Spring Flora and Vegetation Survey

Lots 107 and 108 Wattleup Rd, Hammond Park

Project No: EP16-076(02)

Prepared for OpenCorp
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Executive Summary

OpenCorp engaged Emerge Associates (Emerge) to undertake a spring flora and vegetation survey within Lots 107 and 108 Wattleup Road in Hammond Park. These lots (referred to herein as 'the site') are zoned 'development' under the City of Cockburn's Town Planning Scheme No.3 and are currently utilized for sprout growing, dwellings, orchards and as remnant bushland.

A botanist from Emerge Associates visited the site on 28th September 2016 and undertook a detailed flora and vegetation survey. During the survey targeted searches were conducted for 'threatened' and 'priority' flora and an assessment was made on the type, condition and values of vegetation across the site.

Results of the survey include:

- Non-native vegetation is present across 4.77 hectares (ha) of the site including a large portion of Lot 108 and a portion in the south of Lot 107. Remnant native vegetation is present across 3.32 ha of the site within Lots 107 and 108.
- No threatened or priority flora species were recorded or are considered likely to occur within the site due to lack of suitable habitat.
- The remnant native vegetation within the site was mapped as a single plant community (**BaBm**).
- The **BaBm** vegetation aligns closely with floristic community type (FCT) '28 -Spearwood *Banksia attenuata* or *Banksia attenuata* – *Eucalyptus* woodlands'.
- Native vegetation in the north-western portion of the site is in 'excellent' condition and native vegetation in the north and north-east of the site is in 'very good' condition. An area of 'good' condition vegetation is present in the centre of Lot 107. The remainder of the vegetation is in 'degraded' or 'completely degraded' condition.
- Based on the relevant criteria, the majority of the remnant native vegetation represents the 'Banksia Woodlands of the Swan Coastal Plain' threatened ecological community (TEC), which was recently listed under the *Environment Protection and Biodiversity Conservation Act 1999*. Approximately 3.32 ha of the banksia woodland TEC is present within the site.
- The remnant native vegetation represents the state listed priority ecological community (PEC) 'Banksia dominated woodlands of the Swan Coastal Plain IBRA region'. Approximately 3.32 ha of this PEC is present within the site.

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1 Introduction

1.1 Project background

OpenCorp intends to develop Lots 107 and 108 Wattleup Road in Hammond Park for residential purposes. These lots (referred to herein as 'the site') are located approximately 24 kilometres (km) south of the Perth Central Business District. The site is located within the City of Cockburn (CoC) and is zoned 'urban' under the CoC's Southern Suburbs District Structure Plan – Stage 3 and 'development' under the CoC's Town Planning Scheme No.3.

The site is approximately 8 hectares (ha) in size and is bound by Wattleup Road to the south, private land with native vegetation to the west, Bush Forever Site 392 (Harry Waring Marsupial Reserve) to the north and recently cleared land to the east. The location of the site is shown in **Figure 1.**

1.2 Purpose and scope of work

Emerge Associates (Emerge) were engaged by OpenCorp to provide environmental consultancy services to support the structure planning for residential development process for the site. The purpose of this survey is to provide sufficient information on the flora and vegetation values within the site to inform this process.

The scope of work was specifically to undertake a spring flora and vegetation assessment in accordance with the Environmental Protection Authority's (EPA's) *Guidance Statement No. 51 – Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia* (EPA 2004) and the more recent EPA and Department of Parks and Wildlife's (DPaW's) *Technical Guide - Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA and DPaW 2015).

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 and vegetation condition.
- Identification of conservation significant flora and vegetation.
- Documentation of the desktop assessment, survey methodology and results into a report.

2 Background

2.1 Climate

The south west of Western Australia experiences a Mediterranean climate of hot dry summers and cool wet winters. Long-term climatic data was obtained from the Medina Research Station, which is the nearest current reporting station to the site (BOM 2016). This data indicates the site is located in an area of moderate rainfall, receiving an average of 745.9 millimetres (mm) annually, the majority of which is received between May and August. Mean maximum temperatures range from 18.3^{o}C in July to 31.5^{o}C in February. Mean minimum temperatures range from 8.2^{o}C in July and August to 17.6^{o}C in February (BoM 2016).

2.2 Geomorphology and soils

The site occurs on the Swan Coastal Plain, which is the geomorphic unit that characterises much of the Perth metropolitan region. 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 has formed from the deposition of alluvial material washed down from the Darling Scarp. While it's western side is comprised of three dune systems that run roughly parallel to the Indian Ocean coastline (Seddon 2004). These dune systems, referred to as Quindalup, Spearwood and Bassendean associations, represent a succession of coastal deposition that has occurred since the late Quaternary period (approximately two million years ago) (Kendrick *et al.* 1991) and, as a result, they contain soils at different stages of leaching and formation.

Examination of broad scale mapping places the site within the Bassendean association but near the boundary of the Spearwood association (Churchward and McArthur 1980). Finer scale mapping by Gozzard (2011) places the site in the Spearwood dunes which was later confirmed during the field survey. The Spearwood association typically consists of a core of limestone overlain by yellow sand which is at an intermediate stage of leaching and formation.

The elevation of the site ranges from 47 metres in relation to the Australian Height Datum (mAHD) on the north eastern portion of the site to 37 mAHD on the south west corner of the site (DoW 2008).

2.3 Regional vegetation

Native vegetation is described and mapped at different scales in order to illustrate patterns in its distribution. At 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 broad vegetation associations. Beard *et al.* (2013) mapping shows the site as comprising vegetation association 'Spearwood 6' .This association is described as 'medium woodland; tuart and jarrah' (Beard *et al.* 2013). Spearwood 6 Association has 24.04% of its pre-European extent remaining on the Swan Coastal Plain with 3.31% protected for conservation purposes (Government of WA 2014).

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). However, as this is a purely biodiversity protection orientated objective and on the Swan Coastal Plain, which is considered a 'constrained area', the EPA has applied an objective of retaining 10% of each vegetation complex (EPA 2006). The area remaining of the 'Spearwood 6' vegetation association falls above this retention objective.

2.4 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).

The geomorphic wetland classification system of Semeniuk (1987) is a recognised classification system for the Darling System (which includes the Swan Coastal Plain) and is based on the landform shape and water permanence (hydro-period) of the wetland. A review of DPaW's *Geomorphic Wetlands of the Swan Coastal Plain* dataset indicated that no geomorphic wetlands occur within the site. Two small unnamed wetlands occur to the west of the site (conservation category and multiple use category), a series of wetlands occur to the north of the site within Bush Forever Site 392 (including conservation category Banganup Swamp). Wattleup Lake (resource enhancement category) occurs to the south-west of the site. The Ramsar listed wetland 'Forrestdale and Thomsons Lakes' is located approximately 1.3 km north of the site.

2.5 Threatened and priority flora

Certain flora species that are considered to be rare or under threat warrant special protection under Commonwealth and/or State legislation. At a Commonwealth level, flora species may be listed as 'threatened' pursuant to Schedule 1 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Any action likely to have a significant impact on a species listed under the EPBC Act requires approval from the Commonwealth Minister for the Environment. In Western Australia plant species may also be classed as 'threatened' or 'priority' species under the *Wildlife Conservation Act 1950* (WC Act). Threatened flora species are gazetted under subsection 2 of section 23F of the WC Act and it is an offence to "take" or damage rare flora without Ministerial approval. Priority flora species are potentially rare or threatened and are classed in order of threat. Further information on threatened and priority species and their categories is provided in **Appendix A**.

A search was conducted for threatened and priority flora within a 10 km radius of the site using the *Protected Matters Search Tool* (DoEE 2016a), *NatureMap* (DPaW 2016a) and DPaW's threatened and

priority flora database (reference no. 20-1116FL). Eight threatened and four priority flora species were identified as potentially occurring in the wider local area as listed in **Table 1**. Of these, only flora species suited to terrestrial sandy habitats were deemed likely to occur based on the habitat present at the site. On this basis three threatened flora species (*Caladenia huegelii*, *Drakaea elastica* and *Drakaea micrantha*) and six priority flora species (*Thelymitra variegata, Phlebocarya pilosissima* subsp. *pilosissima, Pimelea calcicola, Jacksonia gracillima, Dodonaea hackettiana* and *Thysanotus glaucus*) were identified as potentially occurring within the site.

Table 1: Significant flora species known to occur within 10km of the site

Species	Level of significance		Life strategy	Habitat	Flowering period	Likelihood of occurrence
	State	EPBC Act				
Andersonia gracilis	T	E	P	White/grey sandy, sandy clay, gravelly loam. Winter-wet areas, near swamps.	Sept-Nov	Unlikely
Caladenia huegelii	T	E	PG	Grey or brown sand, clay loam.	Sept-Oct	**Possible**
Diuris purdiei	T	E	PG	Grey-black sand, moist.	Sept-Oct	Unlikely
Drakaea elastica	T	E	PG	White or grey sand.	Oct-Nov	**Possible**
Lepidosperma rostratum	T	E	P	Peaty sand, clay in swamps.	May-Aug	Unlikely
Diuris micrantha	T	V	PG	Brown loamy clay.	Sept-Oct	Unlikely
Drakaea micrantha	T	V	PG	White-grey sand.	Sept-Oct	**Possible**
Acacia lasiocarpa var. bracteolata long peduncle variant	P1	-	P	Grey or black sand over clay in winter wet areas.	May-Aug	Unlikely
Boronia juncea subsp. *juncea*	P1	-	P	Sand in low scrub.	April	Unlikely
Thelymitra variegata	P2		PG	Sandy clay, sand, laterite.	Jun-Sep	**Possible**
Byblis gigantea	P3	-	P	Sandy-peat swamps. Seasonally wet areas.	Sep-Jan	Unlikely
Cyathochaeta teretifolia	P3	-	P	Grey sand, sandy clay in swamps and creek edges.	Oct-Jan	Unlikely
Eryngium pinnatifidum subsp. Palustre	P3	-	P	Grey brown sand or clay in winter wet flats.	Sep-Nov	Unlikely
Phlebocarya pilosissima subsp. *pilosissima*	P3	-	P	White or grey sand, lateritic gravel.	Aug-Oct	**Possible**
Pimelea calcicola	P3	-	P	Sand, limestone.	Sept-Nov	**Possible**
Jacksonia gracillima	P3	-	P	Brown-grey sand	Oct-Mar	**Possible**
Stylidium paludicola	P3	-	P	Peaty sand over clay. Winter wet habitats.	Oct-Dec	Unlikely
Aponogeton hexatepalus	P4	-	P	Mud. Freshwater: ponds, rivers,	Jul-Oct	Unlikely

Species	Level of significance		Life strategy	Habitat	Flowering period	Likelihood of occurrence
				clay pans.		
Dodonaea hackettiana	P4	-	P	Sand, limestone.	Jul-Oct	**Possible**
Microtis quadrata	P4	-	PG	Sand, loam or peat in winter wet areas	Oct-Dec	Unlikely
Ornduffia submersa	P4	-	A	Sandy clay in inundated wetland/creek.	Aug-Nov	Unlikely
Stylidium ireneae	P4	-	P	Sandy loam in valleys near creek lines.	Oct-Dec	Unlikely
Stylidium longitubum	P4	-	A	Seasonal wetlands on sandy clay/clay	Oct-Dec	Unlikely
Thysanotus glaucus	P4	-	P	White, grey or yellow sand, sandy gravel.	Oct-Mar	**Possible**
Tripterococcus sp. *brachylobus*	P4	-	P	Sand or clay in winter wet areas.	Oct-Feb	Unlikely
Verticordia lindleyi subsp. *lindleyi*	P4	-	P	Sand and sandy clay in winter wet areas.	Nov-Jan	Unlikely

Note: T=threatened, E=endangered, V=vulnerable, P1=Priority 1, P2=Priority 2, P3=priority 3, P4=priority 4, P=perennial, PG=perennial geophyte, A=annual.

