

Detailed Flora and Vegetation Assessment

Coolup Road South Site 1

Project No: EP20-102(01)

**Prepared for Shire of Murray
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Executive Summary

The Shire of Murray engaged Emerge Associates (Emerge) to undertake a detailed flora and vegetation survey along section of Fawcett Road / Coolup Road South in Coolup (referred to herein as the 'site'). Emerge were engaged to conduct a detailed assessment to provide information on the flora and vegetation values to inform a clearing permit application.

As part of the assessment a desktop review of relevant background information was completed and a field survey was undertaken in September and October 2020. During the field survey an assessment was made on the type, condition and values of vegetation across the site.

Outcomes of the survey include the following:

- Road, bare ground or non-native vegetation is present across 0.72 ha of the site.
- Remnant native vegetation is present across 2.00 ha of the site in varying levels of condition.
- A total of 52 native and 20 non-native (weed) species were recorded in the site.
- No threatened flora species were recorded within the site. Two priority flora species were recorded:
 - P1 species *Grevillea bipinnatifida* subsp. *pagna* a
 - P3 species *Chamaescilla gibsonii*.
- The detailed survey was undertaken in the main flowering season (spring) and included two visits. It is nonetheless considered possible that parts of the site provide potential habitat for a variety of threatened and priority species with potential to occur within the site that were not recorded during the survey.
- The vegetation within the site was classified into the following two plant communities that are present in 'very good to good', 'good', 'good to degraded', 'degraded to completely degraded' and 'completely degraded' condition.
- Plant community **CcJs** represents FCT 3c '*Corymbia calophylla* - *Xanthorrhoea preissii* woodlands and shrublands, Swan Coastal Plain' and plant community **Cc** is inferred to be a degraded remnant of this FCT.
- All of 1.57 ha of plant community **CcJs** is considered to represent the SCP3c - *Corymbia calophylla* - *Xanthorrhoea preissii* woodlands and shrublands, Swan Coastal Plain TEC which is listed as 'endangered' under EPBC Act and 'critically endangered' in Western Australia. All 0.43 ha of plant community **Cc** is considered to potentially represent this TEC, subject to further advice from relevant Commonwealth and State agencies.
- The *Corymbia calophylla* trees within site provide a foraging resource for threatened species of black cockatoo and some may also qualify as habitat trees (potential breeding habitat).
- Weed cover was generally high across the site. Two declared pests were recorded **Asparagus asparagoides* (bridal creeper) and **Zantedeschia aethiopica* (arum lily) that are listed in exempt keeping category under the BAM Act for which no permit or conditions are required.

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Abbreviation Tables

Table A1: Abbreviations – Organisations

Organisations	
EPA	Environmental Protection Authority
DBCA	Department of Biodiversity, Conservation and Attractions
DoW	Department of Water (now DWER)
DWER	Department of Water and Environmental Regulation
DPaW	Department of Parks and Wildlife (now DBCA)
WALGA	Western Australia Local Government Association

Table A2: Abbreviations – General terms

General terms	
CCW	Conservation category wetland
ESA	Environmentally sensitive area
FCT	Floristic community type
IBRA	Interim Biogeographic Regionalisation of Australia
MUW	Multiple use wetland
NVIS	National Vegetation Inventory System (ESCAVI 2003)
P1	Priority 1
P2	Priority 2
P3	Priority 3
P4	Priority 4
P5	Priority 5
PEC	Priority ecological community
REW	Resource enhancement wetland
T	Threatened
TEC	Threatened ecological community
UFI	Unique feature identifier

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Table A3: Abbreviations –Legislation

BAM Act	<i>Biosecurity and Agriculture Management Act 2007</i>
EP Act	<i>Environmental Protection Act 1986</i>
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i>
BC Act	<i>Biodiversity Conservation Act 2016</i>
BC Regs	<i>Biodiversity Conservation Regulations 2018</i>

Table A4: Abbreviations – planning

Planning terms	
MRS	Metropolitan region scheme
PRS	Peel Region Scheme
TPS	Town planning scheme

Table A5: Abbreviations – units of measurement

Units of measurement	
cm	Centimetre
ha	Hectare
m	Metre
m ²	Square metre
m AHD	m in relation to the Australian height datum
mm	Millimetre

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1 Introduction

1.1 Project background

The Shire of Murray (the Shire) intends to widen a section of Fawcett Road / Coolup Road South in Coolup. The relevant portions of these roads and their associated road reserves are referred to herein as the 'site'.

The site is located approximately 100 kilometres (km) south of the Perth Central Business District within the Shire of Murray and is zoned 'rural' under the Peel Region Scheme (PRS) and 'rural' under the Shire of Murray *Local Planning Scheme* (LPS) No. 4.

The site is approximately 2.72 hectares (ha) in size and is bound by rail reserve to the east, road reserve to the north, rural land to the west and road reserve to the south. The location and extent of the site is shown in

Figure 1.

1.2 Purpose and scope of work

Emerge Associates (Emerge) were engaged by the Shire of Murray to conduct a flora and vegetation survey of the site to inform a clearing permit application and road design and construction. The purpose of this survey is to provide sufficient information on the flora and vegetation values within the site to inform these processes.

The scope of work was specifically to undertake a flora and vegetation assessment to the standard required of a 'detailed' survey in accordance with the Environmental Protection Authority's (EPA's) technical guidance (EPA 2016).

As part of this scope of work, the following tasks were undertaken:

- Desktop review of relevant background information pertaining to the site and surrounds, including database searches for threatened flora species and ecological communities.
- Compilation of a comprehensive list of flora species recorded as part of the field survey.
- Mapping of plant communities, vegetation condition and conservation significant flora and vegetation.
- Identification of potential habitat for conservation significant flora and vegetation and an assessment of likelihood of occurrence.
- Documentation of the desktop assessment, survey methodology and results into a report.

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2 Environmental Context

2.1 Climate

Climate has a strong influence on the types of vegetation that grow in a region and the life cycles of the flora present. It is therefore critical for a flora and vegetation survey to respond appropriately to climatic conditions to ensure that surveys are conducted during times when flora species are easiest to detect and identify.

The south west of Western Australia experiences a Mediterranean climate of hot dry summers and cool wet winters. In Mediterranean type climates some flora species will typically spend part of their lifecycle as either underground storage organs or as seed. This is an adaptation to unfavourable environmental conditions such as excessive heat and drought that occur over the summer period. These species, known as 'geophytes' or 'annuals', tend to re-emerge during winter when favourable conditions return and are most visible during spring, which is the flowering period for a majority of plant species. Therefore, spring is the optimal time to complete flora and vegetation surveys in the south west of WA.

An average of 992.0 millimetres (mm) of rainfall is recorded annually from the Waroona weather station, which is the closest weather station, located approximately 11 km from the site. The majority of this rainfall is received between the months of May and September. Mean maximum temperatures at the Dwellingup weather station, which is the nearest temperature recording station approximately 18.5 km south-east of the site, range from 15.1°C in July to 29.7°C in January and February, while mean minimum temperatures range from 5.5°C in July and August to 14.6°C in February (BoM 2020).

A total of 256 mm of rain was recorded from May to August 2020 prior to the survey, which is approximately 37.5% of the mean of 682 mm for this period (BOM 2020). Although lower than the annual mean, a greater amount of rain was received at other nearby weather stations over this period and so records from Waroona may not have been representative of rainfall received at the site. Nevertheless, the amount of rainfall was considered to have been sufficient to promote the flowering and emergence of native flora based on species inventory recorded (refer **Section 0**).

2.2 Geomorphology and soils

Landform and soils influence vegetation types at regional and local scales. The site occurs on the Swan Coastal Plain, which is the geomorphic unit that characterises much of the Perth metropolitan area.

The Swan Coastal Plain is approximately 500 km long and 20 to 30 km wide and is roughly bound by the Indian Ocean to the west and the Darling Scarp to the east. Broadly the Swan Coastal Plain consists of two sedimentary belts of different origin. Its eastern side, which is often labelled the Pinjarra Plain, has formed from the deposition of alluvial material washed down from the Darling Scarp. While its western side is comprised of three dune systems that run roughly parallel to the Indian Ocean coastline (Kendrick *et al.* 1991; Seddon 2004).

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Examination of broad scale soil mapping places the site within the Guildford association of the Pinjarra Plain (Churchward and McArthur 1980). The Guildford association comprises a flat plain with medium textured deposits and yellow duplex soils.

Finer scale mapping by (Gozzard 2011) places the northern and southern portions of the site in Pinjarra P1d Phase and the central portion of the site in Pinjarra P6b Phase. The Pinjarra P1d Phase is typically flat to very gently undulating plain with deep acidic mottled yellow duplex soils, consisting of shallow pale sand to sandy loam over clay that are imperfect to poorly drained and moderately susceptible to salinity (Purdie *et al.* 2004). The Pinjarra P6b Phase comprises very gently undulating alluvial terraces and low rises contiguous with the plain, with deep moderately well to well drained soils associated with prior stream deposits, typically consisting of uniform brownish sands.

The site is not known to contain any restricted landforms or unique geological features.

2.3 Topography

The elevation of the site ranges from 20 m in relation to the Australian height datum (mAHD) on the western side of the site to 21 mAHD on the eastern side of the site (DoW 2008) (**Figure 1**).

2.4 Hydrology and wetlands

Wetlands include “areas of seasonally, intermittently or permanently waterlogged soils or inundated land, whether natural or otherwise, fresh and saline, e.g. waterlogged soils, ponds, billabongs, lakes, swamps, tidal flats, estuaries, rivers and their tributaries” (Wetlands Advisory Committee 1977). Wetlands can further be recognised by the presence of vegetation associated with waterlogging or the presence of hydric soils such as peat, peaty sand or carbonate mud (Hill *et al.* 1996).

Wetlands of national or international significance may be afforded special protection under Commonwealth or international agreements. The following lists of important wetlands were checked as part of this assessment:

- *Ramsar List of Wetlands of International Importance* (DBCA 2017b)
- *A Directory of Important Wetlands in Australia* (DBCA 2018).

The Peel-Yalgorup system Ramsar wetland is located approximately 20 km west of the site.

Examination of the Department of Water and Environmental Regulation (DWER) hydrography dataset (DWER 2018) shows one drain occurs within the site.

On the Swan Coastal Plain DBCA (2017a) have used the geomorphic wetland classification system developed by Semeniuk (1987) and Semeniuk and Semeniuk (1995) to classify wetlands based on the landform shape and water permanence (hydro-period). The Department of Biodiversity, Conservation and Attractions (DBCA) maintains the *Geomorphic Wetlands of the Swan Coastal Plain* dataset (DBCA 2020), which further categorises geomorphic wetland features into specific management categories to guide land use and conservation. Note that as this dataset was drafted at a regional scale the boundaries of mapped wetland features are often inconsistent with physical wetland boundaries.

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A review of the *Geomorphic Wetlands, Swan Coastal Plain* dataset (DBCA 2020) indicated three 'multiple use' category wetland features (UFIs 5539, 15802 and 15231) intersect the site. Multiple other features occur in the wide local area. UFI 5539 is classified as a dampland that extends west of the site. UFIs 15802 and 15231 are classified as palusplain wetlands and extend over a large area to the north and south of the site respectively. The locations of the geomorphic wetlands in the site is shown in **Figure 2**.

2.5 Regional vegetation

Native vegetation is described and mapped at different scales in order to illustrate patterns in its distribution. At a continental scale the *Interim Biogeographic Regionalisation of Australia* (IBRA) divides the Swan Coastal Plain into two floristic subregions (Environment Australia 2000). The site is contained within the 'SWA02' or Perth subregion, which is characterised as mainly containing *Banksia* low woodland on leached sands with *Melaleuca* swamps where ill-drained; and woodland of *Eucalyptus gomphocephala* (tuart), *E. marginata* (jarrah) and *Corymbia calophylla* (marri) on less leached soils (Beard 1990). This subregion is recognised as a biodiversity hotspot and contains a wide variety of endemic flora and vegetation types.

Variations in native vegetation within the site can be further classified based on regional vegetation associations. Heddle *et al.* (1980) mapping shows the site within the 'Guildford' complex, which is described as a mixture of open forest to tall open forest of *Corymbia calophylla* - *Eucalyptus wandoo* - *Eucalyptus marginata* and woodland of *Eucalyptus wandoo* (with rare occurrences of *Eucalyptus lane-poolei*). Minor components include *Eucalyptus rudis* - *Melaleuca raphiophylla*. This complex was determined to have 5.09% remaining in 2019, of which 0.26% is under formal protection (Government of Western Australia 2019).

More recent Beard *et al.* (2013) mapping shows the site comprises vegetation association 'Pinjarra_968'. This association is described as 'medium woodland; jarrah, marri & wandoo' (Beard *et al.* 2013). 'Pinjarra_968' association has 6.6% of its pre-European extent remaining on the Swan Coastal Plain with 1.18% protected for conservation purposes (Government of Western Australia 2018).

Studies have indicated that the loss of biodiversity caused by habitat fragmentation is significantly greater once a habitat type falls below 30% of its original extent (Miles 2001). The national objectives and targets for biodiversity conservation established an objective of retaining 30% of the original extent of each vegetation complex (Environment Australia 2001). However, a lower objective of 10% is applied in 'constrained urban areas' such as the Swan Coastal Plain (Ministry for Planning 1995). The percentage protected for conservation of the Guildford complex and the Pinjarra_968 association fall below the 30% and 10% retention objectives.

2.6 Historic land use

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Review of historical images available shows that part of the site had been cleared of native vegetation as a road and associated rural landuse prior to 1979 (WALIA 2020).

2.7 Significant flora and vegetation

2.7.1 Threatened and priority flora

Certain flora taxa that are considered to be rare or under threat warrant special protection under Commonwealth and/or State legislation. At a Commonwealth level, flora taxa may be listed as 'threatened' under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Threatened flora species listed under the EPBC Act are assigned a conservation status according to attributes such as population size and geographic distribution. Any action likely to have a significant impact on a taxon listed under the EPBC Act requires Ministerial approval.

In Western Australia flora species may also be classed as 'threatened' under the *Biodiversity Conservation Act 2016* (BC Act). Similarly, it is an offence to 'take' or 'disturb' threatened flora listed under the BC Act without Ministerial approval.

Flora species that do not currently meet the criteria for listing as threatened but are potentially rare or threatened may be added to the DBCA's *Priority Flora List*. These species are classified into 'priority' levels based on threat. Whilst priority species are not under direct statutory protection, they are considered during State approval processes. Further information on threatened and priority species and their categories is provided in **Appendix A**.

2.7.2 Threatened and priority ecological communities

An ecological community is a naturally occurring group of native plants, animals and other organisms that are interacting in a unique habitat. An ecological community's structure, composition and distribution are influenced by environmental factors such as soil type, position in the landscape, altitude, climate and water availability (DAWE 2020). 'Threatened ecological communities' (TECs) are ecological communities that are recognised as rare or under threat and therefore warrant special protection.

