensure their validity. However, in cases where names of plant taxa have been published recently in scientific literature but have not been adopted on *FloraBase* (Western Australian Herbarium 1998-), nomenclature in the published literature is followed. The conservation status of each taxon was checked against *FloraBase*, which provides the most up-to-date information regarding the conservation status of flora taxa in Western Australia.

Specimens of interest, including significant flora taxa, range extensions of taxa and potential new taxa, will be sent to the WA Herbarium for consideration for vouchering as soon as practicable. However, this process is via donation, and the WA Herbarium may not voucher all specimens, in accordance with its own requirements. The specimen vouchering will be supported by completed Threatened and Priority Flora Report Forms submitted to DBCA (Species and Communities Branch) in the case of listed significant flora (e.g. Threatened and Priority flora taxa).

4. LIMITATIONS OF SURVEY

The project manager / field manager has extensive experience in conducting significant flora assessments within the vicinity of the Survey Area. All other personnel involved in the field survey have experience undertaking similar targeted flora surveys. All field personnel familiarised themselves with significant taxa known from the vicinity of the Survey Area (Table 1).

The following taxa could not be surveyed for because flowering material is essential for identification and/or detection of the taxon, and the survey timing did not coincide with the known flowering period of the following taxa:

- *Acacia cummingiana* (P3)
- *Caladenia speciosa* (P4)
- *Cyanicula ixioides subsp. ixioides* (P4)
- *Diuris recurva* (P4)
- *Drakaea elastica* (T) (see below)
- *Drosera marchantii* subsp. *prophylla* (P3)
- *Podotheca pritzelii* (P3)
- *Stylidium periscelianthum* (P3)
- *Thysanotus vernalis* (P3)
- *Thelymitra apiculata* (P4)
- *Thelymitra pulcherrima* (P2)

The flowering period of *Drakaea elastica* (Threatened) coincides with the survey timing; however, DBCA advises that this taxon should be searched for when its distinctive leaves (which are diagnostic) are visible in July and August (K. Atkins *pers. comm.* 2013). As the leaves of this taxon would have withered by the time the survey was conducted, it is therefore considered that this taxon was not surveyed for.

Although the rainfall recorded prior to the survey was below average, it did not prevent the identification of any significant flora which would be identifiable during the period of time during which the survey was conducted, and is not considered to be a constraint to this survey.

5. RESULTS

5.1 Survey Results

Table 3 presents a list of significant flora taxa recorded in the Survey Area, together with location information. A total of 22 significant flora taxa were recorded during the field survey of the Survey Area. No Threatened flora taxa were recorded during the survey.

Locations of significant flora are presented in Appendix C and on Figures 4.1 – 4.19 (Appendix D). Photos of significant flora are presented in Appendix E. Note that taxa that have photographs presented in previous survey reports for the Project are not included in Appendix E, except where an additional photograph is considered desirable.

Table 3: Summary of Significant Flora Taxa Recorded within the Survey Area

Taxon	Status	No. of Point Locations in the Survey Area	No. Individuals in the Survey Area	Location	Status and Relevant Data Outside the Survey Area *
Anigozanthos humilis subsp. *chrysanthus*	P4	1	1	Survey Area 7	Not observed outside survey area
Arnocrinum gracillimum	P2	1	1	Survey Area 3	Extends outside survey area: 47 individuals recorded across 5 point locations
Beaufortia bicolor	P3	126	457	Survey Area 2, 3	Extends outside survey area: 145 individuals recorded across 44 point locations
Catacolea enodis	P2	4	5	Survey Area 2	Extends outside survey area: 3 individuals recorded at 1 point location
Comesperma rhadinocarpum	P2	71	144	Survey Area 2, 3	Extends outside survey area: 5 individuals recorded at 1 point location, most individuals restricted to gravel shoulder of highway
Conostephium magnum	P4	77	225	Survey Area 1, 4	Extends outside survey area: 111 individuals recorded across 19 point locations, plus numerous further individuals across locations recorded by GHD (2016a, b)
Desmocladus biformis	P3	21	89	Survey Area 2, 3	Extends outside survey area: 13 individuals recorded across 5 point locations
Desmocladus elongatus	P4	42	241	Survey Area, 1, 2. 3	Extends outside survey area: 5 individuals recorded at 1 point location, plus several individuals at locations recorded by GHD (2016a, b), most individuals restricted to historically disturbed verge of highway