2.6 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 determined by environmental factors such as soil type, position in the landscape, altitude, climate and water availability (DoEE 2016). '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 section 181 of the EPBC Act. Any action likely to have a significant impact on a community listed under the EPBC Act requires approval from the Commonwealth Minister for the Environment. TECs are also listed within Western Australia but are currently are not afforded direct statutory protection at a state level. Nonetheless their significance is 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**.

Known locations of TECs and PECs within 10 km of the site were searched for using the publicly available *Weed and native flora dataset* (Keighery 2012), *Protected Matters Search Tool* (DoEE 2016a) and DPaW's threatened and ecological community database (reference no. 02-01116EC).

These search results indicate no TECs or PECs are known to occur within the site, but that seven TECs and five PECs occur within 10 km of the site as listed in **Table 2**. Two of these 12 communities are considered likely to occur in the site based geomorphology, soils and regional vegetation patterns:

- 'Banksia Woodlands of the Swan Coastal Plain' TEC
- 'Banksia dominated woodlands of the Swan Coastal Plain IBRA region' PEC.

The main diagnostic feature for both these communities is the presence of a prominent tree layer of *Banksia attenuata* and/or *B. menziesii*, although other criteria are also applied (DoEE 2016)(DPaW 2016b). A wide range of floristic community types common to the Swan Coastal Plain can be related to these two TEC and PEC categories.

Table 2: TECs and PECs known to occur within 10 km of the site.

Code	Community name	TEC/ PEC	Level of significance	
			State	EPBC Act
Mound Springs SCP	Communities of Tumulus Springs (Organic Mound Springs)	TEC	Critically Endangered	Endangered (Assemblages of plants and invertebrate animals of tumulus (organic mound) springs of the Swan Coastal Plain)
Multiple	Banksia Woodlands of the Swan Coastal Plain	TEC	-	Endangered
Limestone ridges SCP 26a	*Melaleuca huegelii – Melaleuca acerosa* (currently *M. systena*) shrublands on limestone ridges	TEC	-	Endangered (Shrublands and Woodlands on Muchea Limestone of the Swan Coastal Plain)
SCP 19b	Woodland over sedgeland in Holocene dune swales of the southern Swan Coastal Plain	TEC	-	Critically Endangered (Sedgelands in Holocene dune swales of the southern Swan Coastal Plain)
SCP 10a	Shrublands on dry clay flats	TEC	Endangered	Endangered (Clay pans of the Swan Coastal Plain)
SCP 08	Herb rich shrublands in clay pans	TEC	Vulnerable	
SCP 30a	*Callitris preissii* (or *Melaleuca lanceolata*) forests and woodlands, Swan Coastal Plain	TEC	Vulnerable	-
SCP 24	Northern Spearwood shrublands and woodlands	PEC	Priority 3	-
SCP 22	*Banksia ilicifolia* woodlands	PEC	Priority 3	-
SCP 21c	Low lying *Banksia attenuata* woodlands or shrublands	PEC	Priority 3	-
SCP 25	Southern *Eucalyptus gomphocephala – Agonis flexuosa* woodlands	PEC	Priority 3	-
Multiple	Banksia dominated woodlands of the Swan Coastal Plain IBRA region	PEC	Priority 3	-

2.7 *Bush Forever*

The Government of Western Australia's *Bush Forever* policy is a strategic plan for conserving regionally significant bushland within the Swan Coastal Plain portion of the Perth Metropolitan Region. The objective of *Bush Forever* is to protect comprehensive representations of all original ecological communities by targeting a minimum of 10% of each vegetation complex for protection (Government of WA 2000a). *Bush Forever* sites are representative of regional ecosystems and habitat and have a key role in the conservation of Perth's biodiversity.

The site does not contain any *Bush Forever* sites. Harry Waring Marsupial Reserve, 200 ha of fenced vegetation, is located directly north of the site and is classified as Bush Forever Site 392. This reserve is managed by DPaW and covers an area of over 250 ha. The reserve protects conservation significant marsupials such as the quenda (southern brown bandicoot) and is surrounded by a 'feral animal proof' perimeter fence. The location of Bush Forever Site 392 is shown in **Figure 2.**

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 significant, threatened or scheduled flora, vegetation communities or ecosystems. 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, including 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 located within the site. One ESA occurs directly adjacent to the north and west of the site, associated with Bush Forever Site 392 (Harry Waring Marsupial Reserve) and three nearby wetlands including Wattleup Lake.

2.9 Ecological linkages

Ecological linkages are linear landscape elements that allow the movement of fauna, flora and genetic material between areas of remnant habitat. The movement of fauna and the exchange of genetic material between vegetation remnants improve 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). Ecological linkages over the area surrounding the site were identified by the DEC (now DPaW) and the dataset was published in 2009.

One ecological linkage (number 50) from the Perth Biodiversity Project (WALGA and PBP 2004) occurs in a small portion of the north eastern corner of the site. One additional ecological linkage (number 49) occurs approximately 500 m north-east of the site. The location of these linkages is shown in **Figure 2.**

2.10 Local and regionally significant flora and vegetation

The EPA *Guidance Statement No. 51* EPA (2004)states flora species and ecological communities may be significant for a number of reasons irrespective of whether have special protection under legislation. Some of these reasons are outlined in **Appendix A**.

A key reason that vegetation within the site may be significant relates to its potential value habitat for threatened or priority fauna species. While this flora and vegetation assessment does not provide an evaluation of the value of fauna habitat, the site has potential value to two threatened and one priority species:

- The site occurs within the known distribution of Carnaby's black cockatoo and the forest red-tailed black cockatoo (DoEE 2012) which are both listed as 'vulnerable' under the EPBC Act and 'endangered' under the WC Act. Mapping data collated by the Department of Planning (DoP 2011) indicates that potential Carnaby's black cockatoo foraging habitat is located immediately north of the site within Bush Forever Site 392 (**Figure 2**). A confirmed Carnaby's black cockatoo roosting site occurs approximately 4.5 km to the south-east of the site and another approximately 3.8 km north-east of the site. These two black cockatoo species forage on the seeds of trees and shrubs such as *Eucalyptus* spp., *Banksia* spp., *Hakea* spp. and *Pinus* spp. They naturally rely on hollows that form in large mature eucalypt trees for nesting (DoEE 2016b, DoEE 2016c).
- Quenda (southern brown bandicoot) have been recorded within Bush Forever Site 392 (Government of WA 2000b) adjacent to the northern boundary of the site. This small native marsupial is listed as Priority 4 (P4) under the WC Act. Quenda are known to inhabit scrubby vegetation with dense cover up to 1 m high and often feed in adjacent woodland and in areas of pasture and cropland lying close to dense cover (DEC 2012). Therefore habitat for this species could potentially occur within the site.

2.11 Weed species and declared pests

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 the Western Australia's *Biosecurity and Agriculture Management Act 2007* (BAM Act), indicating that it warrants special management to limit its spread. Further information on categories of declared pests is provided in **Appendix A.**

2.12 Previous flora surveys

No previous flora and vegetation surveys of the site are known to have occurred.

3 Methods

3.1 Field survey

One botanist from Emerge visited the site on 28th September 2016 to conduct the flora and vegetation assessment.

3.1.1 Vegetation

The site was traversed on foot and the composition and condition of vegetation was recorded. Searches were conducted for threatened and priority flora species with potential to occur in the site, with a particularly focus on identifying areas of suitable habitat.

Detailed sampling of the vegetation was undertaken using non-permanent 10 x 10 m quadrats, at four locations selected to adequately sample the range of vegetation observed. The position of each quadrat was recorded with a hand-held GPS unit, as shown on **Figure 3**. The data recorded within each quadrat 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, degree of disturbance, species present and species percentage 'foliage projective cover'(FPC)).

In addition, plant taxa not observed within quadrats were recorded opportunistically as the botanist traversed the site. Photographs were taken throughout the field visit to show particular site conditions.

The condition of the vegetation was assessed using a combination of methods from Keighery (1994) and those provided in the conservation advice for the 'Banksia Woodlands of the Swan Coastal Plain' TEC (DoEE 2016), as described in **Table 3**. Vegetation condition was assigned at each quadrat location and changes in vegetation condition were also noted and mapped across the site.

Table 3: Vegetation condition scale applied during field assessment

Condition category	Definition (Keighery 1994)	Weed Cover (DoEE 2016)
Pristine	Pristine or nearly so, no obvious signs of disturbance.	Zero or close to
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.	Less than 10%
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	5-20%
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.	5-50%

Condition category	Definition (Keighery 1994)	Weed Cover (DoEE 2016)
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.	20-70%
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.	Greater than 70%

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.

3.2 Mapping and data analysis

3.2.1 Plant community identification and description

The local plant communities within the site were identified from the quadrat data collected during the field survey. A cluster analysis was performed by converting the FPC for each species at each quadrat location to a Domin value (Kent and Coker 1994). Classification was undertaken using hierarchical clustering within the analysis package Primer-6 (Clarke and Gorley 2006), with groups defined using the Bray-Curtis distance measure and further refined using a similarity probability measure (significance level of 0.05).

Once a group was defined from the cluster analysis, 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 community was then mapped on aerial photography (1:15,000) from the quadrat data points and boundaries interpreted from aerial photography. Vegetation condition was mapped on aerial photography (1: 13,000) based on the locations recorded during the field survey to define areas with changes in condition.

3.2.2 Floristic community type assignment

The identified plant community was 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 quadrat 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-6 (Clarke and Gorley 2006). As data from a localised survey is often spatially correlated, data for each quadrat 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 quadrats tended to cluster with a grouping of different FCTs, individual quadrat similarity was 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, were considered in the final determination of an FCT for vegetation within the site.

3.2.3 Species accumulation curve

A species accumulation curve was plotted from quadrat data in Microsoft Excel. A trendline (log) was generated and forecast to locate the asymptote of the curve (the point at which the curve flattens indicating few species remain undetected). Primer-6 also offers a range of estimators to predict minimum species richness (Clarke and Gorley 2006). Both the Jacknife1 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 curves assists in evaluating the adequacy of sampling effort.

3.3 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 EPA *Guidance Statement No. 51* (2004) is provided in **Table 4**.

Table 4: Evaluation of survey methodology against standard constraints outlined in EPA Guidance Statement 51

Constraint	Degree of limitation	Details
Availability of contextual information	No limitation	Generally, the broad scale contextual information described in **Section 2** is adequate to place the site and vegetation in context.
	Minor limitation	Regarding assignment of FCT the authoritative Gibson *et al* 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 *et al.* (1994) collected data in the spring main flowering period and in many cases sampled plots multiple times to provide a complete species list. Although only sampled once, the site data was considered comparable given it was also collected in spring and much of the vegetation present within the site is still relatively intact.
Experience level of personnel	No limitation	This flora and vegetation assessment was undertaken by a qualified botanist with five years of botanical experience in Western Australia respectively. Technical review was undertaken by a senior environmental consultant with 15 years' experience in environmental science in Western Australia.
Suitability of timing / temporal coverage	No limitation	Some flora species spend part of their life-cycle as either underground storage organs or as seed. This is an adaptation to unfavourable environmental conditions such as excessive heat or drought. These species, also known as 'geophytes' or 'annuals', will re-sprout or germinate when favourable conditions return, such as after rainfall. In the south-west of Western Australia geophytes and annuals tend to re-emerge during winter and are most visible during spring, which is the flowering period for a majority of plant species. Conducting surveys in the main flowering season enhances the detectability of plants and the ability of assessors to confirm species identify. The survey was conducted in September and thus within the main flowering

Constraint	Degree of limitation	Details
		season. Relatively high rainfall was recorded from May to August 2016 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. Furthermore, a wide range of annual and geophytic plants, including orchids, were recorded (refer **Section 4.2**) demonstrating that the survey timing was adequate to allow the detection of species for which seasonal timing is critical.
	Minor 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. Although only sampled once, the site data was considered conclusive as it was collected in the spring main flowering period and much of the vegetation present within the site is still relatively intact. However, the survey does not meet the full requirements of a 'level 2' detailed survey. In order for the survey to be considered a 'level 2' detailed survey a second visit in a different season is required.
Spatial coverage / sampling intensity	No limitation	Site coverage was comprehensive (track logged).
	No limitation	A total of 96 species were recorded, of which 76 were recorded from four sample quadrats and 20 were recorded opportunistically. Minimum species richness within site is estimated at between 94 (Jacknife1) and 91 (Chao2) species (refer species accumulation curve and estimates shown in **Plate 3**). A total number of species above the predicted number indicates that sampling intensity was sufficient. The four quadrats sampled also provide a relatively strong statistical basis for the assignment of an FCT (i.e. four replicates within one vegetation community).
Influence of disturbance	Minor limitation	Time since fire is greater than 60 years as interpreted form aerial imagery and therefore short lived species more common after fire may not have been visible.
	No limitation	Historical ground disturbance was evident in parts of the site but the majority of remnant native vegetation present was relatively intact.
Adequacy of resources	No limitation	All resources required to perform the survey were available.
Access problems	No limitation	All parts of the site could be accessed as required.