Selected TECs are afforded statutory protection at a Commonwealth level under the EPBC Act. Similar to flora species, TECs listed under the EPBC Act are assigned a conservation status. Any action likely to have a significant impact on a community listed under the EPBC Act requires Ministerial approval.

TECs are also listed within Western Australia under the BC Act and the BC Regulations. Their significance is also acknowledged through other state environmental approval processes such as 'environmental impact assessment' pursuant to Part IV of the *Environmental Protection Act 1986* (EP Act) and the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*.

A plant community that is under consideration for listing as a TEC in Western Australia, but does not yet meet survey criteria or has not been adequately defined, may be listed as a 'priority ecological community' (PEC). Listing as a PEC is similarly considered during State approval processes. Further information on categories of TECs and PECs is provided in **Appendix A**.

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2.7.3 Local and regional significance

Flora species and ecological communities may be significant for a number of reasons irrespective of whether they have special protection under policy or legislation.

A key reason that vegetation within the site may be significant is that it has value as habitat for threatened species including, in particular, Carnaby's black cockatoo, Baudin's black cockatoo and the forest red-tailed black cockatoo, which are listed under the EPBC Act and BC Act.

2.7.4 Weeds

The term 'weed' can refer to any plant that requires some form of action to reduce its effect on the economy, the environment, human health and amenity. Many non-native flora species and some native species are considered to be weeds.

A particularly invasive or detrimental weed species may be listed as a 'declared pest' pursuant to Western Australia's *Biosecurity and Agriculture Management Act 2007* (BAM Act), indicating that it warrants special management to limit its spread. At a National level, the Australian government has compiled a list of 32 *Weeds of National Significance* (WoNS) (DAWE 2020c). Whilst the WoNS list is non-statutory, many WoNS are also listed under the BAM Act. Further information on categories of declared pests is provided in **Appendix A**.

Due to historical disturbance weed species are expected to be present at the site.

2.8 Environmentally sensitive areas

'Environmentally sensitive areas' (ESAs) are prescribed under the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004* and have been identified to protect native vegetation values of areas surrounding values such as significant wetlands, threatened flora, threatened communities and *Bush Forever* sites. Within an ESA none of the exemptions under the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004* apply. However, exemptions under Schedule 6 of the EP Act still apply, which includes any clearing in accordance with a subdivision approval under the *Planning and Development Act 2005* (a recognised exemption under the Schedule 6 of the EP Act).

No ESAs are present over the site or in close proximity to the site. Three ESAs are located approximately 2.5 to 5 km away to the east, south and north west of the site respectively that are associated with local tributaries or remnant native vegetation. The location of these ESA is shown in **Figure 2**.

2.9 Regional natural areas

Environmental Protection Bulletin no. 12 *Swan Bioplan – Peel Regionally Significant Natural Areas* (EPB 12) (EPA 2013) is used to inform strategic land use planning in the Peel Region by identifying 'Peel regionally significant natural areas' (Peel RSNAs). Peel RSNAs are natural areas which have significant flora, vegetation and landform values that represent the original landscape of the Peel Region. Development proposals which may potentially impact upon a Peel RSNA require detailed flora, vegetation and fauna investigations to be undertaken. Based on the outcomes of these

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investigations, development proposals should firstly aim to avoid, and then minimise, potential impacts on identified natural areas.

The site intersects the larger 'Coolup Bushland' Peel RSNA that occurs to the east and north west of the site as shown in **Figure 2**. This Peel RSNA extends over areas of native vegetation, the majority of which occurs outside of the site.

2.10 Ecological linkages

Ecological linkages are linear landscape elements that allow the movement of fauna, flora and genetic material between areas of remnant habitat. This exchange of genetic material between vegetation remnants improves the viability of those remnants by allowing greater access to breeding partners and food sources, refuge from disturbances such as fire and maintenance of genetic diversity of plant communities and populations. Ecological linkages are ideally continuous or near-continuous as the more fractured a linkage is, the less ease flora and fauna have in moving within the corridor (Alan Tingay and Associates 1998).

The Perth Biodiversity Project, supported by the Western Australia Local Government Association (WALGA), have identified and mapped regional ecological linkages within the Perth Metropolitan Region (WALGA and PBP 2004). This study was extended beyond the Perth Metropolitan Region through the South West Biodiversity Project, resulting in the identification and mapping of the South West regional ecological linkages (Molloy *et al.* 2009).

There are no mapped ecological linkages within or in close proximity to the site. One south west regional ecological linkage (No. 24) occurs approximately 2 km west of the site running from north to south and associated with the Murray River.

2.11 Previous surveys

No previous surveys of the site are known to have been completed.

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3 Methods

3.1 Desktop assessment

A search was conducted for threatened and priority flora that may occur or have been recorded within a 30 km radius of the site using the *Protected Matters Search Tool* (DAWE 2020a), *NatureMap* (DBCA 2020) and DBCA's threatened and priority flora database (reference no. 24-0920FL).

A search was also conducted for TECs and PECs that may occur or have been recorded within a 10 km radius of the site using the *Protected Matters Search Tool* (DAWE 2020a), the *weed and native flora dataset* (Keighery *et al.* 2012) and DBCA's threatened and priority ecological communities' databases (reference no. 61-102EC).

Prior to undertaking the field survey, information on the habitat preferences of threatened and priority flora species and communities identified from database searches was reviewed. This was compared to existing environmental information available for the site, such as geomorphology, soils, regional vegetation and historic land use, to identify species and communities for which habitat may occur in the site.

3.2 Field survey

Botanists from Emerge visited the site on 22 September and 9 October 2020 to conduct the flora and vegetation field survey.

3.2.1 Flora and vegetation

The site was traversed on foot and the composition and condition of vegetation was recorded.

Detailed sampling of the vegetation was undertaken using permanently marked 10 x 10 m quadrats. The quadrats were established using fence droppers bound by measuring tape. Sample Q1 was arranged as a 5 m x 20 m strip due to the constrained area of vegetation along the road within the site boundary. A total of two locations were sampled with quadrats.

The position of each sample location was recorded with a hand-held GPS unit, as shown in **Figure 3**.

The data recorded within each sample included:

- site details (site name, site number, observers, date, location)
- environmental information (slope, aspect, bare-ground, rock outcropping soil type and colour class, litter layer, topographical position, time since last fire event)
- biological information (vegetation structure and condition, 'foliage projective cover' (FPC), degree of disturbance and species present).

Additional plant taxa not observed within samples were recorded opportunistically as the botanists traversed the site. Photographs were taken throughout the field visit to show particular site conditions.

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The suitability of habitat within the site for conservation significant species identified in the desktop assessment was assessed (refer **Section 3.1**). Where identified, areas of suitable habitat were traversed to search for conservation significant species.

All plant specimens collected during the field survey were dried, pressed and then named in accordance with requirements of the Western Australian Herbarium. Identification of specimens occurred through comparison with named material and through the use of taxonomic keys. Flora species not native to Western Australia are denoted by an asterisk (*) in text and raw data.

Vegetation condition was assigned at each sample and changes in vegetation condition were also noted and mapped across the site. The condition of the vegetation was assessed using methods from Keighery (1994).

Table 1: Vegetation condition scale applied during the field assessment

Condition category	Definition (Keighery 1994)
Pristine	Pristine or nearly so, no obvious signs of disturbance.
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.
Very good	Vegetation structure altered obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.
Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.
Completely degraded	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native trees or shrubs.

3.2.2 Weeds

Weed cover was assigned by weed suites determined based on the dominant weeds types present, including grasses, herbaceous weeds and bulbous weeds. Flora species listed as 'declared pests' and/or weeds of national significance (WoNS) were located and mapped separately as points.

3.3 Mapping and data analysis

3.3.1 Conservation significant flora and vegetation

Based on the information recorded during the field survey, an assessment of the likelihood of occurrence of threatened and priority flora species and communities within the site was undertaken using the categories outlined in **Table 2**.

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Table 2: Likelihood of occurrence assessment categories and definitions

Likelihood	Definition
Recorded	The species was recorded during the current field survey.
Likely	The site contains suitable habitat for the species and it is likely the species may occur based on presence of a recent historical record within or close to the site.
Possible	The site contains suitable habitat for the species but there is no other information to suggest that the species may occur within or close to the site.
Unlikely	The site does not contain suitable habitat for the species <u>or</u> the site contains suitable habitat for the species within which thorough targeted searches were completed and conclusion has been made that the species is unlikely to be present.

3.3.2 Plant community identification and description

The local plant communities within the site were identified from the sample data collected during the field survey. The vegetation was described according to the dominant species present using the structural formation descriptions of the *National Vegetation Inventory System* (NVIS) (ESCAVI 2003). The identified plant communities were mapped on aerial photography from the sample locations and boundaries were interpreted from aerial photography and notes taken in the field. Vegetation condition was mapped on aerial photography based on the locations and notes recorded during the field survey to define areas with differing condition.

3.3.3 Floristic community type assignment

The identified plant communities were then compared to the regional 'floristic community type' (FCT) dataset *A floristic survey of the southern Swan Coastal Plain* by Gibson *et al.* (1994). The sample data (presence/absence) was reconciled with Gibson *et al.* (1994) by standardising the names of taxa with those used in the earlier study. This was necessary due to changes in nomenclature in the intervening period. Taxa that were only identified to genus level were excluded, while some infra-species that have been identified since 1994 were reduced to species level.

The combined dataset was then imported into the statistical analysis package PRIMER v6 (Clarke and Gorley 2006). As data from a localised survey is often spatially correlated, data for each sample was compared to Gibson *et al.* (1994) separately. This removed the influence of spatial correlation when assigning a FCT. Classification was then undertaken using a group-average hierarchical clustering technique using the Bray-Curtis distance measure (as described above for plant community determination).

Where the sample tended to cluster with a grouping of different FCTs, samples were assessed separately to differentiate between FCTs. Ultimately the cluster analysis, as well as contextual information relating to the soils, landforms and known locations of FCTs within the region, was considered in the final determination of an FCT for vegetation within the site.

3.3.4 Threatened and priority ecological communities

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Areas of native vegetation potentially representing a TEC were assessed against key diagnostic characteristics and, if available, size and/or vegetation condition thresholds provided in the following documents:

- *Approved Conservation Advice for Corymbia calophylla - Kingia australis woodlands on heavy soils of the Swan Coastal Plain* (DoEE 2017a)
- *Approved Conservation Advice for Corymbia calophylla - Xanthorrhoea preissii woodlands and shrublands of the Swan Coastal Plain* (DoEE 2017b).

3.3.5 Species accumulation curve

A species accumulation curve was plotted from sample data by generating a trendline (log) in Microsoft Excel. The trendline was forecast to locate the asymptote of the curve (the point at which the curve flattens), which provides an indication of amount of sampling that would be required before it can be assumed few species remain undetected. PRIMER v6 also offers a range of estimators to predict minimum species richness (Clarke and Gorley 2006). Both the Jackknife1 and Chao2 non-parametric estimators are reported, as these are known to perform well in comparison to simulated and real data sets and are also recommended for small sample sizes (Gotelli and Colwell 2011). Comparison between actual and estimated species accumulation assists in evaluating the adequacy of sampling effort.

3.3.6 Weeds

Weed suites were mapped on aerial photography based on the locations and notes on weed cover recorded during the field survey.

3.4 Survey limitations

It is important to note the specific constraints imposed on surveys and the degree to which these may have limited survey outcomes. An evaluation of the survey methodology against standard constraints outlined in the EPA document *Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016) is provided in **Table 3**.

Table 3: Evaluation of survey methodology against standard constraints outlined in EPA (2016)

Constraint	Degree of limitation	Details
Availability of contextual information	No limitation	The broad scale contextual information described in Section 2 is adequate to place the site and vegetation in context.
	No limitation	Regarding assignment of FCTs, the authoritative Gibson <i>et al.</i> (1994) dataset was derived from a necessarily limited sample of vegetation from largely publicly owned land which is now more than 20 years out of date. Consequently, it is unknown to what degree official FCTs are appropriate reference to biodiverse vegetation across the Swan Coastal Plain. Furthermore, Gibson <i>et al.</i> (1994) collected data in the spring main flowering period and in many cases sampled plots multiple times to provide a complete species list. This detailed survey sampled the site twice within the main flowering period, thus FCTs assignment is based on reasonably complete data and may be considered accurate and instructive.

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Table 3: Evaluation of survey methodology against standard constraints outlined in EPA (2016) (continued)

Constraint	Degree of limitation	Details
Experience level of personnel	No limitation	This flora and vegetation assessment was undertaken by a senior and principal environmental consultant with nine and 18 years' experience in environmental science in Western Australia respectively.
Sampling intensity	Minor limitation	A total of 72 species were recorded, of which 63 were recorded from two sample locations and 9 were recorded opportunistically. Minimum species richness within site is estimated at between 84 (Jackknife1) and 105 (Chao2) species (refer species accumulation curve and estimates shown in Plate 4). The number of species recorded in the site is close to the lower estimate and, combined with the degraded nature of the majority of the site, demonstrates that survey effort was adequate to prepare a near-comprehensive species inventory for the site.
Suitability of timing	No limitation	The survey was conducted in spring and thus within the main flowering season. Adequate rainfall was recorded from May to October 2020 in the months preceding the site visit. Therefore, it is likely that many plant species would have been in flower and/or visible at the time of survey. The survey timing was considered adequate to allow the detection of species for which seasonal timing is critical.
Temporal coverage	Limitation	Comprehensive flora and vegetation assessments can require multiple visits, at different times of year, and over a period of a number of years, to enable observation of all species present. The site was visited in September and October 2020. Both visits provided an insight into the composition and condition vegetation and according to the EPA guidelines this survey is considered to meet the requirements of a 'detailed' survey.
Spatial coverage and access	No limitation	Site coverage was comprehensive (track logged).
	No limitation	All parts of the site could be accessed as required.
Influence of disturbance	Minor limitation	Time since fire is greater than 40 years as interpreted from historical aerial imagery and therefore short-lived species more common after fire may not have been visible.
	No limitation	Historical ground disturbance and modification as part of road construction was evident in parts of the site and some native vegetation in the site is likely regrowth. The disturbance history of the site was considered when undertaking field sampling.
Adequacy of resources	No limitation	All resources required to perform the survey were available.

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4 Results

4.1 General site conditions

The site is generally flat and includes a poorly drained road side swale along the north western and north eastern boundary. Soils are heavy, with notable organic layer and litter under treed parts. Native and non-native plants occur on the margins of the site. However, much of the site is non-vegetated bitumen surface or non-vegetated gravel road shoulder.

4.2 Flora

4.2.1 Desktop assessment

The database search results identified a total of 16 threatened and 28 priority flora species as having been recorded within a 10 km radius of the site. Information on these species including their habitat preferences and flowering period is provided in **Appendix B**.

Based on background information and site conditions available for the site, it was considered possible that 5 of the 16 threatened flora species and 11 of the 28 priority flora species could possibly occur within the site as shown in **Table 4**.