Taxon	Status	No. of Point Locations in the Survey Area	No. Individuals in the Survey Area	Location	Status and Relevant Data Outside the Survey Area *
Desmocladus microcarpus	P2	1	1	Survey Area 2	Extends outside survey area: 1 individual observed at previously recorded location (GHD 2016a).
Grevillea rudis	P4	7	27	Survey Area 1, 2	Extends outside survey area: 2 individuals recorded at 1 point location, plus approximately 21 individuals at locations recorded by GHD (2016a, b)
Grevillea saccata	P4	7	13	Survey Area 1	Extends outside survey area: not recorded outside survey area by this survey, however approximately 22 individuals occur outside survey area across locations recorded by GHD (2016b)
Guichenotia alba	P3	8	31	Survey Area 1, 3	Extends outside survey area: 56 individuals recorded across 3 point locations, plus approximately 19 further individuals recorded by GHD (2016b)
Haemodorum loratum	P3	6	9	Survey Area 2, 6, 7	Extends outside survey area: not recorded outside survey area by this survey, however 2 individuals occur outside survey area at 2 locations recorded by Astron (2016)
Hensmania stoniella	P3	3	4	Survey Area 2	Not observed outside survey area
Hypocalymma serrulatum	P3	87	1298	Survey Area 3	Extends outside survey area: 511 individuals recorded across 6 point locations
Hypolaena robusta	P4	17	82	Survey Area 3	Extends outside survey area: 41 individuals recorded across 5 point locations
Jacksonia anthoclada	P3	8	59	Survey Area 3	Not observed outside survey area
Lyginia excelsa	P1	83	625	Survey Area 3	Extends outside survey area: 1,038 individuals recorded across 73 point locations
Persoonia filiformis	P2	4	6	Survey Area 2	Not observed outside survey area
Phlebocarya pilosissima subsp. *pilosissima*	P3	11	11	Survey Area 2, 3	Extends outside survey area: not recorded outside survey area by this survey, however 2 individuals occur outside survey area at 2 locations recorded by GHD (2016b)

Taxon	Status	No. of Point Locations in the Survey Area	No. Individuals in the Survey Area	Location	Status and Relevant Data Outside the Survey Area *
Schoenus griffinianus	P4	12	40	Survey Area 2, 3	Extends outside survey area: 5 individuals recorded across 2 point locations, plus approximately 3 individuals across locations recorded by GHD (2016a)
Tetratheca angulata	P3	13	89	Survey Area 2	Extends outside survey area: 25 individuals recorded at 1 point location, plus 2 individuals across locations recorded by GHD (2016a)

*Note: Please see Appendix C for further detail regarding locations and number of individuals recorded outside of the Survey Area.

5.2 Assessment of Historical Data

Grevillea makinsonii (P3) was previously recorded by GHD (2016a) at four locations within their study areas, with 1 location within the current survey area. When reviewing GHD (2016a) prior to the survey, it was noted that the photograph of *Grevillea makinsonii* presented appeared to represent the common species *Grevillea shuttleworthiana*. The recorded locations are also well outside the known range of *Grevillea makinsonii*; the nearest location with accurate details is approximately 75 km north of the GHD (2016a) records. All four locations were visited, with only *Grevillea shuttleworthiana* subsp. *canarina* found; a specimen was collected and verified at the Western Australian Herbarium. It is considered that the identification of *Grevillea makinsonii* in the survey area is erroneous, and that this species does not occur in the survey area; all records should be removed from Main Roads' datasets.