4 Results

4.1 General site conditions

The site has a south-east facing aspect and gentle slope (5-15°). Surface soils are grey-brown and sandy and no rock cover. Native vegetation exists in the northern portion of Lot 108 and northern and south-west portion of Lot 107. The remaining areas are devoid of native vegetation. Historically, the site was cleared of all native vegetation between 1965 and 1974. By 1979 vegetation had regenerated in the northern portion, a portion in the south-west corner and a narrow connecting strip of vegetation along the eastern side. Since then no further vegetation clearing is evident from aerial imagery (WALIA 2007). Some regeneration has occurred in the centre of Lot 107.

4.2 Flora

A total of 73 native and 23 non-native (weed) species were recorded within the site during the field survey, representing 38 families and 80 genera. The dominant families containing native taxa were Fabaceae (10 native taxa and two weed taxa), Asteraceae (three native taxa and five weed taxa) and Asparagaceae (six native taxa). The most common genus was *Acacia* and *Banksia* with three taxa each. Of the species recorded 76 were recorded in quadrats and 20 were recorded opportunistically. A complete species list is provided in **Appendix B** and quadrat sampled data in **Appendix C**.

4.2.1 Threatened and priority flora

No threatened or priority flora species were recorded within the site.

4.2.2 Declared pests

Two species, **Zantedeschia aethiopica* (arum lily) and **Lantana camara* (common lantana), listed as declared pests (C3) under the BAM Act were recorded within the site.

4.3 Plant communities

One native plant community, **BaBm**, was identified within the site. This community extends over 3.32 ha. The remainder of the site (4.77 ha) was highly disturbed and contained of non-native vegetation. The plant communities are described in **Table 5** and representative photographs of each are provided in **Plate 1** and **Plate 2**. The location of each plant community is shown on **Figure 3.**

Table 5: Plant communities identified within the site

Plant community	Description
BaBm	Low woodland of occasional *Eucalyptus marginata* trees over scattered *Allocasuarina fraseriana* over *Banksia attenuata* and *Banksia menziesii* over open shrubland of *Jacksonia sternbergiana*, *Macrozamia riedlei* and *Xanthorrhoea preissii* over low shrubland of *Hibbertia hypericoides, Stirlingia latifolia* and open sedgeland of *Mesomelaena pseudostygia* and occasional introduced pasture weeds (**Plate 1**).
Non-native vegetation	Heavily disturbed areas comprising scattered planted trees and shrubs over closed grassland of scattered introduced pasture weeds such as *Ehrharta calycina* and *Bromus diandrus* (**Plate 2**).

*Plate 1: Plant community **BaBm** in very good condition.*

Plate 2: Non-native vegetation in completely degraded condition.

4.4 Vegetation condition

The vegetation within the majority of Lot 108 is 'completely degraded' and consists of introduced pasture grasses, planted trees and shrubs and buildings and waste associated with edible sprout farming. Similarly the south-eastern corner of Lot 107 is 'completely degraded' and consists of introduced pasture grasses.

In contrast, the northern portion of the site contains native vegetation in 'very good' condition. In Lot 107 the 'very good' condition vegetation continues along the western boundary of the lot and an area of 'excellent' condition vegetation exists in the north-western corner. The vegetation in 'excellent' and 'very good' condition in the site contains high native species biodiversity, vegetation structure and low disturbance. Some weed species are present, though cover is low and dominated by less aggressive species.

An area of native vegetation in 'good' condition exists in the centre of Lot 107. This vegetation has been subject to historical disturbance which has resulted in a more open structure with areas of bare ground. Native species diversity is low to moderate and signs of regeneration are present. Introduced pasture grasses are the dominant weeds in this area. A small linear strip of vegetation in 'degraded' condition is present on the eastern boundary of the site. This area along the fenceline has low native species diversity and high cover of introduced pasture grasses and introduced *Pelargonium capitatum* (rose pelargonium).

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

Table 6: Size of vegetation condition categories within the site

Condition category	Size (ha)
'Excellent'	0.19
'Very Good'	2.13
'Good'	0.95
'Degraded'	0.05
'Completely Degraded'	4.77

4.5 Floristic community type assignment

Plant community **BaBm** was determined to represent FCT 28 'Spearwood *Banksia attenuata* or *Banksia attenuata – Eucalyptus* woodlands'. This FCT is listed as 'well reserved' and 'low risk' by Gibson *et al.* (1994). All four quadrats grouped with FCT 28 in the cluster analysis. Quadrats 1, 2 and 4 grouped with one Gibson *et al.* (1994) site (HARRY-2) representing FCT 28 with 53 to 60% similarity (**Table 7**). Quadrat 3 grouped with multiple Gibson *et al.* (1994) sites of which the closest were FCTs 21a, 23a and 28 with 49 to 51% similarity (**Table 7**). This quadrat displayed more evidence of disturbance than the other quadrats and more bare ground was present, however species composition and landform characteristics of all four quadrats were very similar and therefore Quadrat 3 is deemed to also represent FCT 28.

The relevant portions of the cluster dendrograms showing similarity to FCT 28 are provided in **Appendix D**.

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

Plant Community	Quadrat	Most similar Gibson *et al.* (1994) sites	Similarity	Floristic community type (FCT)	Reservation and conservation status
BaBm	**1**	HARRY-2 (FCT 28)	60%	FCT 28: Spearwood *Banksia attenuata* or *Banksia attenuata* – *Eucalyptus* woodlands	Well reserved and low risk (Gibson *et al.* 1994).
	2	HARRY-2 (FCT 28)	57%		
	3	WELL-2 (FCT 21a)	51 %		
		HURST03 (FCT 23a)	50 %		
		HARRY-5 (FCT 21a)	49 %		
		NEER-3 (FCT 28)	49%		
	4	HARRY-2 (FCT 28)	53%		

4.6 Threatened and priority ecological communities

The structure and composition of plant community **BaBm** indicates that it represents the 'Banksia Woodlands of the Swan Coastal Plain' TEC. This TEC (herein referred to as the banksia woodland TEC) has recently been listed as 'endangered' under the EPBC Act. Whether a patch of vegetation is considered to represent the banksia woodland TEC depends on a number of diagnostic criteria including geographic location, soils, landform, structure, composition, condition and patch size (DoEE 2016). As outlined in **Table 8,** the majority of **BaBm** community in the site satisfies these criteria. In addition, FCT 28 is one of several FCTs directly associated with the banksia woodland TEC. The eastern linear portion of **BaBm** in 'degraded' condition would not meet the criteria requirements due to the vegetation condition and isolation of the vegetation. All remaining areas of **BaBm** represent the banksia woodland TEC, with a total of 3.28 ha in parts of Lots 107 and 108, as outlined in **Figure** 5.

The plant community **BaBm** also represents the 'Banksia dominated woodlands of the Swan Coastal Plain IBRA region' PEC (P3). All areas of **BaBm** community represent the PEC, totaling 3.32 ha.

No other TECs or PECs occur within the site.

Table 8: Criteria for determining presence of TEC Banksia Woodlands of the Swan Coastal Plain adapted from DoEE (2016).

Criteria	Requirements for meeting criteria	Site implications
1. Must meet key diagnostic characteristics	A variety of factors relating to: • Location • Soils • Structure • Composition	• Site meets location and soils criteria. • The vegetation includes the key diagnostic feature of a tree layer of *Banksia attenuata* and *Banksia menziesii*. • The vegetation within site also Vegetation meets structure and composition criterion. FCT 28 identified as one FCT of the banksia woodland TEC.
2. Must meet condition thresholds	• A patch should at least meet the 'good' condition category.	• The vegetation present in 'good', 'very good' and 'excellent' condition meets this criterion. The linear portion of vegetation on the eastern boundary is in 'degraded' condition and does not meet the criterion.
3. Must meet minimum patch size	Minimum size of patch: • Pristine=no minimum size • Excellent=0.5 ha • Very Good=1 ha • Good=2 ha	• The vegetation in 'very good' condition comprises 2.13 ha and meets this criterion. • Other parts in 'excellent' and 'good' condition would be viewed as contiguous part of same patch and therefore part of the TEC. • The 'degraded' linear portion on the eastern boundary is not considered to be part of another patch due to its condition and isolation and therefore does not represent the TEC.
4. Must incorporate surrounding context	• Breaks (e.g. tracks) < 30 m do not separate vegetation into separate patches • Buffer zones may apply (20-50 m recommended from patch edge) • The site should be thoroughly sampled (2 surveys in spring). • Survey timing should be appropriate. • Surrounding environment should be considered (e.g. connectivity, conservation values, fauna habitat)	• The tracks present in the site are not included in mapping of patches. They are less than 30 m wide and would not separate patches of TEC. • Land surrounding the patch is a combination of agricultural and native vegetation. • One early spring survey conducted, but as results conclusive two surveys are not required. • Spring survey timing is appropriate. • The site is connected to intact native vegetation that will also meet criteria as banksia woodland and known also significant fauna habitat (Bush Forever Site 392), the site vegetation contains potential black cockatoo nesting habitat and is black cockatoo foraging habitat).

4.7 Species richness and sampling adequacy

A species accumulation curve derived from quadrat data is presented in **Plate 3**. A total of 76 species were recorded from four quadrats. After four samples the curve is approaching but has not reached its asymptote. This indicates that a proportion of species remained undetected by quadrat sampling. Minimum species richness based on the given sample was estimated in Primer-6 to be between 94 (Jacknife1) and 91 (Chao2). Based on the trend of the species accumulation curve approximately 10 to 11 quadrats would be required to capture that many species. Nonetheless when the 25 species recorded opportunistically are included with the quadrat tally, a total species count of 96 is achieved. This count is greater than the predicted minimum species richness values and demonstrates that survey effort was adequate to prepare a comprehensive species inventory for the site.