Table 4: Conservation significant flora species considered possible to occur in the site

Species name	Level of significance		Life strategy	Habitat	Flowering period
	BC Act	EPBC Act			
<i>Synaphea</i> sp. Fairbridge Farm (D. Papenfus 696)	CR	CR	P	Low woodland on grey, clayey sand with lateritic pebbles (Pinjarra Plain) near winter wet flats.	Sep-Nov
<i>Synaphea</i> sp. Serpentine (G.R. Brand 103)	CR	CR	P	Seasonally damp areas, loam - sand.	Sep-Oct
<i>Synaphea</i> sp. Pinjarra Plain (A.S. George 17182)	EN	CR	P	White grey clayey sand on edges of seasonally inundated low-lying areas.	Sep-Oct
<i>Thelymitra stellata</i>	EN	E	PG	Sandy loam, clay or gravel over laterite or gravel.	Sep-Nov
<i>Tetraria australiensis</i>	VU	V	P	Sand over clay, winter wet depressions and drainage lines.	Nov-Dec
<i>Grevillea bipinnatifida</i> subsp. <i>pagna</i>	P1	-	P	Grey sandy clay and loam, ironstone. Seasonal wetlands, swamps, roadsides.	Aug or Oct-Nov
<i>Synaphea odocoileops</i>	P1	-	P	Brown orange loam and sandy clay, granite, in swamps and winter wet areas.	Aug-Oct
<i>Grevillea manglesii</i> subsp. <i>ornithopoda</i>	P2	-	P	Red-brown loam over clay	Sep-Nov

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Table 4: Conservation significant flora species considered possible to occur in the site (continued)

Species name	Level of significance		Life strategy	Habitat	Flowering period
	BC Act	EPBC Act			
<i>Chamaescilla gibsonii</i>	P3	-	P	Clay to sandy clay in winter-wet flats, shallow water-filled claypans.	Sep
<i>Eryngium pinnatifidum</i> subsp. <i>Palustre</i> (G.J. Keighery 13459)	P3	-	P	Grey brown sand or clay in winter wet flats.	Sep-Nov
<i>Eryngium</i> sp. <i>Ferox</i> (G.J. Keighery 16034)	P3	-	P	Winter wet flats on clay	Oct-Mar
<i>Schoenus capillifolius</i>	P3	-	A	Brown mud in claypans	Oct-Nov
<i>Schoenus pennisetis</i>	P3	-	A	Grey or peaty sand in swamps and winter-wet depressions.	Aug-Sep
<i>Schoenus</i> sp. <i>Waroona</i> (G.J. Keighery 12235)	P3	-	A	Clay or sandy clay. Winter-wet flats.	Oct-Nov
<i>Acacia semitrullata</i>	P4	-	P	White/grey sand, sometimes over laterite, clay sometimes in sandplains, swampy areas.	May-Oct
<i>Drosera occidentalis</i>	P4	-	P	Flat, brown/white/yellow moist sand/clay/peat, often near swamps.	Oct-Dec/Jan

4.2.2 Species inventory

A total of 52 native and 20 non-native (weed) species were recorded within the site during the field survey, representing 26 families and 70 genera. The dominant families containing native taxa were Fabaceae (eight native taxa and one weed taxa) and Cyperaceae (five native taxa). The family containing the most taxa was Poaceae (three native and eight non-native species). Of the species recorded 63 were recorded in sample locations and 9 were recorded opportunistically.

A complete species list is provided in **Appendix D** and a species list by plant community matrix is provided in **Appendix E**.

4.2.3 Threatened and priority flora

No threatened flora species were recorded. Two priority flora species were recorded both of which had been identified as possibly occurring during the desktop assessment.

Eight individuals of P1 species *Grevillea bipinnatifida* subsp. *pagna* were recorded during the survey of which four are within or close to the eastern site boundary of the site (refer to **Figure 5**).

The P3 species *Chamaescilla gibsonii* was also recorded within the site. Individual records were only collected within quadrat samples or opportunistically for individuals of this species.

The other threatened and priority flora species identified in the desktop assessment were not recorded and are not considered to occur in the site. However, the site contains small areas of

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habitat that is suitable for some of the species and there is potential that further species may occur in adjacent better condition vegetation to the north east of the site.

4.3 Vegetation

4.3.1 Desktop assessment

The database search results identified 12 TECs and 6 PECs occurring or potentially occurring within a 10 km radius of the site. Information on these communities is provided in **Appendix C**.

Based geomorphology, soils and regional vegetation patterns, the following five TECs were considered to have potential to occur in the site:

- SCP08 - Herb rich shrublands in clay pans TEC which is listed as 'critically endangered' under EPBC Act and 'vulnerable' in Western Australia.
- SCP09 - Dense shrublands on clay flats TEC which is listed as 'critically endangered' under EPBC Act and 'vulnerable' in Western Australia.
- SCP3a - *Corymbia calophylla* - *Kingia australis* woodlands on heavy soils, Swan Coastal Plain TEC which is listed as 'endangered' under EPBC Act and 'critically endangered' in Western Australia.
- SCP3b - *Corymbia calophylla* - *Eucalyptus marginata* woodlands on sandy clay soils of the southern Swan Coastal Plain TEC which is listed as 'vulnerable' in Western Australia.
- SCP3c - *Corymbia calophylla* - *Xanthorrhoea preissii* woodlands and shrublands, Swan Coastal Plain TEC which is listed as 'endangered' under EPBC Act and 'critically endangered' in Western Australia.

4.3.2 Plant communities

Two native plant communities and cleared area were identified within the site. Plant community **CcJs**, which is a *Corymbia calophylla* (marri) woodland or forest, exists across the eastern side of the site and extends over 1.57 ha. Plant community **Cc** occurs across the western side of the site and extends over 0.43 ha. The remainder of the site (0.72 ha) is cleared and contains non-native vegetation with bare soil, weeds or bitumen hardstand.

A description and the area of each plant community is provided in **Table 5** and representative photographs of each are provided in **Plate 1** to **Plate 3**. The location of each plant community is shown in **Figure 3**. A matrix of species recorded within each plant community is provided in **Appendix E** and raw sample data in **Appendix F**.

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Table 5: Description and extent of plant communities identified within the site

Plant community	Description	Area (ha)
CcJs	Low woodland to forest of <i>Corymbia calophylla</i> over <i>Jacksonia sternbergiana</i> and <i>Xanthorrhoea preissii</i> over forbland of <i>Mesomelaena tetragona</i> , <i>Tetraria octandra</i> <i>Cyathochaeta avenacea</i> , * <i>Babiana angustifolia</i> , * <i>Watsonia meriana</i> and open grassland of * <i>Ehrharta calycina</i> and * <i>Eragrostis curvula</i> (Plate 1).	1.57
Cc	Low woodland to forest of <i>Corymbia calophylla</i> over occasional <i>Xanthorrhoea preissii</i> over bare ground or weeds (Plate 2).	0.43
Cleared	Heavily disturbed areas comprising bitumen hard stand, bare ground or weeds (Plate 3).	0.72



Plate 1: Plant community **CcJs** in 'very good to good' condition.

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Plate 2: Plant community Cc in 'degraded' condition.



Plate 3: Cleared area in 'completely degraded' condition.

4.3.3 Vegetation condition

The most intact native vegetation is located in the north eastern portion of the site within part of the **CcJs** plant community. Approximately 0.35 ha of **CcJs** vegetation was mapped as being 'very good

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to good' condition as, in that area, the understory structure and native species diversity was relatively intact. Past disturbance was nonetheless evident through the presence of weed species in particular bulbs such as **Babiana angustifolia* and **Watsonia meriana*. The remaining approximately 1.05 ha extent of the **CcJs** vegetation in the central and south eastern portion of the site was mapped as being in 'good' or 'good to degraded' condition due to this area having a higher weed cover and lower frequency of relatively intact understory.

The area of **Cc** vegetation to the western side of the site shows a higher level of disturbance and is largely cleared and comprising of non-native weed species under marri trees. This vegetation was mapped as being in 'degraded' condition due to the degree of disturbance and alteration of the vegetation structure.

Remaining cleared areas in the site are in 'completely degraded' condition and consists of non-native weed species, bare ground or bitumen hardstand.

The extent of vegetation by condition category is detailed in **Table 6** and shown in **Figure 4**.

Table 6: Extent of vegetation condition categories within the site

Condition category (Keighery 1994)	Size (ha)
Pristine	0
Excellent	0
Very good	0
Very good - good	0.35
Good	0.35
Good - degraded	0.70
Degraded - completely degraded	0.60
Degraded	0.01
Completely degraded	0.72

4.3.4 Floristic community types

Plant community **CcJs** was determined to represent FCT 3c '*Corymbia calophylla* - *Xanthorrhoea preissii* woodlands and shrublands, Swan Coastal Plain'. This FCT is listed as 'poorly reserved' and 'vulnerable' by Gibson *et al.* (1994). Sample Q1 grouped with FCT 3c in the cluster analysis and was most similar to three Gibson *et al.* (1994) sites representing FCT 3c with 33-42% similarity (**Table 7**). Sample Q2 also grouped with sites representing FCT 3c in the cluster analysis and was most similar to five Gibson *et al.* (1994) sites representing FCT 3c and the related FCTs 3a and 3b with 35-43% similarity (**Table 7**). The relevant portions of the cluster dendrograms showing Q1 and Q2 are provided in **Appendix G**.

Plant community **Cc** is considered to represent a degraded form of FCT 3c due to the presence of canopy species *Corymbia calophylla* and understory layer of *Xanthorrhoea preissii*. The **Cc** plant

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community was not formally compared to the regional FCT dataset due to the very low number of native species present.

Table 7: Plant community and likely FCT represented within the site for each sample.

Plant community	Sample unit	Most similar Gibson <i>et al.</i> (1994) sites	Similarity (%)	Most likely floristic community type (FCT)	Reservation and conservation status (Gibson <i>et al.</i> 1994)
CcJs	Q1	TALB4 (FCT 3c)	42	FCT 3c ' <i>Corymbia calophylla</i> - <i>Xanthorrhoea preissii</i> woodlands and shrublands, Swan Coastal Plain'	Poorly reserved and vulnerable
		DUCK-2 (FCT 3c)	33		
		DUCK-1 (FCT 3c)	33		
	Q2	TALB4 (FCT 3c)	43		
		BRIX-2 (FCT 3a)	37		
		CARD12 (FCT 3b)	36		
		DUCK-2 (FCT 3c)	35		
		MUD-4 (FCT 3a)	35		

Note: ^ shows highest percent similarity to individual Gibson *et al.* (1994) samples rather than similarity to a cluster of samples.

4.3.5 Threatened and priority ecological communities

The structure and composition of plant community **CcJs**, and to a lesser extent plant community **Cc**, indicate that these plant communities are representative of the TEC SCP3c - *Corymbia calophylla* - *Xanthorrhoea preissii* woodlands and shrublands, Swan Coastal Plain previously identified in desktop assessment (**Section 4.3.1**). This TEC (hereafter referred to as SCP 3c TEC) is listed as 'endangered' under EPBC Act and 'critically endangered' in Western Australia.

Conservation advice for the SCP 3c TEC states that "because of its very restricted distribution, no condition thresholds have been applied to the nationally-listed ecological community and hence all areas meeting the description of the ecological community are habitat areas critical to its survival" (DoEE 2017b).

All of the **CcJs** plant community is identified as the SCP 3c TEC as shown in **Figure 5**. While plant community **Cc** is lacking in native understory it is possible to infer that it is a degraded remnant of SCP 3c TEC based on its composition and structure. Therefore, the **Cc** plant community is identified as a potential patch of SCP 3c TEC. Consultation with relevant Commonwealth and State agencies would be required to verify the status of the **Cc** vegetation.

No other TECs or PECs occur within the site (refer **Section 4.3.1** and **Appendix C**).

4.3.6 Locally and regionally significant vegetation

Some of the marri trees within the site have the potential to provide foraging, roosting and nesting habitat for threatened species of black cockatoos, along with other ecological services. Marri trees with a trunk diameter at breast height larger than 500 mm would qualify as habitat tree (breeding habitat). While not specifically assessed none of the marri trees observed were particularly large or considered likely to be hollow bearing.

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4.4 Species richness and sampling adequacy

A total of 63 species were recorded from two samples. A species accumulation curve derived from sample data is presented in **Plate 4**. After two samples the curve is still increasing and has not reached its asymptote. While this indicates that a proportion of species likely remain undetected, two samples is a relatively low level of effort and the shape of the curve would likely flatten sooner if a greater number of samples were to be collected.

Species richness was estimated in PRIMER v6 to be between 84 (Jackknife1) and 105 (Chao2). Based on the trend of the species accumulation curve approximately 9 samples would be required to record that many species. Including the 9 additional species recorded opportunistically, a total of 72 species was recorded in the site. Considering the degraded nature of the majority of vegetation within the site and the time spent sampling and searching areas of vegetation in good or better condition, the survey effort was considered adequate to prepare a comprehensive species inventory.

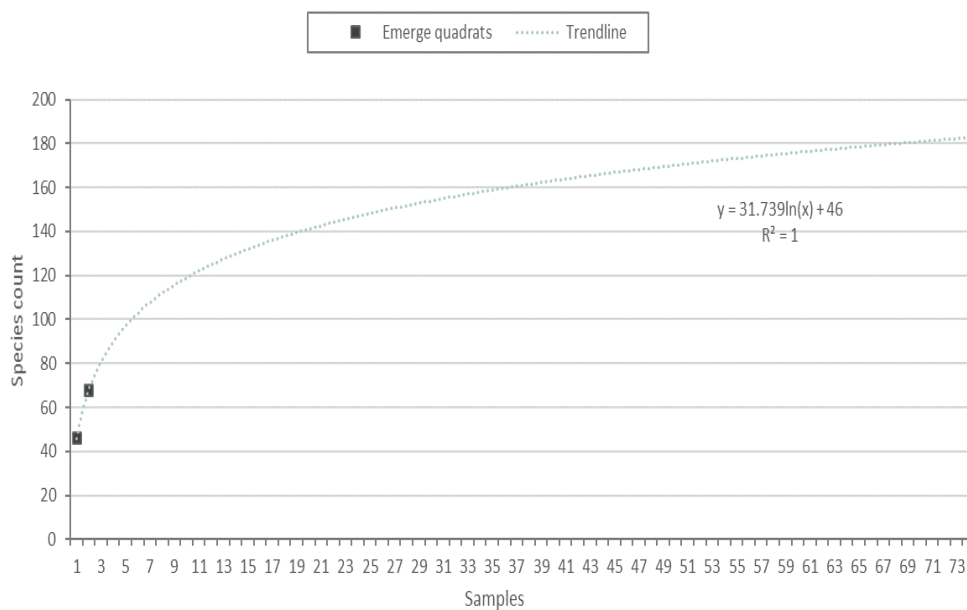


Plate 4: Species accumulation curve derived from sample data ($y = 31.739\ln(x) + 46$
 $R^2 = 1$)

4.5 Weeds

4.5.1 Weed cover

Dominant weeds in the site include grasses, herbs and bulbs. Dominant grasses include **Briza maxima*, **Cenchrus clandestinum*, **Cynodon dactylon*, **Ehrharta calycina*, **Ehrharta longiflora*, **Eragrostis curvula* and **Lolium rigidum*. Dominant herbaceous species include **Hypochaeris glabra*, **Lotus subbiflorus*, **Oxalis pes caprae*, **Oxalis purpurea*, and **Stachys arvensis*. Dominant bulbous

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species include **Babiana angustifolia*, **Sparaxis bulbifera* and **Watsonia meriana*. Weed cover by grasses and herbs weed suite and bulbous weed suite is shown in **Figure 6**.