Hypolaena robusta (P4) was also previously recorded by GHD (2016a) at three locations within their study areas, with two locations within the current survey area. When reviewing GHD (2016a) prior to the survey, it was also noted that the photograph of *Hypolaena robusta* presented appeared to represent a densely clumping rush taxon with short rhizomes; it is suspected that the photograph is the densely clumping *Lyginia excelsa* (P1), a species not recorded by GHD (2016a), but previously recorded in the survey area by GHD (2016b). *Hypolaena robusta* is known to have elongated rhizomes and therefore does not form dense clumps (Meney *et al.* 1996). The two locations in the survey were visited, with *Lyginia excelsa* found at both locations. The third unvisited location outside the survey area also occurs in very close (within 100 m) proximity to a known *Lyginia excelsa* location. It is therefore considered likely that all of the previously recorded locations of *Hypolaena robusta* are erroneous, and should be removed from Main Roads' significant flora dataset; however, *Hypolaena robusta* was recorded elsewhere in the survey area (see above), although not in close proximity to the previously recorded locations.

Hypocalymma gardneri (P3) was previously recorded by Main Roads (2016) at several locations within their surveyed infill areas, with these locations within the current survey

area. When reviewing Main Roads (2016) prior to the survey, it was also noted that the photograph presented in clearly represented the common taxon *Hypocalymma xanthopetalum*; *Hypocalymma gardneri* has needle-like leaves less than 1 mm in width, with the taxon in the photograph having oblong leaves clearly wider than this, as for *Hypocalymma gardneri* (Strid and Keighery 2002). No individuals of *Hypocalymma gardneri* were found at any of the recorded locations, however *Hypocalymma xanthopetalum* was found at several of the recorded locations. It is therefore considered likely that all of the previously recorded locations of *Hypocalymma gardneri* are erroneous, and should be removed from Main Roads' significant flora dataset.

Hypocalymma gardneri (P3) was not recorded elsewhere in the survey area; the survey area is not within the known range of this taxon, with the nearest known location with accurate locality details being 30 km north-west of the northern end of the survey area (a location 7 km east of Badgingarra and the survey area has erroneous coordinates, with the locality description indicating it was collected near Jurien Bay) (DBCA 2007-). *Hypocalymma gardneri* is therefore considered unlikely to occur within the survey area.

GHD (2016b) recorded *Diuris* ?*recurva* (P4) in their study area, and noted that the collection most likely represented *Diuris recurva* based on the size of the plant and flower, however also noted that the common *Diuris refracta* is very similar. The photograph presented in GHD (2016b) is not considered to represent *Diuris recurva*; this species has very differently coloured markings on the labellum lobes to the taxon in the photograph (red-brown versus bright purple in the photographed taxon), and the flowers generally have a recurved appearance, particularly the lateral sepals, unlike the taxon in the photograph which has straight lateral sepals (Brown *et al.* 2008; Hoffman and Brown 2011). The photograph was also taken after the usual flowering period for *Diuris recurva* (Hoffman and Brown 2011). It is also unlikely to represent *Diuris refracta*, as this species has similarly coloured and shaped flowers to *Diuris recurva* (Jones and French 2013a). It is considered likely that the taxon in the photograph is the common *Diuris tinkeri*, based on the colouration and general shape of the flowers (with bright purplish markings and not recurved (Jones and French 2013b), as well as the known flowering period and distribution of this taxon.

The nearest known location of *Diuris recurva* is approximately 10 km north-east of the northern end of the survey area (DBCA 2007-); it is therefore possible that this taxon could still occur in the survey area based on available habitat. However, as discussed in Section 4, the survey timing did not coincide with the known flowering period of this taxon, and therefore it could not be surveyed for during this time.

Banksia dallanneyi subsp. *pollosta* (P3) was recorded by GHD (2016b) at one location adjacent to the current survey area (Survey Area 7); two records from Main Roads' significant flora dataset are also located adjacent to the current survey area (Survey Area 6). Several collections of *Banksia dallanneyi* were made from both survey areas, including from in the vicinity of the recorded location in Survey Area 6 however, all have the leaves broader than 3 mm, and most leaves with less than 60 lobes (occasional leaves had more than 60). This indicates that for the collections made by this survey, it is more appropriate to refer them to the common *Banksia dallanneyi* subsp. *dallanneyi*, as *Banksia dallanneyi* subsp. *pollosta* has leaves 2-3 mm wide, with 60-80 lobes (as per George 1996).