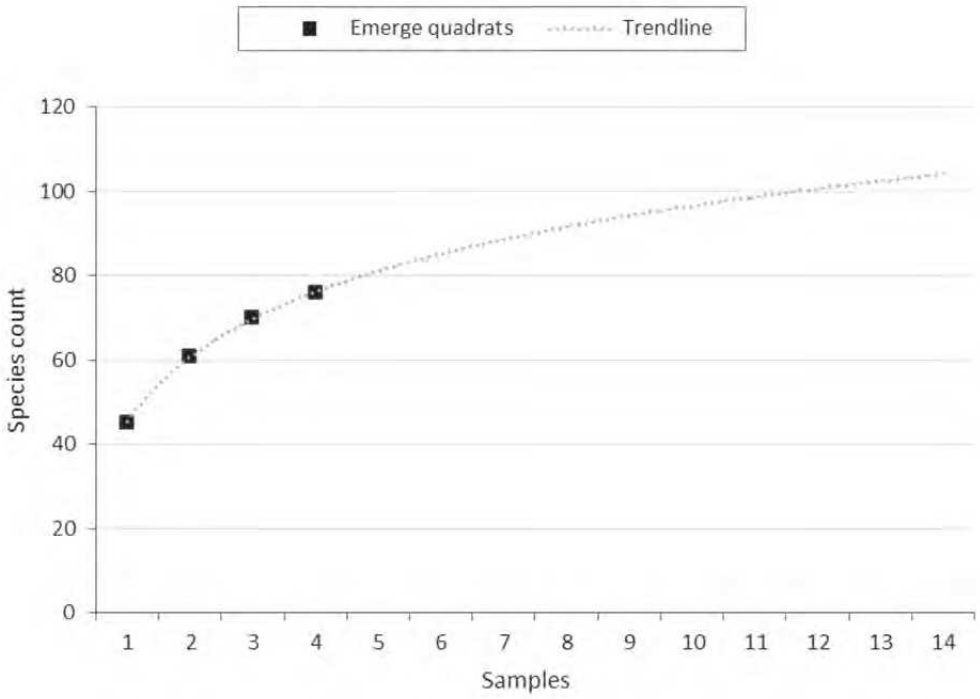

Plate 3: Species accumulation curve derived from quadrat data (y = 22.269ln(x) + 45.328, R^2 = 0.9998)

5 Discussion

Portions of the site have been cleared and now contain non-native vegetation. The areas of native vegetation that do remain comprise a biodiverse and relatively intact patch of an upland banksia woodland community. Given the spring survey timing and intactness of the native vegetation where it remains, the survey is considered to provide an accurate representation of the flora and vegetation present.

No threatened or priority flora species were recorded. The absence of the larger perennial species such as *Dodonaea hackettiana* and *Jacksonia sericea* was relatively easy to confirm. However, species such as *Caladenia huegelii, Drakaea elastica* and *D. micrantha* can be cryptic and more difficult to detect. After considerable search effort within the flowering period, suitable habitat for these species was not identified in the predominantly dry woodland type vegetation at the site. As many other orchids, geophytes and annuals were recorded it is considered that, due to a lack of suitable habitat, these threatened and priority flora species are unlikely to occur within the site.

The **BaBm** native plant community described within the site meets the criteria for the EPBC Act listed banksia woodland TEC. In particular this vegetation includes the key diagnostic feature of a tree layer of *Banksia attenuata* and *B. menziesii*. The **BaBm** community was also conclusively associated with 'FCT 28 - Spearwood *Banksia attenuata* or *Banksia attenuata – Eucalyptus woodlands'* which is one of three FCTs on Spearwood and Quindalup soil associations (super group 4) identified in banksia woodland TEC conservation advice (DoEE 2016). The vegetation is also largely in 'very good' condition where it remains in the northern portion of the site, with some areas of 'excellent' and 'good' condition also present.

The **BaBm** community also represents the state listed PEC 'Banksia dominated woodlands of the Swan Coastal Plain IBRA region' due to the presence of *Banksia attenuata* and *B. menziesii* on deep sands.

6 Conclusions

The majority of the site is highly modified and contains approximately 4.77 ha of completely degraded non-native vegetation. However, the site also contains approximately 3.32 ha of intact remnant native vegetation, mapped as the **BaBm** plant community, of which 3.28 ha represents the EPBC Act listed banksia woodland TEC. The **BaBm** plant community also represents the similar state listed PEC' Banksia dominated woodlands of the Swan Coastal Plain IBRA region'.

No threatened or priority flora species were recorded or are considered likely to occur within the site due to lack of suitable habitat.

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Figures

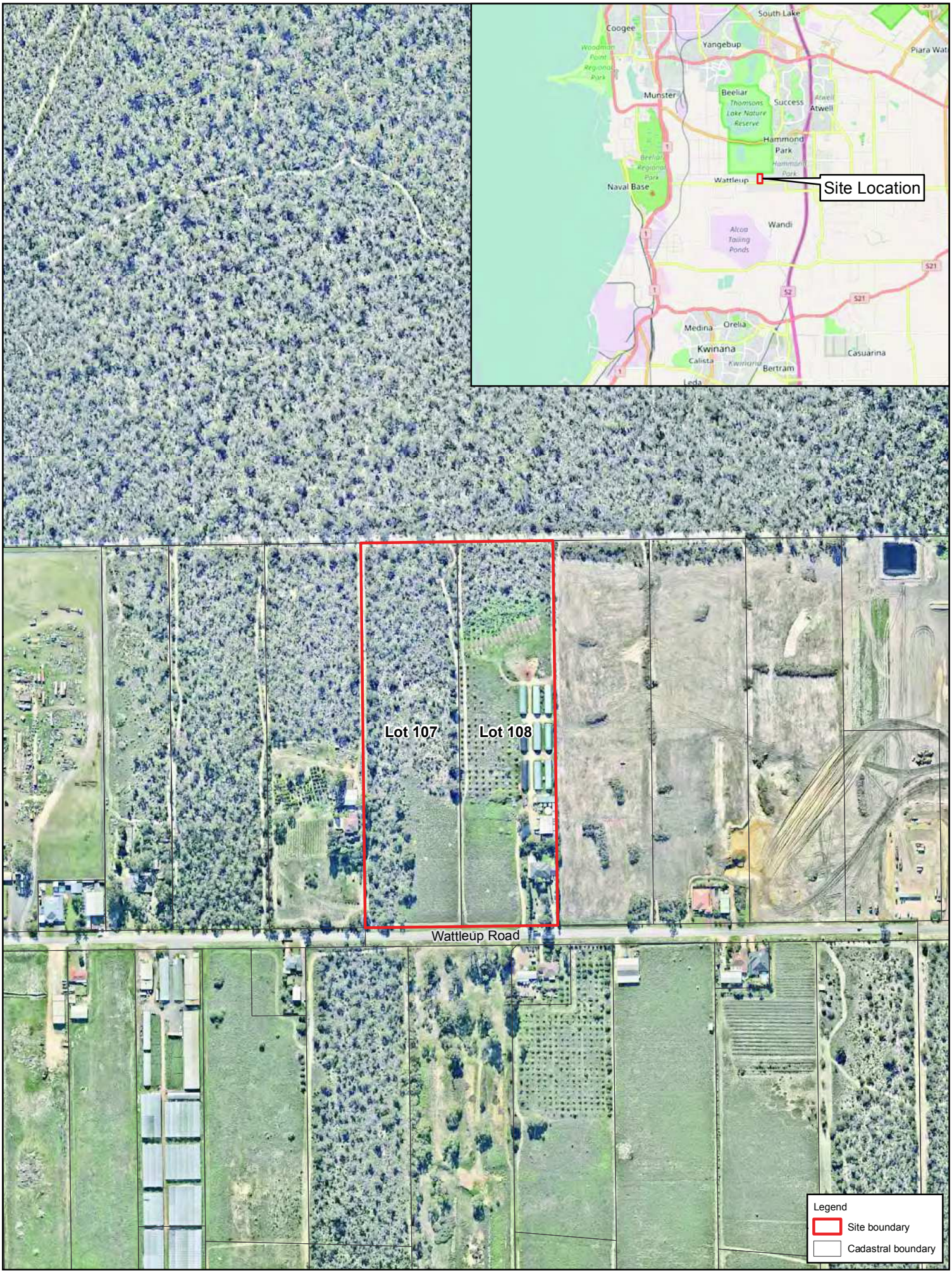

Figure 1:	**Site Locality**
Project:	Flora and Vegetation Survey Lots 107 and 108 Wattleup Road
Client:	OpenCorp

Plan Number: EP16-076(02)--F29a

Drawn:	KNM	Date:	21/11/2016
Approved:	TAA	Date:	21/11/2016
Checked:	RAO	Scale:	1:5,000@A4

0 100 200 Metres

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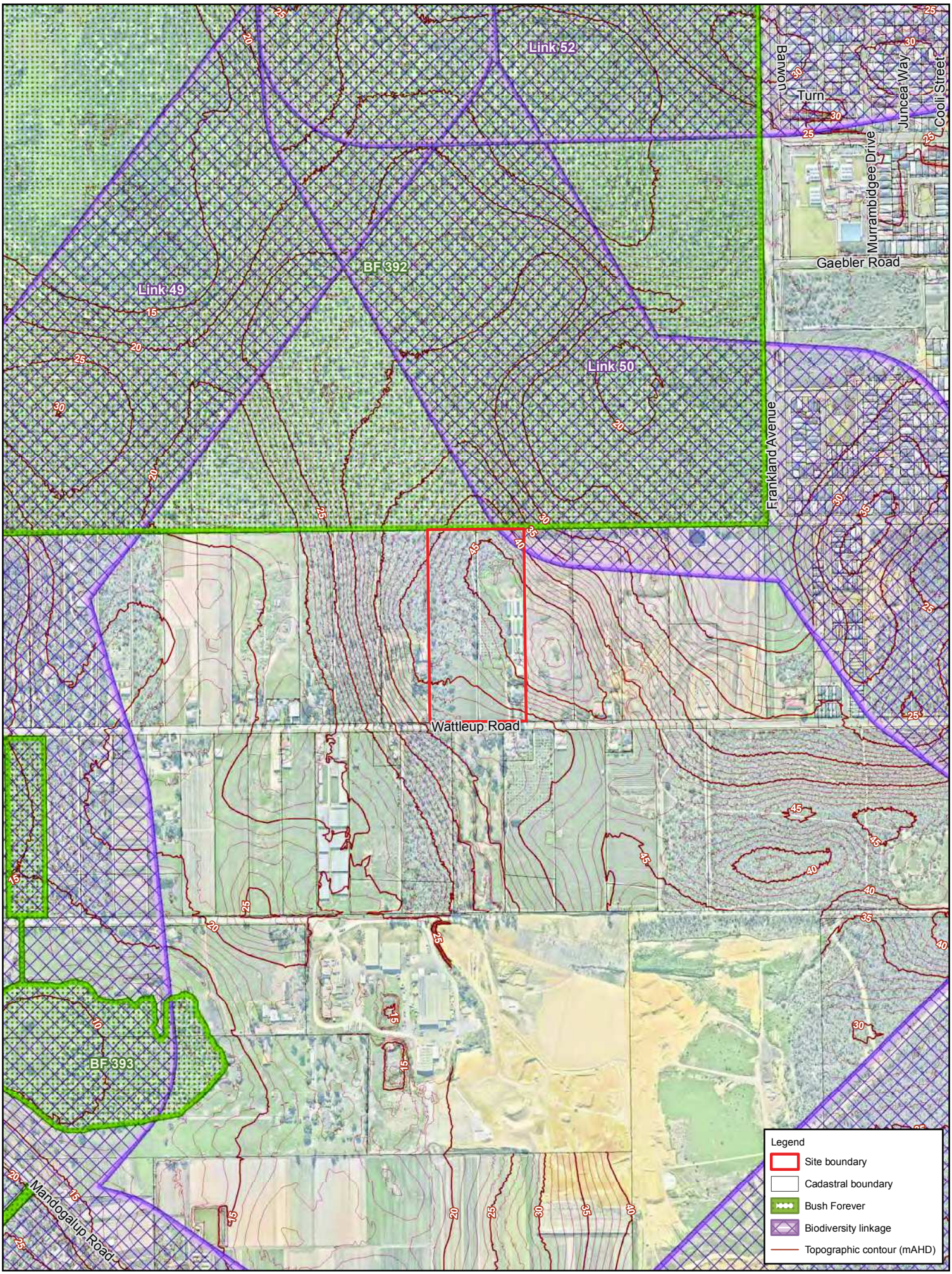

Figure 2:	**Environmental Features**	**Plan Number: EP16-076(02)--F30a**	
Project:	Flora and Vegetation Survey Lots 107 and 108 Wattleup Road	Drawn: KNM	Date: 21/11/2016
		Approved: TAA	Date: 21/11/2016
Client:	OpenCorp	Checked: RAO	Scale: 1:10,000@A4

0 200 400 Metres

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Figure 3: **Floristic Community Type (FCT)**