4.5.2 Declared pests

Two species listed as a declared pest (S-22) pursuant to the BAM Act were recorded within the site including **Asparagus asparagoides* (bridal creeper) and **Zantedeschia aethiopica* (arum lily). Bridal creeper is also a weed of national significance (WoNS).

The location of declared pests and WoNs is shown on **Figure 6**.

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5 Discussion

The site has been subject to significant modification and past disturbance. Approximately 48% of vegetation within the site is present in 'good to degraded' or 'degraded' condition. A further 24% was mapped as 'completely degraded' where bitumen hardstand or cleared road edges occur.

The most intact native vegetation occurs in the north eastern portion of the site where the **CcJs** plant community is present. This vegetation is representative of FCT 3c, making it a remnant of poorly reserved Guildford complex vegetation with relatively high habitat and conservation values.

5.1 Threatened and priority flora

The timing of the survey was optimal for detecting most of the threatened or priority flora with potential to occur in the site. Two visits were conducted and the site was traversed comprehensively.

The identity of both of the priority flora recorded in the site was confirmed at the Western Australian Herbarium by specialist taxonomist (Mr. Frank Obbens). The P1 species *Chamaescilla gibsonii* is a small geophyte that arises from a tuber during winter and spring but is otherwise difficult to detect at other times of the year (Western Australian Herbarium 2020). Individuals of this species were flowering during the survey and were observed to be scattered throughout the site. Anecdotally, *Chamaescilla gibsonii* was noted to be abundant in the better condition vegetation adjacent to the site to the north east. A P1 listing means that a species is known from only a few populations of which at least some are considered to be under immediate threat.

The P3 species *Grevillea bipinnatifida* subsp. *pagna* is relatively easy to detect at any time of year due to its distinctive leaves (Western Australian Herbarium 2020). Individuals of the species were flowering during the survey further aiding detection. The relatively narrow extent of the site and lack of physical markers on the ground meant it was sometimes difficult to interpret whether patches of vegetation were inside or outside the site boundary. Of the eight individuals recorded at least four are outside of the site. A P3 listing means that a species is poorly known, in need of further survey, but known to occur at several locations and is not believed to be under immediate threat.

Generally, while wetland habitats are present in the site, standing surface water was largely a non-natural product of road construction (i.e. road side swales). For this reason, species with aquatic, riparian or specific wetland habitat preferences are considered less likely to occur following completion of the field survey (refer **Section 4.2.1**). The site is nevertheless an example of a palusplain or claypan type wetland that could provide habitat for a variety of threatened and priority flora with preferences for poorly drained, sandy clay or loamy soiled habitats (refer **Section 4.2.1**).

The absence of the larger perennial species with these habitat preferences such as *Acacia semitrullata*, *Andersonia gracilis*, *Grevillea manglesii* subsp. *ornithopoda*, *Lasiopetalum pterocarpum*, *Parsonsia diaphanophleba* and *Synaphea* spp. was relatively easy to confirm. However, due to their size and seasonality, the smaller annual or geophytic species with potential to occur could have been more difficult to detect. As such the presence or absence of smaller taxa in particular cannot be ruled out entirely on the basis of a survey completed across a single year. Therefore, while only two

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priority flora were recorded the site it is considered that the site provides potential habitat for a range of threatened and priority flora that were not detected during the survey.

The quality of the habitat for threatened and priority flora within the site varies and is only likely to be of high worth in the northeast portion of the site where **CcJs** vegetation condition is at least partially good or better. Furthermore, the quantum area of potential habitat in the site is relatively small, with vegetation condition sharply changing to completely degraded from east to west due to the effects of historical clearing and modification for road construction. On the eastern side of the site the extent of native vegetation relative to the boundary of the site was somewhat difficult to interpret on the ground due to lack of physical markers and spatial error associated with handheld GPS receivers. Difficulty quantifying the extent of potential habitat was further exacerbated by the fact plant community mapping was primarily derived from tree canopy extent interpreted from aerial imagery. In many instances the canopy boundary extends over bitumen or gravel, which is generally an unsuitable landform for supporting threatened or priority flora.

5.2 Vegetation condition

Assigning condition using a categorical scale is always most difficult when vegetation qualities are close to the boundary between two categories. Categorical schemes may also invariably yield different results when applied by different assessors, because of differences in skill levels or personal bias. A vegetation condition score has the greatest implications when the condition of vegetation is close the boundary between 'good' and 'degraded'. This is because good condition is typically accepted as the threshold for conservation significance, while 'degraded' condition implies a lower conservation requirement. Separating these two condition categories is further complicated by the fact that good condition is more correctly understood to mean 'average' condition. Applying the Keighery (1994) condition scale good condition vegetation can be expected to be significantly altered, with very obvious disturbance and the presence of aggressive weeds at high density. Therefore, good does not literally mean "good" as the label implies.

In one sense classifying the condition of vegetation within the site was straight forward. The understorey of all of plant community **Cc** and the southern portion of plant community **CcJs** has almost entirely been removed by historic disturbances. Due to the presence of a marri overstorey these plant communities were still recognisable as 'marri woodland' and so were classed as being present in degraded condition. Where the **CcJs** vegetation was more intact a compound category was used to describe condition category. At a fine scale the area of **CcJs** mapped as being in 'good to degraded' condition comprised small and scattered patches of more intact vegetation surrounding by areas of less intact vegetation with high proportion of non-native flora such as **Babiana angustifolia* and **Watsonia meriana*. Where **CcJs** was mapped as being in 'very good to good' condition the proportion of area dominated by weeds was much smaller.

Mapping vegetation condition within the site was hampered by the previously identified difficulties in locating native vegetation in relation to the boundary of the site and that plant community mapping was derived from tree canopy that extended over the 'completely degraded' road area. Due to these factors the vegetation condition mapping provided likely over estimates vegetation cover as, in many instances, what is mapped as native plant community is either inaccurately located at a fine scale or mapping of tree canopy over road. Physical marking of the site boundary would improve the

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ability to confirm the extent of native vegetation within the site. However, as mapping a plant community from canopy is typically the most straightforward approach for mapping vegetation, it is somewhat unavoidable that the plant community mapping needs to be interpreted as an approximation of the true location of native vegetation at ground level.

5.3 Floristic community type assignment

The results of the FCT cluster analysis were conclusive, with the samples within plant community **CcJs** showing high similarity to FCT 3c. This FCT is furthermore recorded as occurring in conservation reserves 200 m north east of the site and more generally is expected to occur on the eastern Swan Coastal Plain.

Plant community **Cc** can be inferred to be a degraded remnant of FCT 3c on the basis of marri canopy, limited but diagnostic shrub layer of *Xanthorrhoea preissii* and co-location with confirmed nearby occurrences of the community.

5.4 Threatened and priority ecological communities

Plant community **CcJs** can be directly attributed to the SCP3c TEC (DoEE 2017b). Nominally, all areas of the plant community can be considered the TEC including areas mapped as being present in degraded condition. The conservation advice indicates that to be considered the TEC vegetation must meet the description provided but that no condition threshold be applied in its assessment. On the basis that **CcJs** was confirmed conclusively to be FCT 3c and the **CcJs** plant community is essentially contiguous vegetation, it is reasonable to assign the whole **CcJs** patch to the TEC.

Greater difficulty arises when assessing plant community **Cc** against the conservation advice. Emerge considers that classifying an occurrence of an ecological community on the basis of its floristics and vegetation attributes, but then requiring that condition not be considered, as (DoEE 2017b) do in the conservation advice, is flawed and largely impractical guidance. The **Cc** vegetation provides a clear example of the deficiency in the conservation advice as, while it is possible to characterise this vegetation as marri woodland that would have once met the description of FCT 3c, it is less clear that it should automatically be considered to be a TEC. Arguably systematic diagnostic advice would preclude vegetation in degraded condition, such as the **Cc** plant community within the site, from being considered to have the conservation significant values associated with a TEC.

For this reason, in the results of this survey the **CcJs** plant community is identified as the SCP 3c TEC whereas the **Cc** plant community is identified as potential SCP 3c TEC. Confirmation of the status of plant community **Cc** would be contingent on consultation with relevant Commonwealth and State agencies.

5.5 Local and regional significance

The marri trees within plant communities **CcJs** and **Cc** are a foraging resource for threatened species of black cockatoo and may also include trees that qualify as habitat trees (potential breeding habitat). A formal assessment of black cockatoo habitat values was not completed as part of this assessment. However, anecdotally, none of the trees appeared to be of sufficient size or age that

Detailed Flora and Vegetation Assessment

Coolup Road South Site 1



they would contain hollows suitable for use by black cockatoos so it is unlikely that the site currently provides breeding habitat.

5.6 Weeds

Weed cover within the site reflects a past history of disturbance. The two declared pests recorded, bridal creeper and arum lily, are currently listed by the DPIRD in an 'exempt' keeping category (s-22) and so there is no requirement to take action to manage these weeds under the BAM Act.

Detailed Flora and Vegetation Assessment

Coolup Road South Site 1



6 Conclusions

Native and non-native plants occur on the margins of the site. However, much of the site is non-vegetated bitumen surface or non-vegetated road shoulder.

No threatened flora species were recorded within the site. Two priority flora species were recorded: P1 *Grevillea bipinnatifida* subsp. *pagna* and P3 *Chamaescilla gibsonii*. The detailed survey was undertaken in the main flowering season (spring) and included two visits and so no threatened or additional priority flora are considered to occur. However, the site is considered to provide potential habitat for threatened and priority species with potential to occur that were not recorded during the survey.

The site contains approximately 2.0 ha of marri woodland vegetation (plant communities **CcJs** and **Cc**). Plant community **CcJs** represents FCT 3c and plant community **Cc** is inferred to be a degraded remnant of FCT 3c.

Approximately 25% of the site comprises road, bare ground or 'completely degraded' non-native vegetation. A further 50% of vegetation within the site was mapped as being in 'degraded' or 'good to degraded' condition. The remaining 25% of the site retains native vegetation in 'very good to good' or 'good' condition.

All of 1.57 ha of plant community **CcJs** is considered to represent the SCP3c - *Corymbia calophylla* - *Xanthorrhoea preissii* woodlands and shrublands, Swan Coastal Plain TEC which is listed as 'endangered' under EPBC Act and 'critically endangered' in Western Australia. All 0.43 ha of plant community **Cc** is considered to potentially represent this TEC, subject to further advice from relevant Commonwealth and State agencies.

The marri trees within site provide a foraging resource for threatened species of black cockatoo and may also include trees that qualify as habitat trees (potential breeding habitat).

Weed cover was generally high across the site. Two declared pests were recorded **Asparagus asparagoides* (bridal creeper) and **Zantedeschia aethiopica* (arum lily) that are listed in exempt keeping category under the BAM Act for which no permit or conditions are required.

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Coolup Road South Site 1



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Figures



Figure 1: Site Location

Figure 2: Environmental Features

Figure 3: Plant Communities

Figure 4: Vegetation Condition

Figure 5: Conservation Significant Values

Figure 6: Weeds

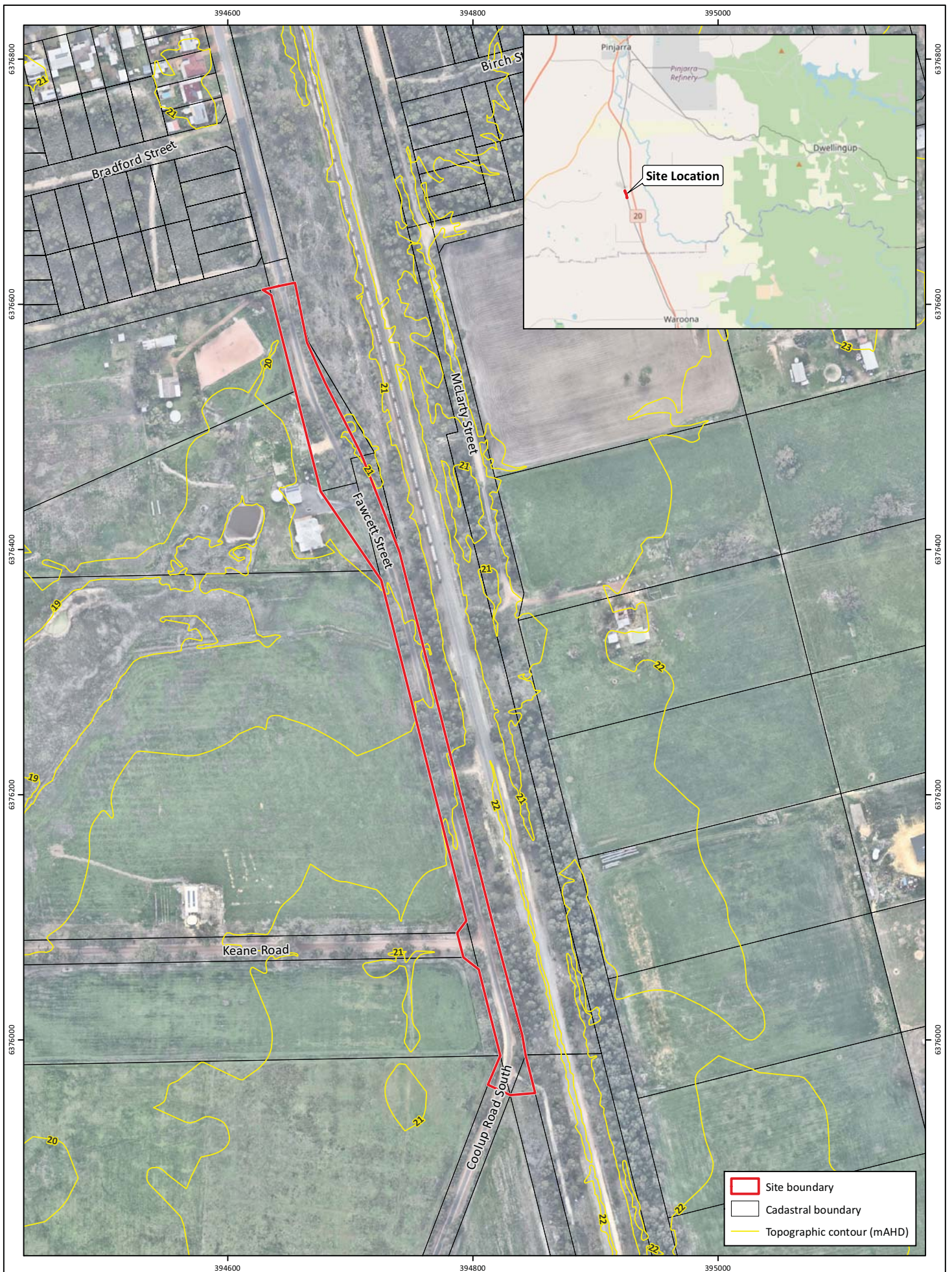


Figure 1: Site Location and Topographic Contours

Project: Detailed Flora and Vegetation Assessment
Coolup Road South Site 1

Client: Shire of Murray

Plan Number: EP20-102(01)--F06
Drawn: GAR
Date: 30/10/2020
Checked: TAA
Approved: TAA
Date: 9/11/2020