However, George (1996) noted that *Banksia dallanneyi* subsp. *pollosta* grades into *Banksia dallanneyi* subsp. *dallanneyi*. It is therefore possible that the specimens with some leaves with more than 60 lobes may be intergrades between the two subspecies. Further study of *Banksia dallanneyi* appears to be required to resolve whether *Banksia dallanneyi* subsp. *pollosta* should be maintained as a discrete taxon, given the noted intergradation with *Banksia dallanneyi* subsp. *dallanneyi*, and the consequential difficulties in ascribing many specimens to either subspecies. Based on the collections made by this survey, it is considered that *Banksia dallanneyi* subsp. *pollosta* does not occur in the survey area.

Two locations of *Stylidium hymenocraspedum* (P3) in Main Roads' significant flora dataset are within the survey area. Both were inspected, however this taxon could not be found. It is possible the previously recorded individuals have senesced, as this species is likely relatively short-lived. *Stylidium hymenocraspedum* was observed outside the survey area in nearby areas during the survey, so would have been visible at the time of survey.

5.3 Assessment of Likelihood of Presence of Further Significant Flora Taxa

As discussed in Section 4, a number of taxa could not be surveyed for by this survey because flowering material is essential for identification and/or detection of the taxon, and the survey timing did not coincide with the known flowering period of the taxon. Table 4 presents an assessment of the likelihood of such taxa being present in the Survey Area, and the individual survey areas that such taxa could be present within based on the presence of suitable habitat, and the proximity to known records. Of the 11 taxa that could not be surveyed for at this time, it is considered that six could possibly occur in the Survey Area.

No additional taxa as listed in Table 1 are considered likely to occur in the Survey Area, including the 28 Threatened taxa.

The Threatened taxon *Drakaea elastica* is considered unlikely to occur in the Survey Area. Although there is a record in relatively close (<2 km) proximity to Survey Area 7, the record is adjacent to Red Gully Creek; this is considered typical habitat for this species, which occurs in low-lying sandy sites adjacent to wetlands. No such habitat exists in Survey Area 7; the habitat is *Banksia attenuata-Banksia menziesii* woodland, however it is not low-lying, and the Survey Area does not intersect any wetlands. It is therefore considered unlikely that this taxon occurs in the Survey Area.

Table 4: Assessment of Likelihood of Presence of Further Significant Flora Taxa

Taxon	Status	Likelihood of Occurrence in Survey Areas	Reasoning
Acacia cummingiana	P3	Possible – Survey Areas 1, 2, 3	Occurs in lateritic soils, including sand over laterite – suitable habitat observed in survey areas
Caladenia speciosa	P4	Unlikely	Known records only in vicinity of Survey Area 8 only; no habitat present in this survey area – vegetation is highly degraded

Taxon	Status	Likelihood of Occurrence in Survey Areas	Reasoning
Cyanicula ixioides subsp. *ixioides*	P4	Unlikely	Known records only in vicinity of Survey Area 8; no habitat present in this survey area – vegetation is highly degraded
Diuris recurva	P4	Possible – Survey Area 1	Occurs in winter-wet areas – suitable habitat observed in survey areas
Drakaea elastica	Threatened	Unlikely	Occurs in low-lying sandy areas adjacent to wetlands - Known record only in vicinity of Survey Area
Drosera marchantii subsp. *prophylla*	P3	Possible – Survey Areas 1, 2, 3	Occurs in lateritic soils, including sand over laterite – suitable habitat observed in survey areas
Podotheca pritzelii	P3	Unlikely	Occurs exclusively in saline areas – no suitable habitat observed in any survey areas (4 and 5) in vicinity of known records
Stylidium periscelianthum	P3	Unlikely	Occurs in winter-wet areas, particularly seepage areas and creek lines – no suitable habitat observed in any survey areas (4 and 5) in vicinity of known records
Thysanotus vernalis	P3	Possible – Survey Area 1	Occurs in winter wet areas or occasionally sandy areas – suitable habitat observed in survey areas
Thelymitra apiculata	P4	Possible – Survey Areas 1, 2, 3	Occurs in lateritic soils, including sand over laterite – suitable habitat observed in survey areas
Thelymitra pulcherrima	P2	Possible – Survey Areas 1, 2, 3	Occurs in lateritic soils, including sand over laterite – suitable habitat observed in survey areas