Project: Flora and Vegetation Survey
Lots 107 and 108 Wattleup Road

Client: OpenCorp

Plan Number: EP16-076(02)--F04a

Drawn:	KNM	Date:	21/11/2016
Approved:	TAA	Date:	21/11/2016
Checked:	RAO	Scale:	1:2,000@A4

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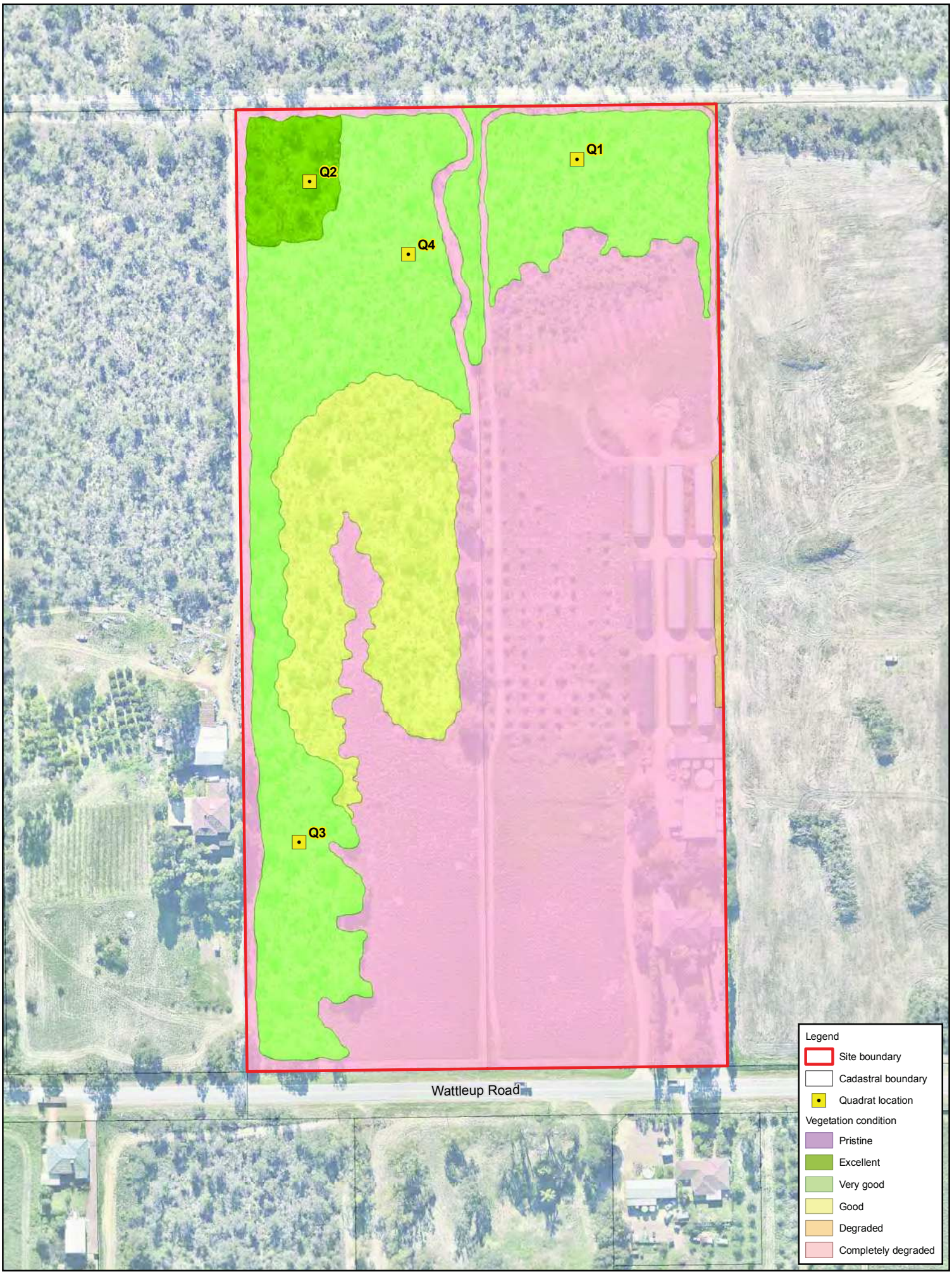

Figure 4:	**Vegetation Condition**
Project:	Flora and Vegetation Survey Lots 107 and 108 Wattleup Road
Client:	OpenCorp

Plan Number: EP16-076(02)--F03a

Drawn:	KNM	Date:	21/11/2016
Approved:	TAA	Date:	21/11/2016
Checked:	RAO	Scale:	1:2,000@A4

0 25 50 75 Metres

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Figure 5:	**Threatened Ecological Communities**
Project:	Flora and Vegetation Survey Lots 107 and 108 Wattleup Road
Client:	OpenCorp

Plan Number: EP16-076(02)--F31a

Drawn:	KNM	Date:	21/11/2016
Approved:	TAA	Date:	21/11/2016
Checked:	RAO	Scale:	1:2,000@A4

0 25 50 75 Metres

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Appendix A

Additional Background Information

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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 can be considered 'threatened' pursuant to Schedule 1 of the EPBC Act and listed as either 'critically endangered' (CE), 'endangered' (E) or 'vulnerable' (V).

In Western Australia, plant species may be classed 'threatened' or 'priority' under the *Wildlife Conservation Act 1950* (WC Act), enforced by Department of Parks and Wildlife (DPaW). Priority flora species are potentially rare or threatened and are classified in order of threat. Threatened and priority flora category definitions are listed in **Table 1**. Threatened flora species are gazetted under subsection 2 of section 23F of the WC Act and therefore it is an offence to "take" or damage rare flora without Ministerial approval. Section 23F of the Act defines "to take" as "… to gather, pluck, cut, pull up, destroy, dig up, remove or injure the flora to cause or permit the same to be done by any means".

Table 1: Definition of threatened and priority flora species under the WC Act (Smith 2010).

Conservation Code	Category
T	Threatened Flora – Extant Taxa Taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection, and have been gazetted as such.
X	Threatened Flora – Presumed Extinct Taxa 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.
P1	Priority One – Poorly Known Taxa 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 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 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.

Conservation Code	Category
P4	Priority Four – Rare Taxa 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.

Note that the WC Act is expected to be repealed some time in 2017 and will be replaced by the *Biodiversity Conservation Act 2016* (BC Act). The BC Act includes updated provisions for the management of threatened flora along with increased penalties and requirements for reporting, management programmes and recovery plans. The BC Act was only recently granted Royal assent on 21 September 2016. Currently, most of the provisions of the BC Act have not come into effect and until they do, the WC Act will continue to guide the management of threatened flora in Western Australia.

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 Minister of the Environment. Once listed under the EPBC Act, communities are categorised as either 'critically endangered', 'endangered' or 'vulnerable'. Any action likely to have a significant impact on a community listed under the EPBC Act requires approval from the Commonwealth Minister for the Environment.

Within Western Australia TECs are determined by the Western Australian Threatened Ecological Communities Scientific Advisory Committee (WATECSAC) and endorsed by the Minister for the Environment. The WATECSAC is an independent group comprised of representatives from organizations including tertiary institutions, the Western Australian Museum and Department of Parks and Wildlife (DPaW). TECs are assigned to one of the categories outlined in **Table 2** according to their status (in relation to the level of threat). Currently TECs are not afforded direct statutory protection at a state level and their significance is 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 2009a).

Conservation category	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.

Conservation category	Description
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.

In addition to listing as a TEC, a plant community may be listed as a 'priority ecological community' (PEC). This is 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. PECs are categorised as priority category 1, 2 or 3 (these are 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 2009a).

Table 3: Categories of priority ecological communities (DEC 2009a).

Priority categories	Description
Priority 1	Ecological communities with apparently few, small occurrences, all or most not actively managed for conservation (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) and for which current threats exist. 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.
Priority 2	Communities that are known from few small occurrences, all or most of which are actively managed for conservation (e.g. within national parks, conservation parks, nature reserves, State forest, unallocated Crown land, water reserves, etc.) and not under imminent threat 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.
Priority 3	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: (i) communities known from a few widespread occurrences, which are either large or within significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat, or; (ii) communities made up of large, and/or widespread occurrences, that may or 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, and inappropriate fire regimes. 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.
Priority 4	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.
Priority 5	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.

Note the BC Act, previously introduced in **Section 1**, does include provisions for the management of TECs, as well as, penalties for impacting TECS and requirements for reporting, management programmes and recovery plans. The provisions of the BC Act relating to TECs have not yet come into effect and until they do the management of TECs will continue to be guided by existing environmental approval processes.

Local and regionally significant flora and vegetation

Apart from being listed as either threatened or priority flora, plant species may be significant for a number of other reasons. EPA (2004) *Guidance Statement No. 51* states that significant flora may include taxa that:

- have a keystone role in a particular habitat for threatened species, or supporting large populations representing a significant proportion of the local regional population of a species
- have relic status
- have anomalous features that indicate a potential new discovery
- are representative of the range of a species (particularly, at the extremes of range, recently discovered range extensions, or isolated outliers of the main range)
- have the presence of restricted subspecies, varieties or naturally occurring hybrid
- have local endemism/a restricted distribution
- are poorly reserved.

Similarly, plant communities may be significant for reasons other than a listing as a TEC or PEC. EPA (2004) *Guidance Statement No. 51* indicates that these reasons include:

- scarcity
- the presence of unusual species
- a novel combinations of species
- a role as a refuge
- a role as a key habitat for threatened species
- a role as a key habitat for large populations representing a significant proportion of the local to regional total population of a species
- being representative of the range of a unit (particularly, a good local and/or regional example
- of a unit in 'prime' habitat, at the extremes of range, recently discovered range extensions, or isolated outliers of the main range
- a restricted distribution.

Other Flora

Declared Pests

Declared pests are listed pursuant to the State's *Biosecurity and Agriculture Management Act 2007* (BAM Act). Part 2.3.23 of the BAM Act requires a person must not; "*a) keep, breed or cultivate the declared pest; b) keep, breed or cultivate an animal, plant or other thing that is infected or infested with the declared pest; c) release into the environment the declared pest, or an animal, plant or other thing that is infected or infested with the declared pest; or d) intentionally infect or infest, or expose to infection or infestation, a plant, animal or other thing with a declared pest*".

Under the BAM Act, all declared pests are placed in one of three categories, namely C1 (exclusion), C2 (eradication) or C3 (management). These categories are described further in **Table 4**. The Western Australian Organism List (WAOL) provides the status of organisms which have been categorised under the BAM Act (DAFWA 2016).

Table 4: Categories of declared pest species under the BAM Act (DAFWA 2016).

Category	Description
C1 (Exclusion)	Not established in Western Australia and control measures are to be taken, including border checks, in order to prevent them entering and establishing in the State.
C2 (Eradication)	Present in Western Australia in low enough numbers or in sufficiently limited areas that their eradication is still a possibility.
C3 (Management)	Established in Western Australia but it is feasible, or desirable, to manage them in order to limit their damage. Control measures can prevent a C3 pest from increasing in population size or density or moving from an area in which it is established into an area which currently is free of that pest.

Wetland Habitat

Geomorphic wetland types

The geomorphic wetland classification system of Semeniuk (1987) is a recognised classification system for the south west of Western Australia. The Semeniuk system uses the landform shape and water permanence (hydro-period) to categorise wetlands.

Table 5: Wetland types defined within the global geomorphic classification system (DEC 2009b).

-	Basin	Flat	Channel	Slope
Permanently inundated	Lake	-	River	-
Seasonally inundated	Sumpland	Floodplain	Creek	-
Seasonally waterlogged	Dampland	Palusplain	-	Paluslope

Wetland management categories

DPaW maintains the *Geomorphic Wetland of the Swan Coastal Plain* dataset, which also categorises individual wetlands into specific management categories as described in **Table 6**.

Table 6: Geomorphic Wetlands of the Swan Coastal Plain management categories (Hill et al. 1996).