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Scale: 1:4,000@A4
GDA 1994 MGA Zone 50



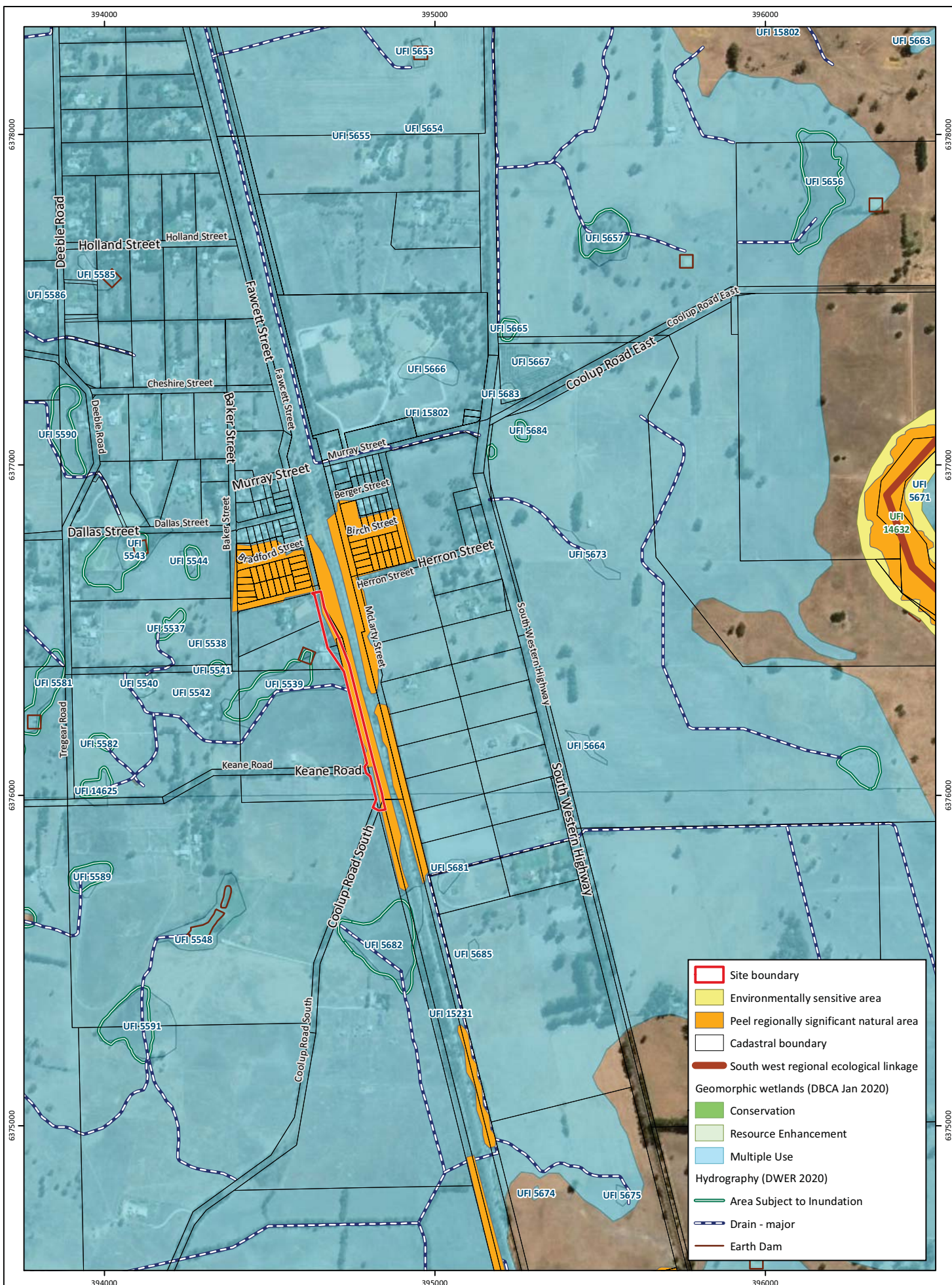


Figure 2: Environmental Features

Project: Detailed Flora and Vegetation Assessment
Coolup Road South Site 1

Client: Shire of Murray

Plan Number: EP20-102(01)--F07
Drawn: AFF
Date: 9/11/2020
Checked: TAA
Approved: TAA
Date: 9/11/2020



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Metres
Scale: 1:15,000@A4
GDA 1994 MGA Zone 50

emerge
ASSOCIATES

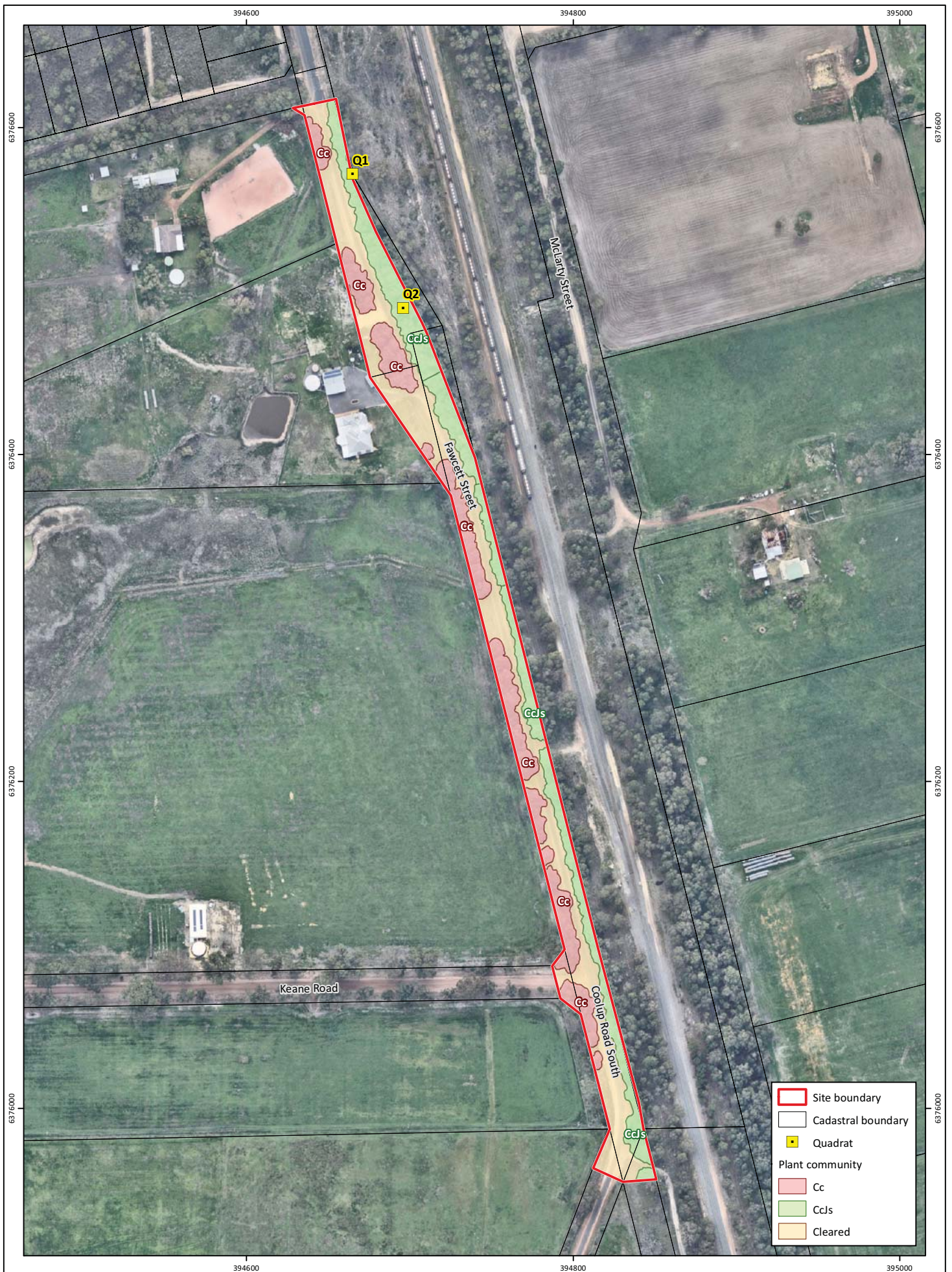


Figure 3: Plant Communities

Project: Detailed Flora and Vegetation Assessment
Coolup Road South Site 1

Client: Shire of Murray

Plan Number: EP20-102(01)--F08
Drawn: GAR
Date: 30/10/2020
Checked: TAA
Approved: TAA
Date: 9/11/2020



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ASSOCIATES

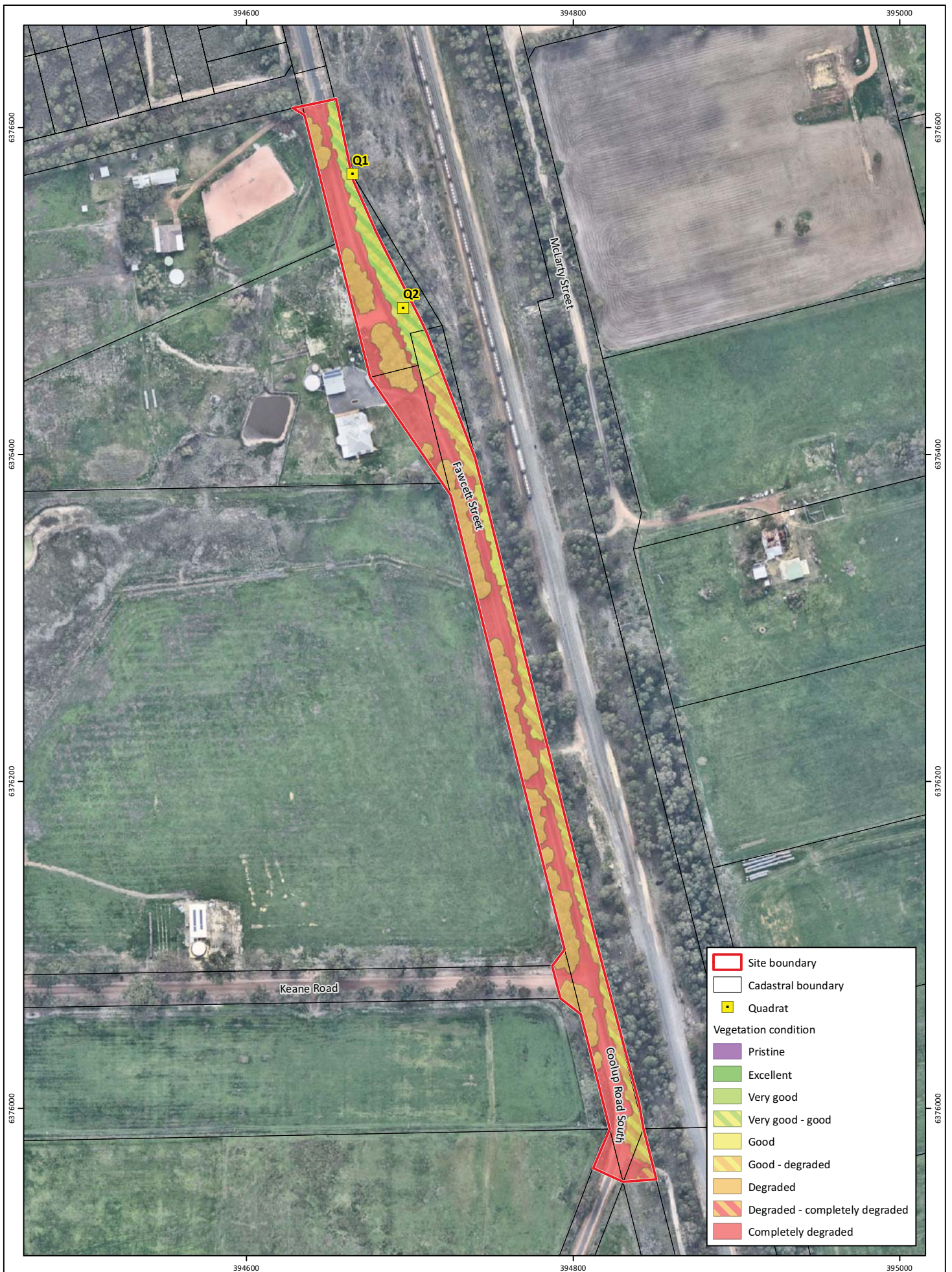


Figure 4: Vegetation Condition

Project: Detailed Flora and Vegetation Assessment
Coolup Road South Site 1

Client: Shire of Murray

Plan Number: EP20-102(01)--F09
Drawn: GAR
Date: 30/10/2020
Checked: TAA
Approved: TAA
Date: 9/11/2020