6. DISCUSSION

A total of 22 significant flora taxa were recorded within the Survey Area. The majority of taxa recorded are relatively widespread and known from a reasonable (more than 10) number of populations across their range (DBCA 2007-). However, four of these significant taxa, being *Catacolea enodis* (P2), *Desmocladus microcarpus* (P2), *Lyginia excelsa* (P1) and *Tetratheca angulata* (P3), are considered to be of higher significance, either because they have a relatively restricted range, and/or are known from relatively few (less than 10) populations (DBCA 2007-).

Catacolea enodis (P2) is known from a total of 12 records which appear to comprise six populations (DBCA 2007-). It is relatively geographically restricted, with a range extending approximately 55km north – south and 30km east – west, with the Survey Area situated within this range (DBCA 2007-). At least one of these known populations is located within conservation estate (Alexander Morrison National Park), with two others in the vicinity of Badgingarra National Park. During this survey, this taxon was recorded at four point locations, with a total of five individuals recorded (within Survey Area 2), located adjacent to the Badgingarra National Park. None of these surveyed locations form part of the public record. In addition, there were three individuals recorded at a single point location outside the Survey Area, and it is expected that there are additional locations of this taxon outside but in the immediate vicinity of the Survey Area.

Desmocladus microcarpus (P2) is known from a total of nine records which appear to comprise five populations (DBCA 2007-). As with *C. enodis*, this taxon has a restricted distribution, occurring over a range of approximately 120km north-south and 40km east-west. It is known to occur within the Badgingarra National Park, as well as within Nature Reserve 2654/215 (DBCA 2007-). During this survey, it was recorded at a single location, with one individual recorded (in Survey Area 2). This taxon is also known to occur outside the Survey Area with a single individual observed at location previously recorded by GHD (2016a); additional locations of this taxon are also likely to occur the immediate vicinity of Survey Area due to suitable habitat.

Lyginia excelsa (P1) is known from 11 records which appear to comprise seven populations (Western Australian Herbarium 1998-; DBCA 2007-). The majority (six) of these populations are located in the northern sandplains, over a range of 70km north-south and 15km east-west, with an additional outlier population in the vicinity of Perth. One of these populations is located within the Badgingarra National Park. During this survey, a total of 83 locations were recorded for this taxon within the Survey Area, with 652 individuals recorded (Survey Area 3). Numerous individuals were also recorded outside the Survey Area (1,038 individuals recorded across 73 point locations); as the populations were not completed surveyed outside of the Survey Area, it is expected that more individuals in these populations are present.

Tetratheca angulata (P3) is known from a total 15 records which appear to comprise eight populations (DBCA 2007). The range of this taxon extends 70km north-south and 35km east-west, and is known to occur in the Alexander Morrison National Park (DBCA 2007-). During this survey, this taxon was recorded at 13 point locations within the Survey Area, with 89 individuals recorded, within Survey Area 2. However, this taxon extends outside

survey area, with 25 individuals recorded at one point location (Appendix C), and an additional two individuals recorded across locations recorded by GHD (2016a) outside the Survey Area.

There were also several significant flora taxa found within the Survey Area which were not recorded outside the Survey Area during this survey, including *Anigozanthos humilis* subsp. *chrysanthus* (P4), *Hensmania stoniella* (P3*), Jacksonia anthoclada* (P3) and *Persoonia filiformis* (P2). However, these taxa are all known to occur from numerous (>10) other populations within the general region of the Survey Area (DBCA 2007-) and are likely to be present outside the Survey Area in adjacent vegetation.

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