Management category	Description of wetland	Management objectives
Conservation (CCW)	Support high levels of attributes	Preserve wetland attributes and functions through reservation in national parks, crown reserves and state owned land. Protection provided under environmental protection policies.
Resource enhancement (REW)	Partly modified but still supporting substantial functions and attributes	Restore wetland through maintenance and enhancement of wetland functions and attributes. Protection via crown reserves, state or local government owned land, environmental protection policies and sustainable management on private properties.
Multiple use (MUW)	Few wetland attributes but still provide important hydrological functions	Use, development and management considered in the context of water, town and environmental planning through land care.

The management categories of wetlands are determined based on hydrological, biological and human use features. This dynamic dataset is continually updated with site-specific wetland surveys providing new and relevant information. The guidelines for proposing changes to the wetland boundaries and management categories state that relevant information should be obtained in the optimal season for vegetation condition and water levels, which is usually spring (DEC 2009b). Each classified wetland listed in the *Geomorphic Wetland of the Swan Coastal Plain* dataset is given a 'unique feature identifier' (UFI). However in the case of larger wetlands that have undergone a degree of disturbance, a separate management category may be assigned to parts of the wetland in order to reflect the current values.

References

General references

Department of Environment and Conservation (DEC) 2009a, *Definitions, Categories and Criteria for Threatened and Priority Ecological Communities*, Department of Environment and Conservation, Perth.

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Hill, A. L., Semeniuk, C. A., Semeniuk, V. and Del Marco, A. 1996, *Wetlands of the Swan Coastal Plain: Volume 2A - Wetland Mapping, Classification and Evaluation,* Water and Rivers Commission and the Department of Environmental Protection, Perth.

Semeniuk, C. A. 1987, *Wetlands of the Darling System - a geomorphic approach to habitat classification,* Journal of the Royal Society of Western Australia, 69: 95-112.

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Online references

Department of Agriculture and Food (DAFWA) 2016, *The Western Australian Organism List* (WAOL), <https://www.agric.wa.gov.au/bam/western-australian-organism-list-waol>

Appendix B

Species List

Flora Species List -Lots 107 and 108 Wattleup Rd, Hammond Park

Note: * denotes introduced weed species

Family	Species
Aizoaceae	
	* *Carpobrotus edulis*
Anarthriaceae	
	Lyginea barbata
Apiaceae	
	Eryngium pinnatifidum
Araceae	
	* *Zantedeschia aethiopica*
Araliaceae	
	Trachymene pilosa
Asparagaceae	
	Chamaescilla corymbosa
	Laxmannia grandiflora
	Lomandra sericea
	Lomandra caespitosa
	Sowerbaea laxiflora
	Thysanotus manglesianus
Asteraceae	* *Arctotheca calendula*
	Asteraceae sp.
	* *Hypochaeris glabra*
	* *Hypochaeris radicata*
	Podolepis gracilis
	Podotheca angustifolia
	Rhodanthe citrina
	* *Sonchus oleraceus*
	* *Ursinia anthemoides*
Brassicaceae	
	* *Brassica tournefortii*
Casuarinaceae	
	Allocasuarina fraseriana
	Allocasuarina humilis
Centrolepidaceae	
	Centrolepis ?drummondiana
Colchicaceae	
	Burchardia congesta

Flora Species List -Lots 107 and 108 Wattleup Rd, Hammond Park

Note: * denotes introduced weed species

Family	Species
Crassulaceae	
	Crassula colorata var. *colorata*
Cyperaceae	
	Isolepis marginata
	Lepidosperma scabrum
	Mesomelaena pseudostygia
	Schoenus clandestinus
Dasypogonaceae	
	Dasypogon bromeliifolius
Dilleniaceae	
	Hibbertia huegelii
	Hibbertia hypericoides
Droseraceae	
	Drosera erythrorhiza
	Drosera menziesii
Ericaceae	*Astroloma ?glaucescens*
	Conostephium pendulum
	Leucopogon conostephioides
Euphorbiaceae	
	* *Euphorbia terracina*
	* *Ricinus communis*
Fabaceae	
	Acacia pulchella
	Acacia pycnantha
	Acacia stenoptera
	Bossiaea eriocarpa
	Daviesia nudiflora
	Daviesia triflora
	Gompholobium tomentosum
	Hardenbergia comptoniana
	Jacksonia sternbergiana
	Kennedia prostrata
	* *Lupinus cosentinii*
	* *Trifolium dubium*
Hemerocallidaceae	
	Dianella revoluta
Geraniaceae	
	* *Pelargonium capitatum*

Flora Species List -Lots 107 and 108 Wattleup Rd, Hammond Park

Note: * denotes introduced weed species

Family	Species
Goodeniaceae	
	Dampiera linearis
	Scaevola canescens
Haemodoraceae	*Anigozanthos humilis*
	Anigozanthus manglesii
	Conostylis aculeata
	Conostylis setigera
Iridaceae	
	* *Gladiolus caryophyllaceus*
	Patersonia occidentalis
	* *Romulea rosea*
Myrtaceae	
	Corymbia ficifolia
	Eucalyptus marginata
	Hypocalymma robustum
	Kunzea glabrescens
	Scholtzia involucrata
Orchidaceae	
	Caladenia flava subsp. *flava*
	Diuris magnifica
	Microtis media subsp. *media*
Papaveraceae	
	* *Fumaria capreolata*
Phyllanthaceae	
	Phyllanthus calycinus
	Poranthera microphylla
Poaceae	
	Amphipogon turbinatus
	* *Briza maxima*
	* *Briza minor*
	* *Ehrharta calycina*
	* *Ehrharta longiflora*
	* *Bromus diandrus*
Primulaceae	
	* *Lysimachia arvensis*
Proteaceae	
	Banksia nivea

Flora Species List -Lots 107 and 108 Wattleup Rd, Hammond Park

Note: * denotes introduced weed species

Family		Species
		Banksia attenuata
		Banksia menziesii
		Persoonia saccata
		Petrophile linearis
		Stirlingia latifolia
Restionaceae		
		Desmocladus flexuosus
		Hypolaena exsulca
Rubiaceae		
		Opercularia vaginata
Stylidiaceae		
		Stylidium brunonianum subsp. *brunonianum*
		Stylidium repens
Verbenaceae		
	*	*Lantana camara*
Violaceae		
		Hybanthus calycinus
Xanthorrhoeaceae		
		Xanthorrhoea brunonis
		Xanthorrhoea preissii
Zamiaceae		
		Macrozamia riedlei

Appendix C

Sample Data

Site Details			
Locality	EP16-076	Photo No.	49
Date	28/09/2016	Photo direction	SE
Author	RAO	Geographic datum and zone	GDA94 50
Sampling unit	Quadrat	Easting	390269
Sample number	1	Northing	6439717

Geographic and Habitat Data			
Aspect	NE	Hydrology	-
Slope	low-moderate	Adjacent Vegetation	same
Topographic position	mid-upper slope	Vegetation Condition	very good
Altitude (m)	39	Time since fire	> 5 yrs
Bare ground %	5	Disturbance	low
Soil type/texture	sand	Rock type	N/A
Soil colour	brown grey	Rock %	0
Microclimate	-	Litter type and %	leaves, sticks, 20%

Vegetation Description

Low woodland *Banksia attenuata* and *Banksia menziesii* over open tall shrubland *Jacksonia sternbergiana* over low shrubland *Hibbertia hypericoides* over open sedgeland *Mesomelaena pseudostygia* over forbland *Burchardia congesta* and *Eharta calycina*

Q1 Species Data						
Coll. No.	**Species**	**Layer**	**Life Form**	**Height**	**Habit**	**% Cover**
	Mesomelaena pseudostygia					20
	Ehrharta calycina					15
1	*Jacksonia sternbergiana*					15
	Banksia attenuata					10
	Hibbertia hypericoides					10
	Allocasuarina fraseriana					1
	Banksia menziesii					1
opp.	*Acacia pycnantha*					0.5
	Amphipogon turbinatus					0.5
opp.	*Brassica tournefortii*					0.5
	Briza maxima					0.5
	Burchardia congesta					0.5
	Caladenia flava subsp. *flava*					0.5
	Carpobrutus edulis					0.5
	Chaemescilla corymbosa					0.5
13	*Conostylis setigera*					0.5
5	*Conostylis aculeata* subsp. *aculeata*					0.5
	Crassula colorata					0.5
	Dampiera linearis					0.5
	Drosera erythrorhiza					0.5
	Ehrharta longiflora					0.5
	Gladiolus caryophyllaceus					0.5
opp.	*Gompholobium tomentosum*					0.5
	Hypocalymma robustum					0.5
	Hypochaeris glabra					0.5
12	*Laxmannia grandiflora*					0.5
8	*Lomandra caespitosa*					0.5
	Lysimachia arvensis					0.5
	Macrozamia riedlei					0.5
	Phyllanthus calycinus					0.5
6	*Podolepis gracilis*					0.5
2	*Podotheca angustifolia*					0.5
4	*Poranthera microphylla*					0.5
9	*Poranthera microphylla*					0.5
7	*Rhodanthe citrina*					0.5
11	*Schoenus clandestinus*					0.5
3	*Scholtzia involucrata*					0.5
	Sonchus oleraceus					0.5
	Sowerbaea laxiflora					0.5
	Stirlingia latifolia					0.5
	Stylidium brunonianum subsp. *brunonianum*					0.5
	Thysanotus manglesianus					0.5
	Trachymene pilosa					0.5
	Ursinia anthemoides					0.5
	Xanthorrhoea preissii					0.5

Site Details			
Locality	EP16-076	Photo No.	82
Date	28/90/2016	Photo direction	SE
Author	RAO	Geographic datum and zone	GDA94 50
Sampling unit	Quadrat	Easting	390157
Sample number	2	Northing	6439707

Geographic and Habitat Data			
Aspect	NW	Hydrology	-
Slope	low-moderate	Adjacent Vegetation	same
Topographic position	mid-slope	Vegetation Condition	excellent
Altitude (m)	36	Time since fire	>5 yrs
Bare ground %	10	Disturbance	low
Soil type/texture	sand	Rock type	N/A
Soil colour	grey brown	Rock %	0
Microclimate		Litter type and %	leaves, sticks, 40%

Vegetation Description

Low woodland *Eucalyptus marginata, Banksia attennuata* and *Banksia menziesii* over tall open shrubland *Jacksonia sternbergiana* over low shrubland *Xanthorrhoea preisii* and *Hibbertia hypericoides* over open sedgeland *Mesomelaena pseduostygia* over open forbland *Burchardia congesta*

Q2 Species Data						
Coll. No.	**Species**	**Layer**	**Life Form**	**Height**	**Habit**	**% Cover**
	Eucalyptus marginata					20
	Banksia menziesii					15
	Hibbertia hypericoides					10
	Mesomelaena pseudostygia					8
	Stirlingia latifolia					8
	Jacksonia sternbergiana					2
	Xanthorrhoea preissii					2
	Allocasuarina fraseriana					1
	Banksia attenuata					1
	Lomandra caespitosa					1
	Phyllanthus calycinus					1
24	*Dasypogon bromeliifolius*					0.5
	Briza maxima					0.5
	Burchardia congesta					0.5
	Caladenia flava subsp. *flava*					0.5
	Carpobrutus edulis					0.5
	Chaemescilla corymbosa					0.5
	Conostylis aculeata subsp. *aculeata*					0.5
	Crassula colorata					0.5
	Poranthera microphylla					0.5
19	*Desmocladus flexuosus*					0.5
	Drosera erythrorhiza					0.5
	Ehrharta calycina					0.5
	Eryngium pinnatifidum					0.5
	Hypochaeris radicata					0.5
	Gladiolus caryophyllaceus					0.5
	Gompholobium tomentosum					0.5
	Hardenbergia comptoniana					0.5
23	*Isolepis marginata*					0.5
3	*Scholtzia involucrata*					0.5
22	*Conostephium pendulum*					0.5
21	*Astroloma ?glaucescens*					0.5
	Asteraceae sp.					0.5
	Patersonia occidentalis					0.5
	Petrophile linearis					0.5
	Poranthera microphylla					0.5
	Centrolepis ?drummondiana					0.5
	Schoenus clandestinus					0.5
	Sowerbaea laxiflora					0.5
	Podotheca angustifolia					0.5
20	*Stylidium brunonianum* subsp. *brunonianum*					0.5
	Thysanotus manglesianus					0.5
	Trachymene pilosa					0.5
	Ursinia anthemoides					0.5
	Xanthorrhoea brunonis					0.5
	Acacia pulchella					opp.
	Anigozanthus humilis					opp.
	Bossiaea eriocarpa					opp.