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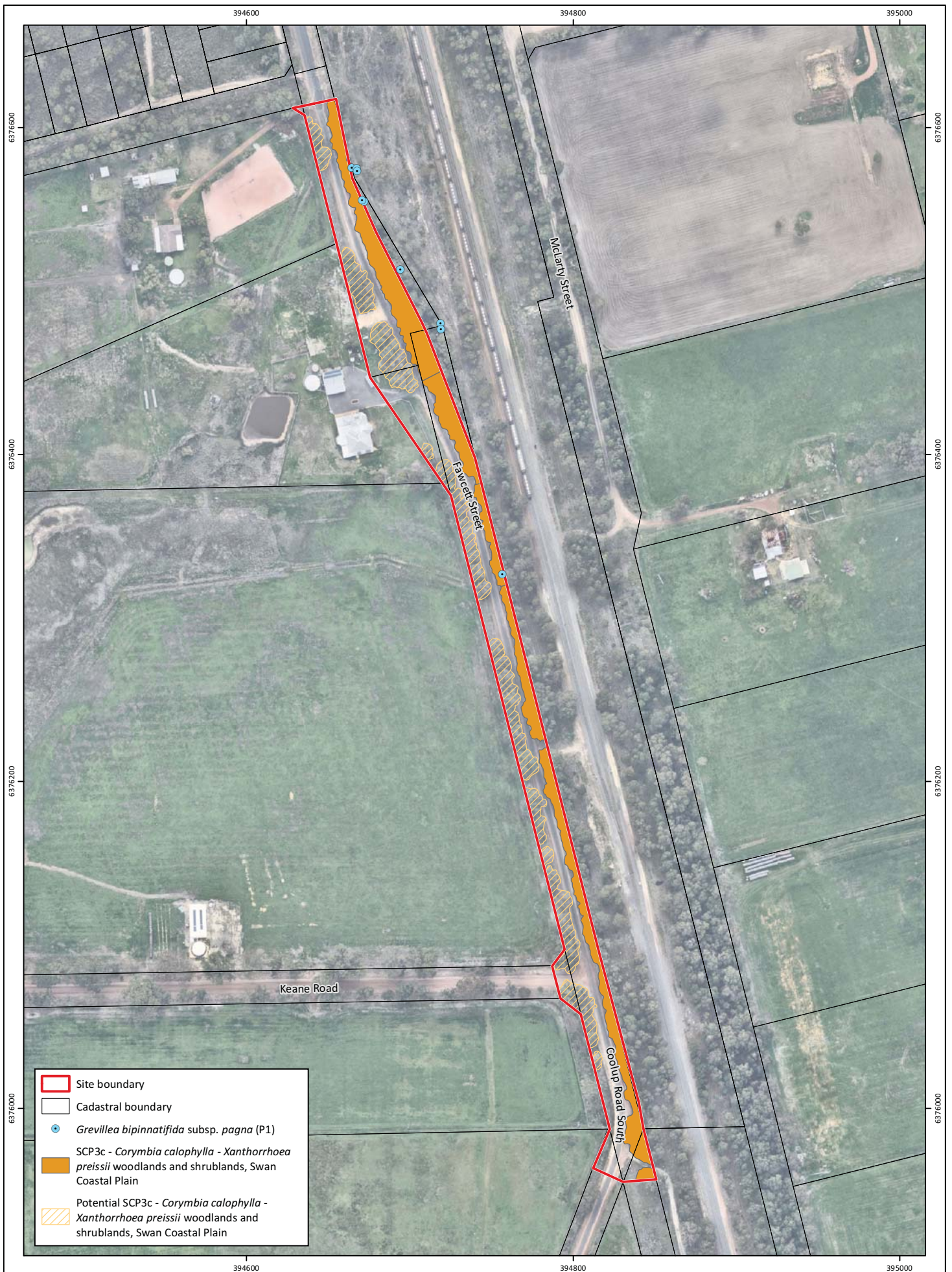


Figure 5: Conservation Significant Values

Project: Detailed Flora and Vegetation Assessment
Coolup Road South Site 1

Client: Shire of Murray

Plan Number: EP20-102(01)--F10
Drawn: GAR
Date: 30/10/2020
Checked: TAA
Approved: TAA
Date: 9/11/2020



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Metres
Scale: 1:3,000@A4
GDA 1994 MGA Zone 50

emerge
ASSOCIATES



Figure 6a: Weeds - Grasses and Herbs

Project: Detailed Flora and Vegetation Assessment
Coolup Road South Site 1
Client: Shire of Murray

Plan Number:
EP20-102(01)--F11
Drawn: RAW
Date: 09/11/2020
Checked: TAA
Approved: TAA
Date: 09/11/2020



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GDA 1994 MGA Zone 50

emerge
ASSOCIATES

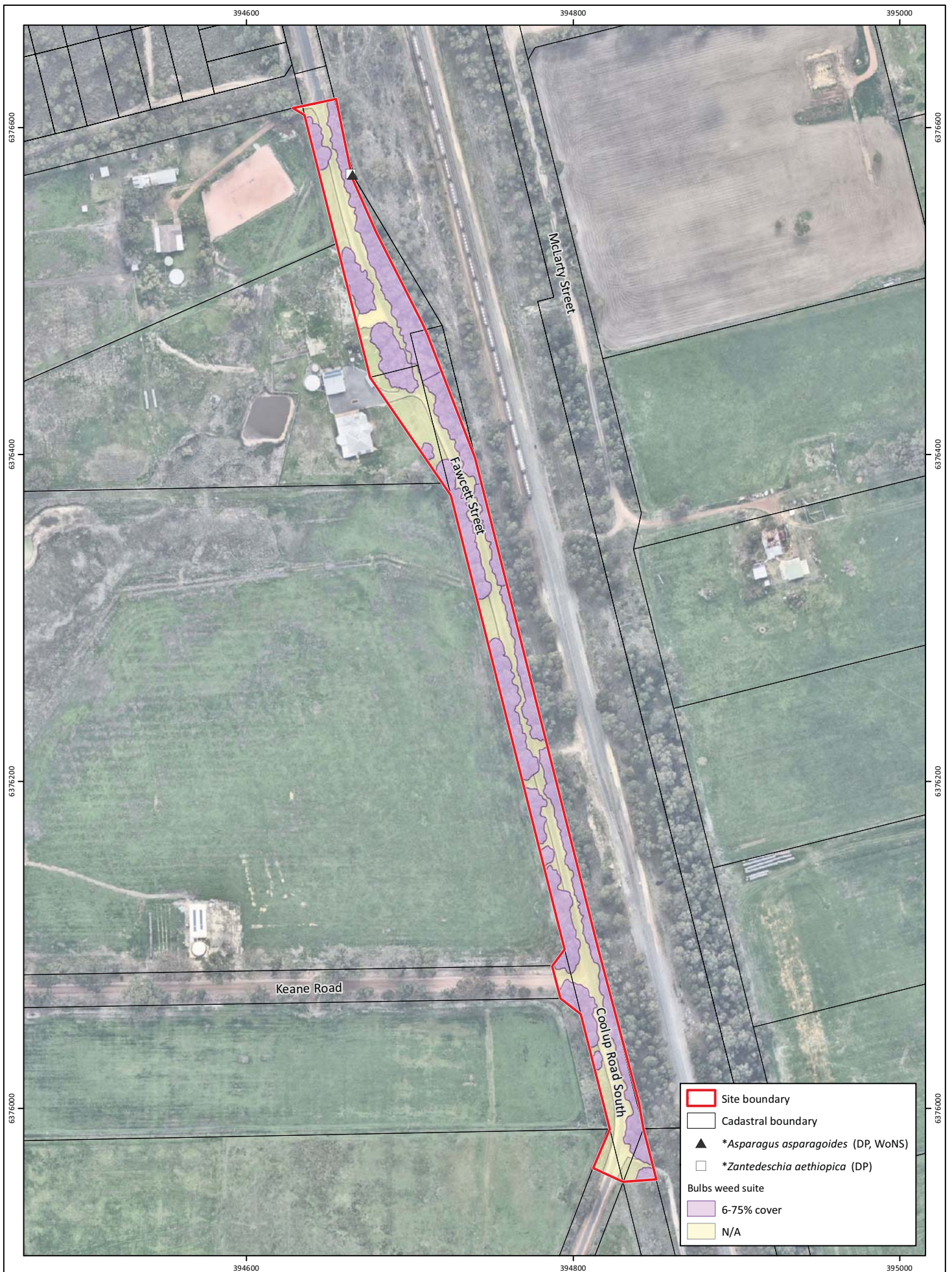


Figure 6b: Weeds - Bulbs

Project: Detailed Flora and Vegetation Assessment
Coolup Road South Site 1

Client: Shire of Murray

Plan Number:
EP20-102(01)--F12

Drawn: RAW

Date: 09/11/2020

Checked: TAA

Approved: TAA

Date: 09/11/2020



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Metres

Scale: 1:3,000@A4

GDA 1994 MGA Zone 50

emerge
ASSOCIATES

Appendix A

Additional Information



Conservation Significant Flora and Vegetation

Threatened and priority flora

Flora species considered rare or under threat warrant special protection under Commonwealth and/or State legislation. At the Commonwealth level, flora species can be listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Flora species considered 'threatened' pursuant to Schedule 1 of the EPBC Act are assigned categories according to their conservation status, as outlined in **Table 1**.

In Western Australia, plant taxa may be classed as 'threatened' under the *Biodiversity Conservation Act 2016* (BC Act) which is enforced by Department of Biodiversity Conservation and Attractions (DBCA). Threatened flora species are listed under sections 19(1) and 26(2) of the BC Act. It is an offence to 'take' or disturb threatened flora without Ministerial approval. Section 5(1)1 of the Act defines to take as including "... to gather, pluck, cut, pull up, destroy, dig up, remove, harvest or damage flora by any means" or to cause or permit the same to be done. The definition of threatened flora under the BC Act is provided in **Table 1**.

Section 43 of the BC Act requires that an occurrence of a threatened species or threatened ecological community is reported to DBCA where the occurrence has been identified as part of field work completed:

- as part of an assessment under Part IV of the *Environmental Protection Act 1986*; or
- in relation to an application for a clearing permit under the *Environmental Protection Act 1986* section 51E(1)(d).

Penalties apply to individuals and organisations that fail to provide accurate reports of threatened species or communities.

The *Biodiversity Conservation Regulations 2018* (BC Regulations 2018) came into effect on January 1 2019. The BC Regulations include provisions for licencing, charges, penalties and other provisions associated with the BC Act.

Flora species that may be threatened or near threatened but lack sufficient information to be listed under the BC Act may be added to the DBCA's *Priority Flora List* (DBCA 2018b). Priority flora species are considered during State approval processes. Priority flora categories and definitions are listed in **Table 1**.

Additional Background Information



Table 1: Definitions of conservation significant flora species pursuant to the EPBC Act and BC Act and on DBCA's Priority Flora List (DBCA 2018b)

Conservation code	Description
EX [†]	Threatened Flora – Presumed Extinct Taxa which have not been collected, or otherwise verified, over the past 50 years despite thorough searching, or of which all known wild populations have been destroyed more recently, and have been gazetted as such.
T [†]	Threatened Flora – Extant Taxa which are declared to be likely to become extinct or is rare, or otherwise in need of special protection.
CR [^]	Threatened Flora – Critically Endangered Taxa which are considered to be facing an extremely high risk of extinction in the wild.
EN [^]	Threatened Flora – Endangered Taxa which are considered to be facing a very high risk of extinction in the wild.
VU [^]	Threatened Flora – Vulnerable Taxa which are considered to be facing a high risk of extinction in the wild.
P1 [□]	Priority One – Poorly Known Taxa which are known from one or a few (generally <5) populations which are under threat, either due to small population size, or being on lands under immediate threat e.g. road verges, urban areas, farmland, active mineral leases etc., or the plants are under threat, e.g. from disease, grazing by feral animals etc. May include taxa with threatened populations on protected lands. Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.
P2 [□]	Priority Two – Poorly Known Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but urgently need further survey.
P3 [□]	Priority Three – Poorly Known Taxa which are known from several populations, and the taxa are not believed to be under immediate threat (i.e. not currently endangered), either due to the number of known populations (generally >5), or known populations being large, and either widespread or protected. Such taxa are under consideration for declaration as 'rare flora' but needs further survey.
P4 [□]	Priority Four – Rare Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors. These taxa require monitoring every 5-10 years.

[^]pursuant to the EPBC Act, [†]pursuant to the BC Act, [□]on DBCA's *Priority Flora List*

Threatened and priority ecological communities

'Threatened ecological communities' (TECs) are recognised as ecological communities that are rare or under threat and therefore warrant special protection. Selected TECs are afforded statutory protection at a Commonwealth level under section 181 of the EPBC Act. TECs nominated for listing under the EPBC Act are considered by the Threatened Species Scientific Committee and a final decision is made by the Commonwealth Minister for the Environment. Once listed under the EPBC Act, communities are categorised as either 'critically endangered', 'endangered' or 'vulnerable' as defined in **Table 2**. Any action likely to have a significant impact on a community listed under the EPBC Act requires approval from the Minister for the Environment.

Additional Background Information



Within Western Australia TECs are determined by the Western Australian Threatened Ecological Communities Scientific Advisory Committee (WATECSAC) and endorsed by the State Minister for the Environment. The WATECSAC is an independent group comprised of representatives from organisations including tertiary institutions, the Western Australian Museum and DBCA. The TECs endorsed by the State Minister are published by DBCA (DBCA 2018a).

TECs are assigned to one of the categories outlined in **Table 2** according to their status (in relation to the level of threat). TECs are afforded direct statutory protection at a State level under the BC Act and BC Regulations. Ecological communities are listed under Section 27(1) and 33 of the BC Act. Their significance is also acknowledged through other state environmental approval processes such as 'environmental impact assessment' pursuant to Part IV of the *Environmental Protection Act 1986* (EP Act) and the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*.

Table 2: Categories of threatened ecological communities (English and Blyth 1997; DEC 2009)

Conservation code	Description
PD	Presumably Totally Destroyed An ecological community that has been adequately searched for but for which no representative occurrences have been located.
CE	Critically Endangered An ecological community that has been adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future.
E	Endangered An ecological community that has been adequately surveyed and is not critically endangered but is facing a very high risk of total destruction in the near future.
V	Vulnerable An ecological community that has been adequately surveyed and is not critically endangered or endangered but is facing a high risk of total destruction or significant modification in the medium to long-term future.

An ecological community that is under consideration for listing as a TEC, but does not yet meet survey criteria or has not been adequately defined may be listed as a 'priority ecological community' (PEC). PECs are categorised as priority category 1, 2 or 3 as described in **Table 3**. Ecological communities that are adequately known and are rare but not threatened, or meet criteria for 'near threatened', or that have been recently removed from the threatened list, are placed in 'priority 4'. These ecological communities require regular monitoring. Conservation dependent ecological communities are placed in 'priority 5' (DEC 2013). Listed PECs are published by DBCA (DBCA 2017).