25	*Opercularia vaginata*					opp.
	Hybanthus calycinus					opp.
	Kennedia prostrata					opp.
	Macrozamia riedlei					opp.
	Microtis media subsp. *media*					opp.
26	*Conostylis setigera*					opp.
	Podolepis gracilis					opp.
	Acacia stenoptera					opp.
	Stylidium repens					opp.

Site Details			
Locality	EP16-076	Photo No.	124
Date	28/90/2016	Photo direction	SE
Author	RAO	Geographic datum and zone	GDA94 50
Sampling unit	Quadrat	Easting	390153
Sample number	3	Northing	6439431

Geographic and Habitat Data			
Aspect	flat	Hydrology	-
Slope	flat	Adjacent Vegetation	same
Topographic position	flat	Vegetation Condition	very good
Altitude (m)	40	Time since fire	>5 yrs
Bare ground %	12	Disturbance	moderate
Soil type/texture	sand	Rock type	N/A
Soil colour	grey brown	Rock %	0
Microclimate	-	Litter type and %	leaves, sticks, 10%

Vegetation Description

Low woodland *Eucalyptus marginata, Banksia attennuata and Banksia menziesii* over low shrubland *Xanthorrhoea preisii* and *Hibbertia hypericoides* over open sedgeland *Mesomelaena pseudostygia* over open forbland *Burchardia congesta* and *Ursinia anthemoides*

Q3 Species Data						
Coll. No.	**Species**	**Layer**	**Life Form**	**Height**	**Habit**	**% Cover**
	Ehrharta calycina					30
	Mesomelaena pseudostygia					25
	Banksia attenuata					10
	Hypochaeris glabra					10
	Hibbertia hypericoides					8
	Banksia menziesii					5
	Eucalyptus marginata					5
	Xanthorrhoea preissii					3
	Ursinia anthemoides					1
	Amphipogon turbinatus					0.5
	Anigozanthus humilis					0.5
	Briza maxima					0.5
	Briza minor					0.5
	Burchardia congesta					0.5
	Bossiaea eriocarpa					0.5
	Caladenia flava subsp. *flava*					0.5
30	*Trifolium dubium*					0.5
	Conostylis setigera					0.5
	Conostylis aculeata subsp. *aculeata*					0.5
	Crassula colorata					0.5
31	*Dampiera linearis*					0.5
	Desmocladus flexuosus					0.5
	Drosera menziesii					0.5
29	*Drosera menziesii*					0.5
	Drosera erythrorhiza					0.5
	Ehrharta longiflora					0.5
	Opercularia vaginata					0.5
	Gladiolus caryophyllaceus					0.5
	Gompholobium tomentosum					0.5
27	*Lomandra sericea*					0.5
	Hardenbergia comptoniana					0.5
	Hibbertia huegelii					0.5
	Hypocalymma robustum					0.5
	Conostephium pendulum					0.5
	Lomandra caespitosa					0.5
	Patersonia occidentalis					0.5
28	*Dasypogon bromeliifolius*					0.5
	Acacia stenoptera					0.5
	Sowerbaea laxiflora					0.5
	Stirlingia latifolia					0.5
	Thysanotus manglesianus					0.5
	Trachymene pilosa					0.5
	Diuris magnifica					opp.

Site Details			
Locality	EP16-076	Photo No.	195
Date	28/90/2016	Photo direction	SE
Author	RAO	Geographic datum and zone	GDA94 50
Sampling unit	Quadrat	Easting	390199
Sample number	4	Northing	6439677

Geographic and Habitat Data			
Aspect	W	Hydrology	-
Slope	low	Adjacent Vegetation	same
Topographic position	mid-slope	Vegetation Condition	very good
Altitude (m)	42	Time since fire	>5 yrs
Bare ground %	12	Disturbance	low
Soil type/texture	sand	Rock type	N/A
Soil colour	grey brown	Rock %	0
Microclimate	-	Litter type and %	leaves, sticks, branches, 25%

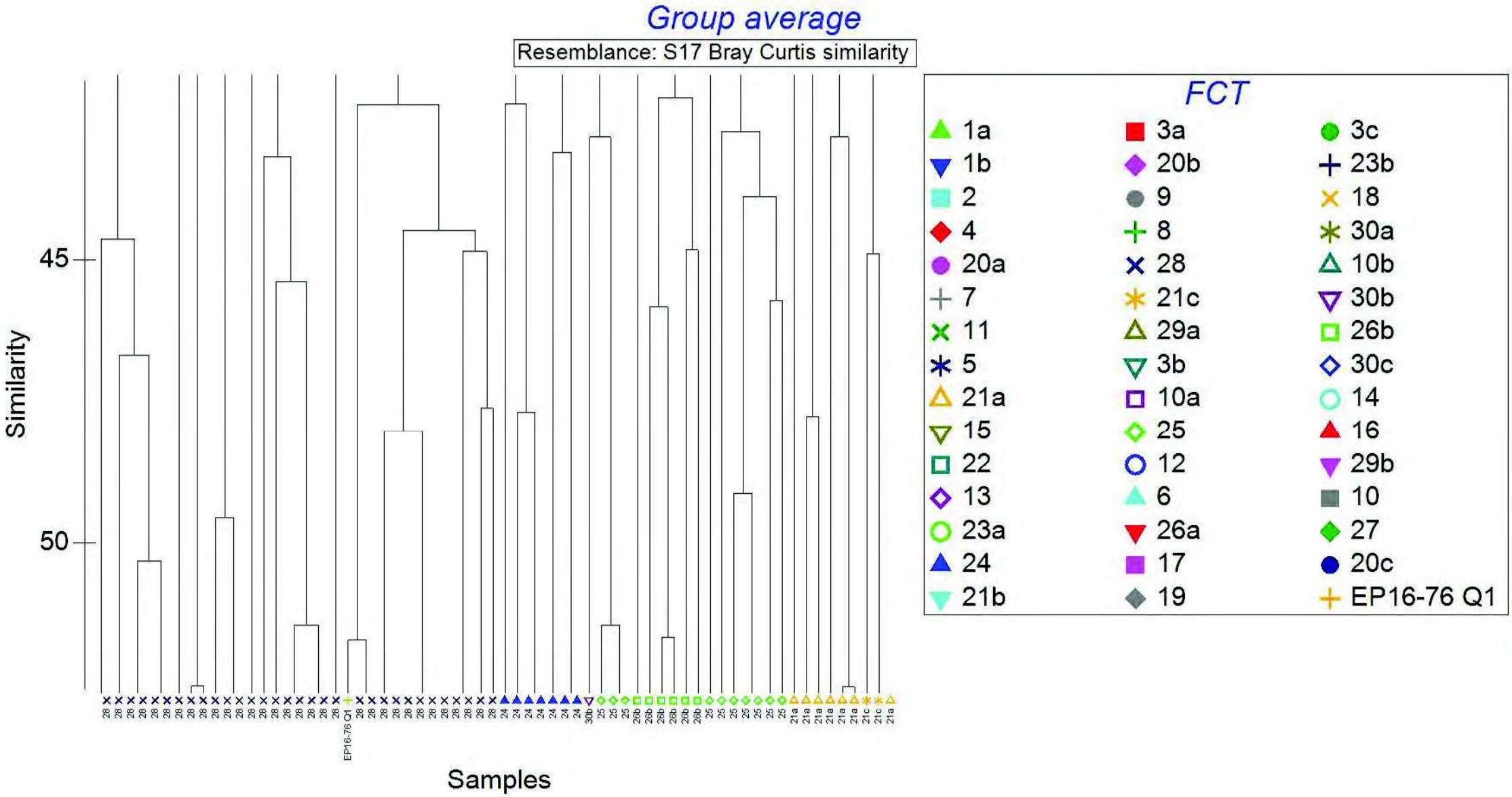
Vegetation Description

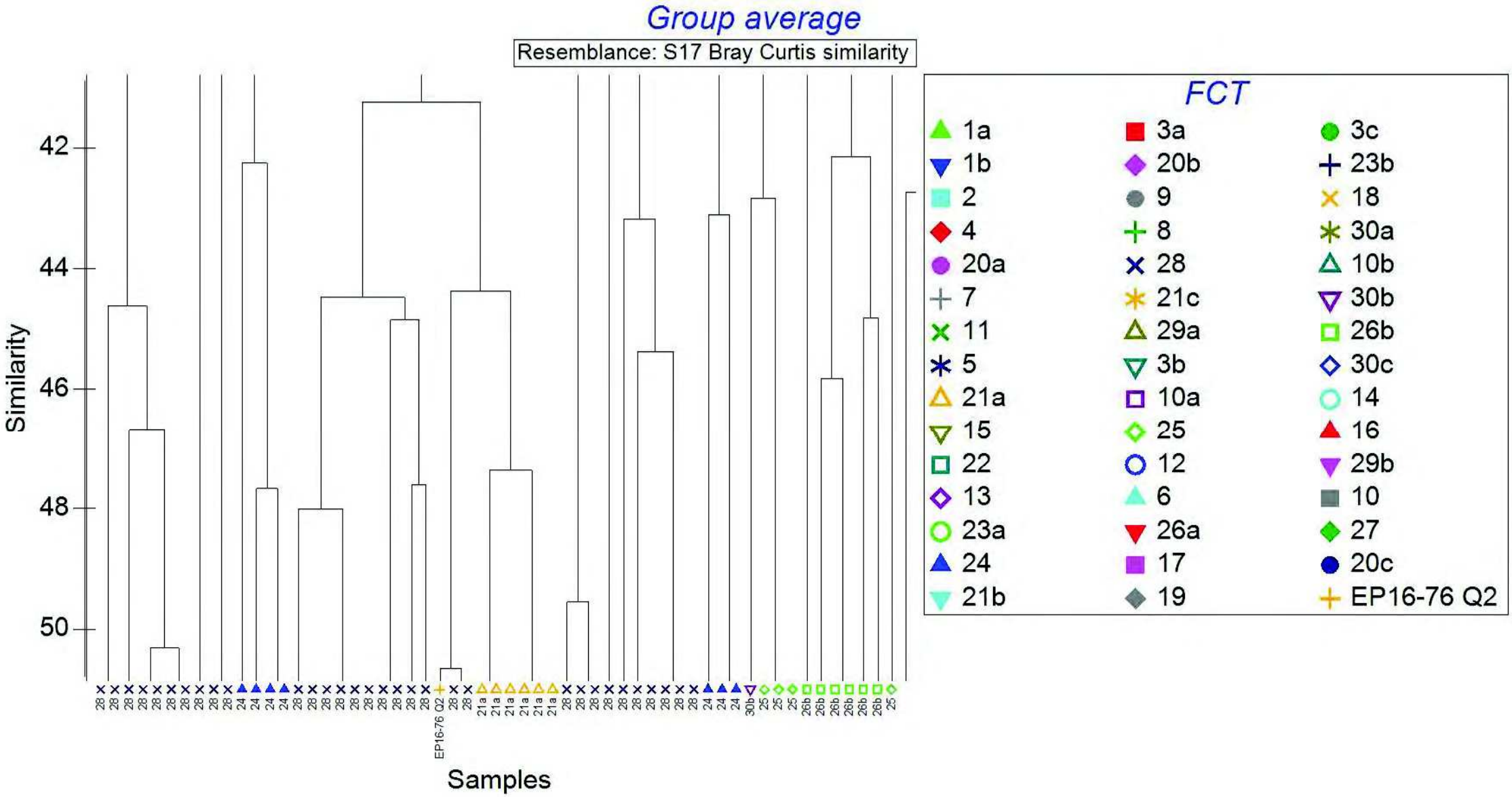
Low woodland *Banksia attennuata* and *Banksia menziesii* over tall open shrubland *Jacksonia sternbergiana* over low shrubland *Xanthorrhoea preisii* and *Hibbertia hypericoides* over open sedgeland Mesomelaena pseudostygia over open forbland *Burchardia congesta* and *Ehrahrta calycina*

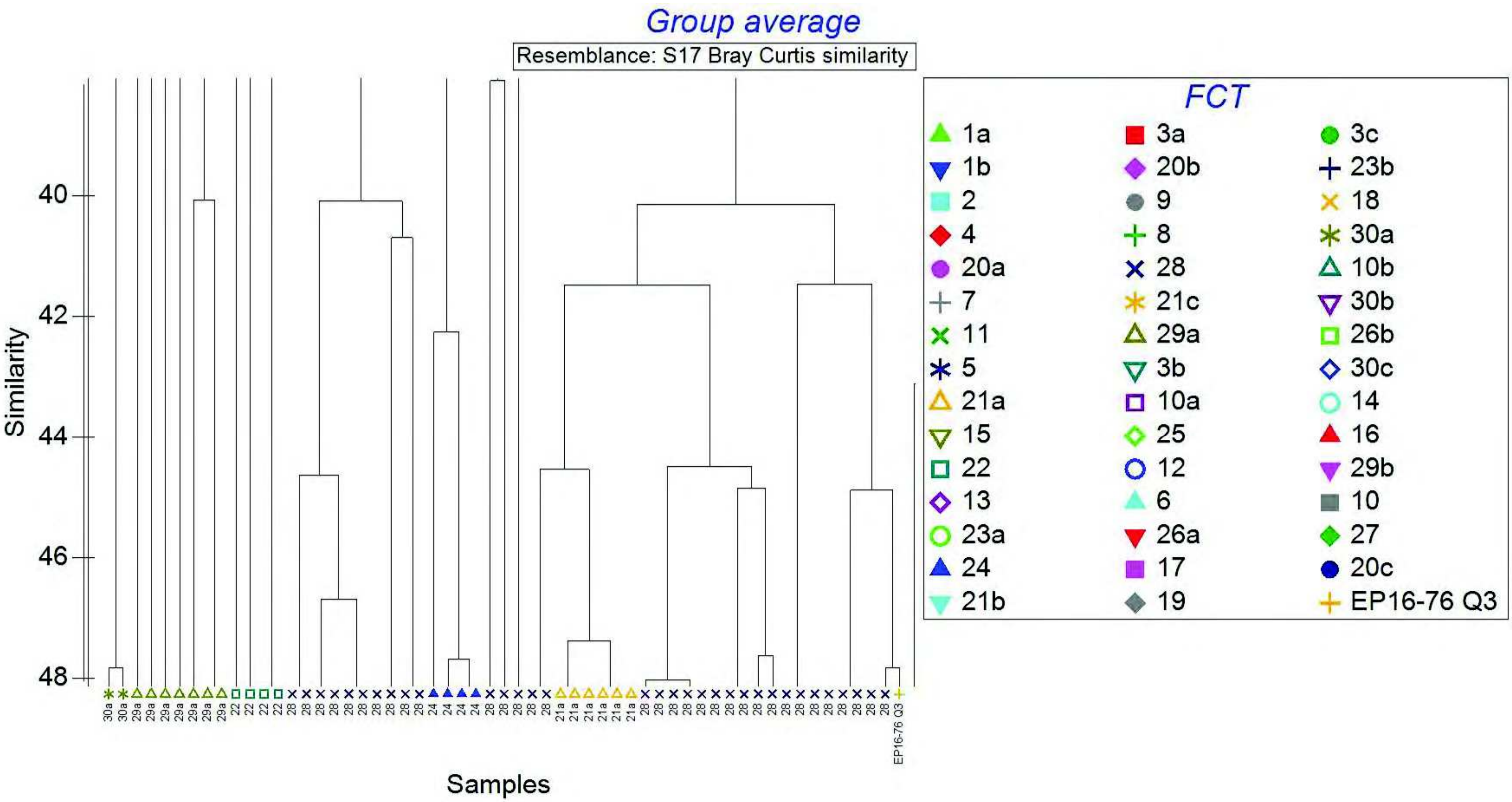
Q4 Species Data						
Coll. No.	**Species**	**Layer**	**Life Form**	**Height**	**Habit**	**% Cover**
	Mesomelaena pseudostygia					30
	Banksia menziesii					25
	Banksia attenuata					20
	Hibbertia hypericoides					20
	Ehrharta calycina					10
	Xanthorrhoea preissii					10
	Jacksonia sternbergiana					2
	Hypochaeris radicata					2
	Ursinia anthemoides					1
	Amphipogon turbinatus					0.5
	Briza maxima					0.5
	Burchardia congesta					0.5
	Caladenia flava subsp. *flava*					0.5
	Carpobrutus edulis					0.5
	Chaemescilla corymbosa					0.5
	Conostylis setigera					0.5
	Conostylis aculeata subsp. *aculeata*					0.5
	Crassula colorata					0.5
	Dasypogon bromeliifolius					0.5
	Daviesia nudiflora					0.5
	Drosera erythrorhiza					0.5
	Ehrharta longiflora					0.5
	Fumaria capreolata					0.5
	Gladiolus caryophyllaceus					0.5
	Hibbertia huegelii					0.5
	Hypocalymma robustum					0.5
	Lomandra caespitosa					0.5
	Microtis media subsp. *media*					0.5
	Podolepis gracilis					0.5
	Podotheca angustifolia					0.5
	Poranthera microphylla					0.5
	Scaevola canescens					0.5
	Schoenus clandestinus					0.5
	Scholtzia involucrata					0.5
	Sonchus oleraceus					0.5
	Sowerbaea laxiflora					0.5
	Stirlingia latifolia					0.5
	Thysanotus manglesianus					0.5
	Trachymene pilosa					0.5

Appendix D

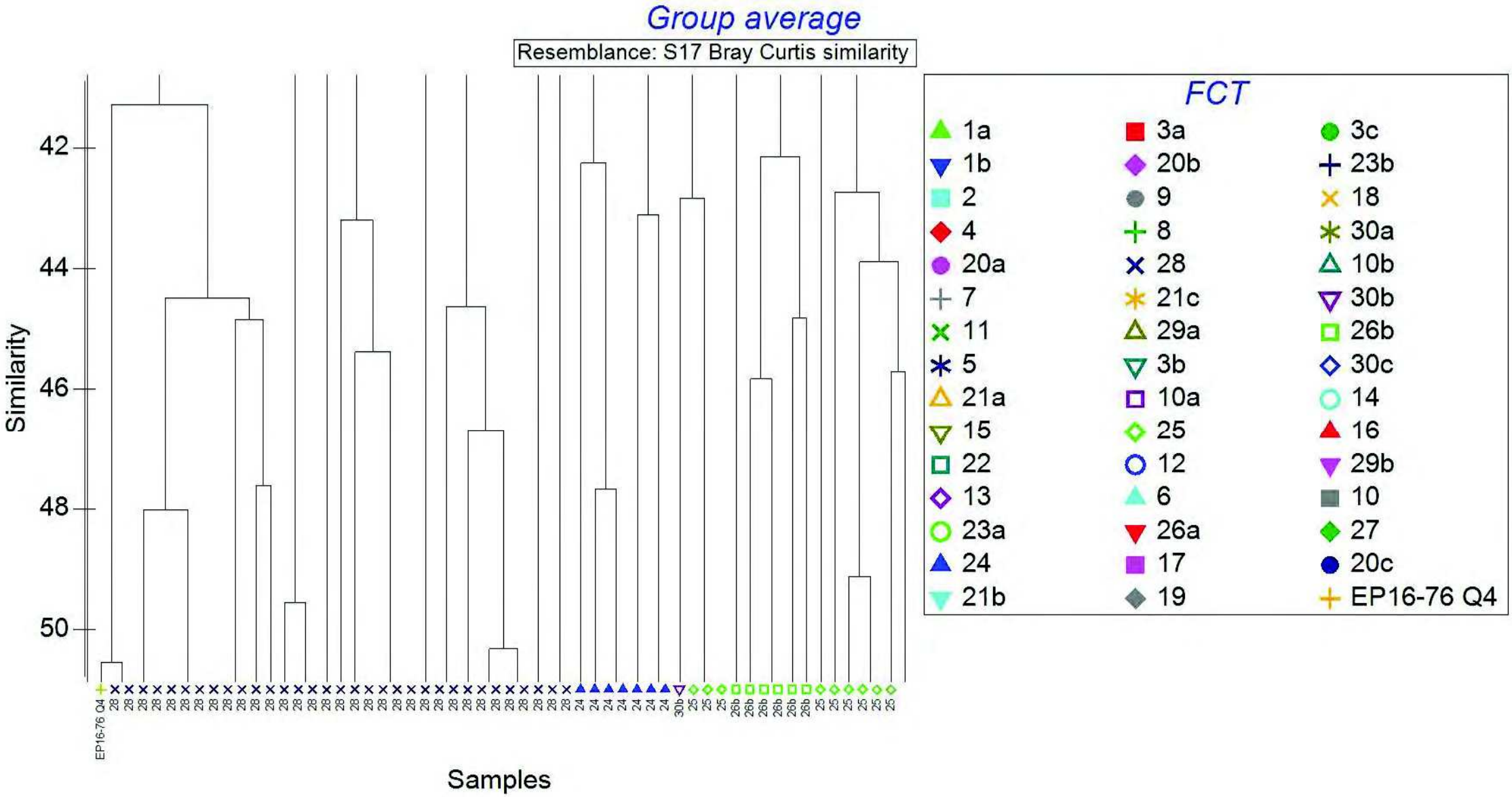
Cluster Dendrograms


Group average
Resemblance: S17 Bray Curtis similarity
Similarity
45
50
Samples
FCT
1a
1b
2
4
20a
7
11
5
21a
15
22
13
23a
24
21b
3a
20b
9
8
28
21c
29a
3b
10a
25
12
6
26a
17
19
3c
23b
18
30a
10b
30b
26b
30c
14
16
29b
10
27
20c
EP16-76 Q1


Group average
Resemblance: S17 Bray Curtis similarity
Similarity
42
44
46
48
50
Samples
FCT
1a
1b
2
4
20a
7
11
5
21a
15
22
13
23a
24
21b
3a
20b
9
8
28
21c
29a
3b
10a
25
12
6
26a
17
19
3c
23b
18
30a
10b
30b
26b
30c
14
16
29b
10
27
20c
EP16-76 Q2



Group average
Resemblance: S17 Bray Curtis similarity
Similarity
40
42
44
46
48
Samples
30a 30a 29a 29a 29a 29a 29a 29a 29a 22 22 22 22 28 28 28 28 28 28 28 28 28 28 24 24 24 24 28 28 28 28 28 21a 21a 21a 21a 21a 21a 28 28 28 28 28 28 28 28 28 28 28 28 28 28 28 28 28 28 28 EP16-76 Q3
FCT
1a
1b
2
4
20a
7
11
5
21a
15
22
13
23a
24
21b
3a
20b
9
8
28
21c
29a
3b
10a
25
12
6
26a
17
19
3c
23b
18
30a
10b
30b
26b
30c
14
16
29b
10
27
20c
EP16-76 Q3


Group average
Resemblance: S17 Bray Curtis similarity
Similarity
42
44
46
48
50
Samples
EP16-76 Q4
28
24
30b
25
26b
FCT
1a
1b
2
4
20a
7
11
5
21a
15
22
13
23a
24
21b
3a
20b
9
8
28
21c
29a
3b
10a
25
12
6
26a
17
19
3c
23b
18
30a
10b
30b
26b
30c
14
16
29b
10
27
20c
EP16-76 Q4