Additional Background Information



Table 3: Categories of priority ecological communities (DEC 2013)

Priority code	Description
P1	<p>Priority One: Poorly known ecological communities</p> <p>Ecological communities that are known from very few occurrences with a very restricted distribution (generally ≤ 5 occurrences or a total area of ≤ 100ha). Occurrences are believed to be under threat either due to limited extent, or being on lands under immediate threat (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) or for which current threats exist. May include communities with occurrences on protected lands. Communities may be included if they are comparatively well-known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range.</p>
P2	<p>Priority Two: Poorly known ecological communities</p> <p>Communities that are known from few occurrences with a restricted distribution (generally ≤ 10 occurrences or a total area of ≤ 200ha). At least some occurrences are not believed to be under immediate threat (within approximately 10 years) of destruction or degradation. Communities may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under threat from known threatening processes.</p>
P3	<p>Priority Three: Poorly known ecological communities</p> <p>(i) Communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation or;</p> <p>(ii) communities known from a few widespread occurrences, which are either large or with significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat (within approximately 10 years), or;</p> <p>(iii) communities made up of large, and/or widespread occurrences, that may or may not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, inappropriate fire regimes, clearing, hydrological change etc.</p> <p>Communities may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and/or are not well defined, and known threatening processes exist that could affect them.</p>
P4	<p>Priority Four: Ecological communities that are adequately known, rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list. These communities require regular monitoring.</p> <p>(i) Rare. Ecological communities known from few occurrences that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These communities are usually represented on conservation lands.</p> <p>(ii) Near Threatened. Ecological communities that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for a higher threat category.</p> <p>(iii) Ecological communities that have been removed from the list of threatened communities during the past five years.</p>
P5	<p>Priority Five: Conservation Dependent ecological communities</p> <p>Ecological communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years.</p>

Additional Background Information



References

General references

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Appendix B

Conservation Significant Flora Species and Likelihood of
Occurrence Assessment



Species name	Level of significance		Life strategy	Habitat	Flowering period	Likelihood of occurrence (Prior to survey)	Likelihood of occurrence (Post survey)
	WA	EPBC Act					
<i>Synaphea sp. Fairbridge Farm (D. Papenfus 696)</i>	CR	CR	P	Low woodland on grey, clayey sand with lateritic pebbles (Pinjarra Plain) near winter wet flats.	Sep-Nov	Possible	Unlikely
<i>Synaphea sp. Serpentine (G.R. Brand 103)</i>	CR	CR	P	Seasonally damp areas, loam - sand.	Sep-Oct	Possible	Unlikely
<i>Synaphea stenoloba</i>	CR	E	P	Swampy loam in depressions that are occasionally inundated.	Aug but mainly Sep-Oct	Possible	Unlikely
<i>Caladenia huegelii</i>	CR	E	PG	Well-drained, deep sandy soils in lush undergrowth in a variety of moisture levels.	Sep-early Nov	Unlikely	Unlikely
<i>Drakaea elastica</i>	CR	E	PG	Bare patches of sand within otherwise dense vegetation in low-lying areas alongside winter-wet swamps.	late Sep-Oct/Nov, survey Jul-Aug	Unlikely	Unlikely
<i>Lasiopetalum pterocarpum</i>	CR	E	P	Dark brown or red brown loam or clayey-sand over granite, near creek lines and on sloping banks. Associated with riparian vegetation including flooded gum, marri and swamp peppermint.	Aug-Nov	Unlikely	Unlikely
<i>Synaphea sp. Pinjarra Plain (A.S. George 17182)</i>	EN	CR	P	White grey clayey sand on edges of seasonally inundated low lying areas.	Sep-Oct	Possible	Unlikely
<i>Thelymitra stellata</i>	EN	E	PG	Sandy loam, clay or gravel over laterite or gravel.	Sep-Nov	Possible	Unlikely
<i>Diuris purdiei</i>	EN	E	PG	Sand to sandy clay soils in areas subject to winter inundation.	late September to mid-October, but only after a summer or early autumn fire (Brown et al., 1998)	Unlikely	Unlikely
<i>Drakaea micrantha</i>	EN	V	PG	Open sandy patches often adjacent to winter-wet swamps.	Sept- early Oct	Unlikely	Unlikely

	WA	EPBC Act				(Prior to survey)	(Post survey)
<i>Tetraria australiensis</i>	VU	V	P	Sand over clay, winter wet depressions and drainage lines.	Nov-Dec	Possible	Unlikely
<i>Andersonia gracilis</i>	VU	E	P	Seasonally damp, black sandy clay flats near or on the margins of swamps.	Sep-Nov	Unlikely	Unlikely
<i>Diuris drummondii</i>	VU	V	PG	In low-lying depressions in peaty and sandy clay swamps.	Nov-Jan	Unlikely	Unlikely
<i>Diuris micrantha</i>	VU	V	PG	Dark grey-black sandy clay-loam in winter wet depressions or swamps. Often in shallow standing water.	Aug/Sep-early Oct	Unlikely	Unlikely
<i>Eleocharis keigheryi</i>	VU	V	P	Clay or sandy loam in freshwater creeks and transient waterbodies such as seasonally wet clay pans.	Aug-Dec	Unlikely	Unlikely
<i>Anthocercis gracilis</i>	VU	V	P	Steep granite slopes along the Darling Scarp in shallow, humic-rich sandy or loamy soils.	Sep-Oct, Apr	Unlikely	Unlikely
<i>Grevillea bipinnatifida</i> subsp. <i>pagna</i>	P1	-	P	Grey sandy clay and loam, ironstone. Seasonal wetlands, swamps, roadsides.	Aug or Oct-Nov	Possible	Recorded
<i>Synaphea odocoileops</i>	P1	-	P	Brown orange loam and sandy clay, granite, in swamps and winter wet areas.	Aug-Oct	Possible	Unlikely
<i>Hibbertia acrotoma</i>	P1	-	P	Brown loam with granite/laterite.	Aug-Sep/Oct	Unlikely	Unlikely
<i>Grevillea manglesii</i> subsp. <i>ornithopoda</i>	P2	-	P	Red-brown loam over clay	Sep-Nov	Possible	Unlikely
<i>Lepyrodia curvescens</i>	P2	-	P	Sand, laterite. Seasonally inundated swampland.	Sep-Nov	Unlikely	Unlikely
<i>Melaleuca viminalis</i>	P2	-	P	Sand, clay in creeklines and wetlands.	Oct-Dec	Unlikely	Unlikely
<i>Phyllangium palustre</i>	P2	-	A	Winter-wet claypans, low-lying seasonal wetlands on clay	Oct-Nov	Unlikely	Unlikely
<i>Trithuria australis</i>	P2	-	A	Seasonally wet areas. Edge of wetlands. Grey clay, clay over sand. Sand over laterite.	Oct-Nov	Unlikely	Unlikely
<i>Craspedia</i> sp. <i>Waterloo</i> (G.J. Keighery 13724)	P2	-	P	Winter wet flats with clay and sandy clay in wandoo woodland.	Aug-Sep	Unlikely	Unlikely
<i>Chamaescilla gibsonii</i>	P3	-	P	Clay to sandy clay in winter-wet flats, shallow water-filled claypans.	Sep	Possible	Recorded
<i>Angianthus drummondii</i>	P3	-	A	Grey or brown clay soils, ironstone. On seasonally wet flats.	Oct-Dec	Possible	Unlikely

	WA	EPBC Act				(Prior to survey)	(Post survey)
<i>Eryngium pinnatifidum</i> subsp. <i>Palustre</i> (G.J. Keighery 13459)	P3	-	P	Grey brown sand or clay in winter wet flats.	Sep-Nov	Possible	Unlikely
<i>Eryngium</i> sp. <i>Ferox</i> (G.J. Keighery 16034)	P3	-	P	Winter wet flats on clay	Oct-Mar	Possible	Unlikely
<i>Schoenus capillifolius</i>	P3	-	A	Brown mud in claypans	Oct-Nov	Possible	Unlikely
<i>Schoenus pennisetis</i>	P3	-	A	Grey or peaty sand in swamps and winter-wet depressions.	Aug-Sep	Possible	Unlikely
<i>Schoenus</i> sp. <i>Waroona</i> (G.J. Keighery 12235)	P3	-	A	Clay or sandy clay. Winter-wet flats.	Oct-Nov	Possible	Unlikely
<i>Myriophyllum echinatum</i>	P3	-	A	Clay in winter-wet flats.	Nov	Unlikely	Unlikely
<i>Stylidium aceratum</i>	P3	-	A	Sandy soils in swamp heathland.	Oct-Nov	Unlikely	Unlikely
<i>Haemodorum loratum</i>	P3	-	P	Grey or yellow sand, gravel.	Nov	Unlikely	Unlikely
<i>Drosera occidentalis</i>	P4	-	P	Flat, brown/white/yellow moist sand/clay/peat, often near swamps.	Oct-Dec/Jan	Possible	Unlikely
<i>Acacia semitrullata</i>	P4	-	P	White/grey sand, sometimes	May-Oct	Possible	Unlikely
<i>Parsonsia</i>	P4	-	P	Alluvial soils along rivers.	Jan-Feb or	Unlikely	Unlikely
<i>Schoenus natans</i>	P4	-	A	Aquatic, in winter-wet	Oct	Unlikely	Unlikely
<i>Aponogeton hexatepalus</i>	P4	-	P	Mud. Freshwater: ponds, rivers, claypans.	Jul-Oct	Unlikely	Unlikely
<i>Caladenia speciosa</i>	P4	-	PG	White, grey or black sand.	Sep-Oct	Unlikely	Unlikely
<i>Ornduffia submersa</i>	P4	-	A	Sandy clay in inundated wetland/creek.	Aug-Nov	Unlikely	Unlikely
<i>Stylidium longitubum</i>	P4	-	A	Seasonal wetlands.	Oct-Dec	Unlikely	Unlikely
<i>Calothamnus graniticus</i> subsp. <i>leptophyllus</i>	P4	-	P	Clay over granite, lateritic soils. Hillsides.	Jun-Aug	Unlikely	Unlikely

Note: T=threatened, CE=critically endangered, E=endangered, V=vulnerable, P1=Priority 1, P2=Priority 2, P3=Priority 3, P4=Priority 4, P=perennial, PG=perennial geophyte, A=annual. Species considered to potentially occur within the site are shaded green

Appendix C

Conservation Significant Communities and Likelihood of
Occurrence Assessment



Code	Community name	TEC/PEC	Level of significance		Likelihood of occurrence	
			WA	EPBC Act	Prior to survey	Post survey
SCP10a	Shrublands on dry clay flats (floristic community type 10a as originally described in Gibson et al. (1994))	TEC	EN	CR	Unlikley	Unlikley
Tuart woodlands	Tuart (<i>Eucalyptus gomphocephala</i>) woodlands and forests of the Swan Coastal Plain	TEC/PEC	P3	CR	Unlikley	Unlikley
SCP07	Herb rich saline shrublands in clay pans (floristic community type 7 as originally described in Gibson et al. (1994))	TEC	VU	CR	Unlikley	Unlikley
SCP08	Herb rich shrublands in clay pans (floristic community type 8 as originally described in Gibson et al. (1994))	TEC	VU	CR	Possible	Unlikley
SCP09	Dense shrublands on clay flats (floristic community type 9 as originally described in Gibson et al. (1994))	TEC	VU	CR	Possible	Unlikley
SCP3a	<i>Corymbia calophylla</i> - <i>Kingia australis</i> woodlands on heavy soils, Swan Coastal Plain (floristic community type 3a as originally described in Gibson et al. (1994))	TEC	CR	EN	Possible	Unlikley
SCP3c	<i>Corymbia calophylla</i> - <i>Xanthorrhoea preissii</i> woodlands and shrublands, Swan Coastal Plain (floristic community type 3c as originally described in Gibson et al. (1994))	TEC	CR	EN	Possible	Recorded
SCP20b	<i>Banksia attenuata</i> and/or <i>Eucalyptus marginata</i> woodlands of the eastern side of the Swan Coastal Plain (floristic community type 20b as originally described in Gibson et al. (1994))	TEC	EN	EN	Unlikley	Unlikley
Clifton-	Stromatolite like freshwater microbialite	TEC	CR		Unlikley	Unlikley
SCP15	Forests and woodlands of deep seasonal	TEC	VU		Unlikley	Unlikley
SCP3b	<i>Corymbia calophylla</i> - <i>Eucalyptus marginata</i>	TEC	VU		Possible	Unlikley
SCP21c	Low lying <i>Banksia attenuata</i> woodlands or shrublands	TEC/PEC	P3	EN	Unlikley	Unlikley
SCP22	<i>Banksia ilicifolia</i> woodlands	TEC/PEC	P4	EN	Unlikley	Unlikley
Coastal Saltmarsh	Subtropical and Temperate Coastal Saltmarsh	TEC/PEC	P3	VU	Unlikley	Unlikley
Banksia	<i>Banksia</i> Dominated Woodlands of the Swan	PEC	P3	EN	Unlikley	Unlikley
SCP25	Southern <i>Eucalyptus gomphocephala</i> - <i>Agonis</i>	PEC	P3		Unlikley	Unlikley

Note: TEC=threatened ecological community, PEC=priority ecological community, CR=critically endangered, EN=endangered, VU=vulnerable, P3=priority 3, P4=priority 4

Appendix D

Species List



Flora Species List - Coolup Road South Site 1

Note: * denotes introduced weed species

Family	Status	Species
Apiaceae		<i>Xanthosia candida</i> <i>Xanthosia huegelii</i>
Araceae	*	<i>Zantedeschia aethiopica</i>
Asparagaceae	*	<i>Asparagus asparagoides</i> <i>Laxmannia squarrosa</i> <i>Lomandra caespitosa</i> <i>Sowerbaea laxiflora</i> <i>Thysanotus manglesianus</i>
Asteraceae	*	<i>Hyalosperma cotula</i>
	*	<i>Sonchus oleraceus</i>
	*	<i>Ursinia anthemoides</i>
	*	<i>Hypochaeris glabra</i>
Colchicaceae		<i>Burchardia congesta</i>
Crassulaceae		<i>Crassula colorata</i>
Cyperaceae		<i>Cyathochaeta avenacea</i> <i>Lepidosperma squamatum</i> <i>Mesomelaena tetragona</i> <i>Schoenus sp.</i> <i>Tetraria octandra</i>
Dasypogonaceae		<i>Kingia australis</i>
Dilleniaceae		<i>Hibbertia hypericoides</i>
Droseraceae		<i>Drosera drummondii</i>
Ericaceae		<i>Conostephium sp.</i>
Fabaceae		<i>Acacia pulchella</i> <i>Bossiaea eriocarpa</i>

Flora Species List - Coolup Road South Site 1

Note: * denotes introduced weed species

Family	Status	Species
		<i>Daviesia physodes</i>
		<i>Gompholobium marginatum</i>
		<i>Jacksonia sternbergiana</i>
		<i>Kennedia prostrata</i>
	*	<i>Lotus subbiflorus</i>
		<i>Viminaria juncea</i>
Goodeniaceae		<i>Dampiera linearis</i>
		<i>Scaevola calliptera</i>
Haemodoraceae		<i>Conostylis aculeata</i>
		<i>Haemodorum spicatum</i>
Hemerocallidaceae		<i>Agrostocrinum hirsutum</i>
		<i>Caesia micrantha</i>
		<i>Tricoryne elatior</i>
Iridaceae	*	<i>Babiana angustifolia</i>
		<i>Patersonia occidentalis</i>
	*	<i>Romulea rosea</i>
	*	<i>Sparaxis bulbifera</i>
	*	<i>Watsonia meriana</i>
Lamiaceae	*	<i>Stachys arvensis</i>
Myrtaceae		<i>Corymbia calophylla</i>
		<i>Kunzea micrantha</i> subsp. <i>micrantha</i>
		<i>Melaleuca preissiana</i>
Orchidaceae		<i>Microtis media</i> subsp. <i>media</i>
		<i>Thelmitra macrophylla</i>
Oxalidaceae	*	<i>Oxalis pes-caprae</i>
	*	<i>Oxalis purpurea</i>
Phyllanthaceae		<i>Phyllanthus calycinus</i>
Poaceae	*	<i>Austrostipa flavescens</i>
		<i>Briza maxima</i>

Flora Species List - Coolup Road South Site 1

Note: * denotes introduced weed species

Family	Status	Species
	*	<i>Cenchrus clandestinus</i>
	*	<i>Cynodon dactylon</i>
	*	<i>Ehrharta calycina</i>
	*	<i>Ehrharta longiflora</i>
	*	<i>Eragrostis curvula</i>
		<i>Microlaena stipoides</i>
		<i>Neurachne alopecuroidea</i>
	*	<i>Lolium rigidum</i>
	*	<i>Poaceae sp</i>
Portulacaceae		<i>Portulaca oleracea</i>
Proteaceae		<i>Banksia dallyaniana</i>
	P3	<i>Grevillea bipinnatifida subsp. pagna</i>
Restionaceae		<i>Desmocladius fasciculatus</i>
		<i>Hypolaena exsulca</i>
		<i>Leptocarpus decipiens</i>
Rubiaceae		<i>Opercularia vaginata</i>
Xanthorrhoeaceae		
	P1	<i>Chamaescilla gibsonii</i>
		<i>Xanthorrhoea preissii</i>

Appendix E

Species x Plant Community Matrix



Flora Species x Plant Community Matrix - Coolup Road South Site 1

Species	Plant community	
	CcJs	Cc
<i>Acacia pulchella</i>	X	
<i>Agrostocrinum hirsutum</i>	X	
<i>Asparagus asparagoides</i>	X	X
<i>Austrostipa flavescens</i>	X	
<i>Babiana angustifolia</i>	X	
<i>Banksia dallyaniana</i>	X	
<i>Bossiaea eriocarpa</i>	X	
<i>Briza maxima</i>	X	
<i>Burchardia congesta</i>	X	
<i>Caesia micrantha</i>	X	
<i>Cenchrus clandestinum</i>	X	X
<i>Chamaescilla gibsonii</i>	X	
<i>Conostephium sp.</i>	X	
<i>Conostylis aculeata</i>	X	
<i>Corymbia calophylla</i>	X	X
<i>Cyathochaeta avenacea</i>	X	
<i>Cynodon dactylon</i>	X	X
<i>Dampiera linearis</i>	X	
<i>Daviesia physodes</i>	X	
<i>Desmocladius fasciculatus</i>	X	
<i>Drosera drummondii</i>	X	
<i>Ehrharta calycina</i>	X	
<i>Ehrharta longiflora</i>	X	X
<i>Eragrostis curvula</i>	X	X
<i>Gompholobium marginatum</i>	X	X
<i>Grevillea bipinnatifida subsp. pagna</i>	X	
<i>Haemodorum ?spicatum</i>	X	
<i>Haemodorum spicatum</i>	X	
<i>Hibbertia hypericoides</i>	X	
<i>Hyalosperma cotula</i>	X	
<i>Hypochaeris glabra</i>	X	
<i>Hypolaena exsulca</i>	X	
<i>Jacksonia sternbergiana</i>	X	
<i>Kennedia prostrata</i>	X	
<i>Kingia australis</i>	X	
<i>Kunzea micrantha subsp. micrantha</i>	X	
<i>Laxmannia squarrosa</i>	X	
<i>Lepidosperma squamatum</i>	X	
<i>Leptocarpus decipiens</i>	X	
<i>Lolium rigidum</i>	X	X
<i>Lomandra caespitosa</i>	X	
<i>Lotus subbiflorus</i>	X	X
<i>Mesomelaena tetragona</i>	X	
<i>Microlaena stipoides</i>	X	
<i>Microtis media subsp. media</i>	X	
<i>Neurachne alopecuroidea</i>	X	
<i>Opercularia vaginata</i>	X	

Flora Species x Plant Community Matrix - Coolup Road South Site 1

Species	Plant community	
	CcJs	Cc
<i>Oxalis pes caprae</i>	X	X
<i>Oxalis purpurea</i>	X	
<i>Patersonia occidentalis</i>	X	
<i>Phyllanthus calycinus</i>	X	
<i>Poaceae sp</i>	X	
<i>Portulaca oleracea</i>	X	X
<i>Romulea rosea</i>	X	X
<i>Scaevola calliptera</i>	X	
<i>Schoenus sp.</i>	X	
<i>Sonchus oleraceus</i>	X	
<i>Sowerbaea laxiflora</i>	X	
<i>Sparaxis bulbifera</i>	X	X
<i>Stachys arvensis</i>	X	X
<i>Tetraria octandra</i>	X	
<i>Thelmytra macrophylla</i>	X	
<i>Thysanotus manglesianus</i>	X	
<i>Tricoryne elatior</i>	X	
<i>Ursinia anthemoides</i>	X	
<i>Viminaria juncea</i>	X	X
<i>Watsonia meriana</i>	X	

Appendix F

Sample Data



Sample Name: Q1

Project no.: EP19-107

Date: 24/10/2019

Author: TAA,RAO

Status Permanent

Q1: Page 2 of 3

Quadrat and landform details

Sample type: quadrat

Size: other

NW corner easting: 394665

NW corner northing: 6376572

Altitude (m): 19

Geographic datum/zone: GDA94/Zone 50

Soil water content: damp

Landform: flat

Time since fire: > 5 yrs

Disturbance: low -

Soil type/texture sand/loam with organic layer

Bare ground (%): 1

Rocks (%) and type: No rocks

Soil colour: brown/

Litter: 70% (leaves,twigs,branches)

Vegetation condition: very good



Sample Name: Q1

Project no.: EP19-107

Date: 24/10/2019

Author: TAA,RAO

Status Permanent

Q1: Page 2 of 3

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	<i>Corymbia calophylla</i>	40
	<i>Mesomelaena tetragona</i>	40
	<i>Tetraria octandra</i>	20
	* <i>Babiana angustifolia</i>	15
	<i>Xanthorrhoea preissii</i>	15
	* <i>Watsonia meriana</i>	10
	<i>Cyathochaeta avenacea</i>	5
	<i>Kingia australis</i>	5
	<i>Neurachne alopecuroidea</i>	5
	<i>Viminaria juncea</i>	5
	<i>Jacksonia sternbergiana</i>	1
	<i>Agrostocrinum hirsutum</i>	0.1
	* <i>Briza maxima</i>	0.1
	<i>Burchardia congesta</i>	0.1
P1	<i>Chamaescilla gibsonii</i>	0.1
	<i>Conostylis aculeata</i>	0.1
	<i>Dampiera linearis</i>	0.1
	<i>Desmocladius fasciculatus</i>	0.1
	* <i>Ehrharta calycina</i>	0.1
	* <i>Ehrharta longiflora</i>	0.1
	* <i>Eragrostis curvula</i>	0.1
P3	<i>Grevillea bipinnatifida subsp. pagna</i>	0.1
	<i>Laxmannia squarrosa</i>	0.1
	* <i>Lotus subbiflorus</i>	0.1
	* <i>Oxalis purpurea</i>	0.1
	<i>Phyllanthus calycinus</i>	0.1
	<i>Sowerbaea laxiflora</i>	0.1
	* <i>Lolium rigidum</i>	0.1
	<i>Lepidosperma squamatum</i>	0.1
	<i>Caesia micrantha</i>	0.1
	<i>Cicendia filiformis</i>	0.1
	<i>Drosera drummondii</i>	0.1
	<i>Gompholobium marginatum</i>	0.1
	<i>Kunzea micrantha subsp. micrantha</i>	0.1
	<i>Leptocarpus decipiens</i>	0.1
	* <i>Romulea rosea</i>	0.1

Sample Name:

Q1

Project no.: EP19-107

Date: 0/01/1900

Author: TAA,RAO

Status Permanent

Q1: Page 2 of 3

* <i>Stachys arvensis</i>	0.1
<i>Hyalosperma cotula</i>	0.1
<i>Patersonia occidentalis</i>	0.1
<i>Xanthosia huegelii</i>	0.1
<i>Acacia pulchella</i>	opp
DP <i>Asparagus asparagoides</i>	opp
<i>Kennedia prostrata</i>	opp

Sample Name:

Q2

Project no.: EP19-107

Date: 24/10/2019

Author: TAA,RAO

Status Permanent

Q2: Page 2 of 3

Quadrat and landform details

Sample type: quadrat	Size: 10 m x 10 m
NW corner easting: 394696	NW corner northing: 6376490
Altitude (m): 22	Geographic datum/zone: GDA94/Zone 50
Soil water content: damp	Landform: flat
Time since fire: > 5 yrs	Disturbance: low -
Soil type/texture sand/loam with organic layer	Bare ground (%): 2
Rocks (%) and type: No rocks	Soil colour: brown/grey
Litter: 60% (leaves,twigs,branches)	Vegetation condition: very good



Sample Name:

Q2

Project no.: EP19-107

Date: 24/10/2019

Author: TAA,RAO

Status Permanent

Q2: Page 2 of 3

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	<i>Corymbia calophylla</i>	70
	* <i>Tetraria octandra</i>	40
	<i>Mesomelaena tetragona</i>	25
	<i>Jacksonia sternbergiana</i>	20
	* <i>Oxalis purpurea</i>	15
	* <i>Cyathochaeta avenacea</i>	5
	<i>Kingia australis</i>	5
	<i>Desmocladius fasciculatus</i>	3
	<i>Daviesia physodes</i>	2
	<i>Sowerbaea laxiflora</i>	2
	* <i>Bossiaea eriocarpa</i>	1
	* <i>Briza maxima</i>	1
	<i>Caesia micrantha</i>	1
	<i>Xanthosia candida</i>	1
	<i>Austrostipa flavescens</i>	1
	<i>Agrostocrinum hirsutum</i>	0.1
	* <i>Babiana angustifolia</i>	0.1
	<i>Burchardia congesta</i>	0.1
	<i>Conostylis aculeata</i>	0.1
	<i>Drosera drummondii</i>	0.1
	<i>Haemodorum spicatum</i>	0.1
	<i>Hypolaena exsulca</i>	0.1
	<i>Microtis media subsp. media</i>	0.1
	<i>Neurachne alopecuroidea</i>	0.1
	* <i>Romulea rosea</i>	0.1
	* <i>Sonchus oleraceus</i>	0.1
	<i>Thelmytra macrophylla</i>	0.1
	<i>Thysanotus manglesianus</i>	0.1
	<i>Tricoryne elatior</i>	0.1
	* <i>Ursinia anthemoides</i>	0.1
	* <i>Hypochaeris glabra</i>	0.1
DP	<i>Zantedeschia aethiopica</i>	0.1
	<i>Banksia dallyaniana</i>	0.1
	* <i>Eragrostis curvula</i>	0.1
	<i>Kennedia prostrata</i>	0.1
	<i>Microlaena stipoides</i>	0.1

Sample Name:

Q2

Project no.: EP19-107

Date: 24/10/2019

Status Permanent

Author: TAA,RAO

Q2: Page 2 of 3

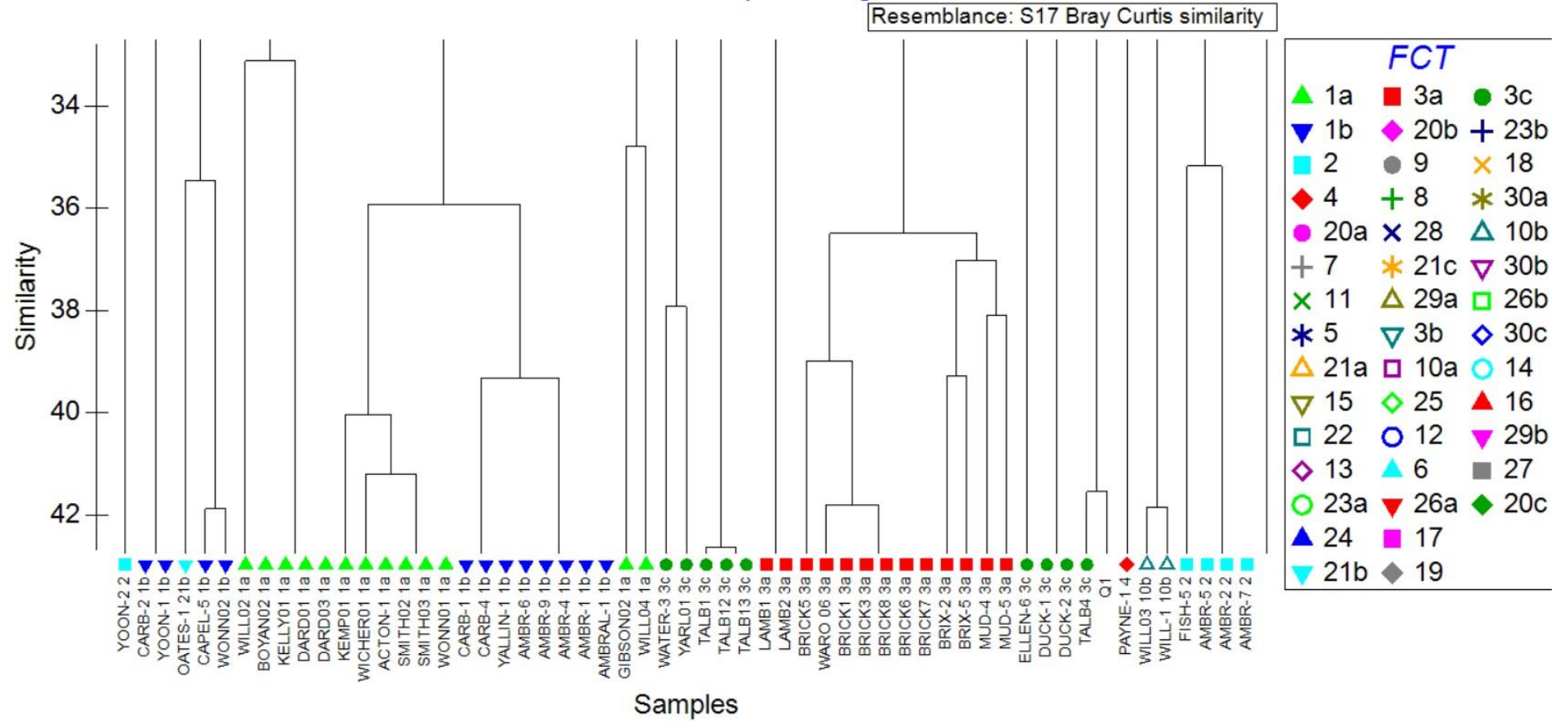
	<i>Opercularia vaginata</i>	0.1
	<i>Scaevola calliptera</i>	0.1
	<i>Schoenus sp.</i>	0.1
	<i>Xanthorrhoea preissii</i>	0.1
	<i>Lepidosperma squamatum</i>	0.1
	<i>Conostephium sp.</i>	0.1
	<i>Lomandra caespitosa</i>	0.1
*	<i>Watsonia meriana</i>	opp
	<i>Hibbertia hypericoides</i>	opp
	<i>Microlaena stipoides</i>	opp
	<i>Kunzea micrantha subsp. micrantha</i>	opp

Appendix G

Cluster Dendrograms



Q1 Group average



Q2 Group average

