

Winter flora & vegetation survey with Floristic Community Type analysis

Lot 102 Farrall Rd, Stratton (Western Australia)



Tauss & Associates Biodiversity Consultants (July 25, 2016)



Report by Tauss & Associates Biodiversity Consultants (Padbury WA) for the Blackadder–Woodbridge Catchment Group Inc.

Winter Flora and Vegetation Survey with FCT Analysis – Lot 102 Farrall Rd Stratton WA

Version	Author	Submitted to	Date
Draft Report: Summary & Appendices	C.Tauss	P. Cloran, Hon Secretary BWCG	26/6/16
Final Draft Report	“	“	11/7/16
Final Report	“	“	28/7/16

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Thanking members of the GWCG for their assistance in the field

Cover Photo: Mature *Banksia menziesii*- *B. attenuata*- *B. ilicifolia* low woodland of the Priority Ecological Community (FCT 21c) in the mid-west of Lot 102 Farrall Rd, Stratton in June, 2016.

We acknowledge and respect the Noongar traditional custodians upon whose ancestral lands we conducted this survey and the deep feelings of attachment and relationship of Aboriginal peoples to Country. We pay our respects to their Elders past and present.

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This botanical survey and report, commissioned by the client (Blackadder – Woodbridge Catchment Group Inc) from the consultant (Catherine Tauss) was limited with regard to the scope of services due to budget and timeline constraints. Due to these limitations, the consultant was fully reliant on the client to provide the background to all of the planning issues of the proposed development. Also the field survey needed to be completed in early winter and a report produced rapidly thereafter. Within these constraints, the project was performed by the consultant in a professional manner, in accordance with generally accepted practices and using a degree of skill and care ordinarily exercised by reputable environmental consultants under similar circumstances. No other warranty, expressed or implied, is made. The conclusions of this report are contingent upon the accuracy and completeness of the data which may have been influenced by the above limitations. The consultant will not be liable in relation to any incorrect conclusions arrived at in this report should any data prove to be incorrect or incomplete due to the acknowledged limitations, or for any conclusions determined from data subsequently available. Copyright of all information (data, maps, analysis results and conclusions) contained in this report is the property of the consultant and this information is solely for the use of the client, for the purpose for which it has been prepared. No representation is made, or is to be implied as being made, to any third party who may use or rely upon the information in this document.

Summary

The current flora and vegetation study was commissioned by the Blackadder-Woodbridge Catchment Group Inc. to assess Lot 102 Farrall Rd, Stratton ('Lot 102', or 'the Survey Area'). The main objective of this study was to investigate the Floristic Community Type (FCT) of the upland vegetation and record any other significant conservation values that may be impacted by the proposed development of Lot 102.

Lot 102 (8.8 ha) is located east of Farrall Rd, immediately west of the Avon freight railway line and just south of Blackadder Creek. It is part of a proposed urban housing development that encompasses a total area of about 88.6 ha extending on both sides of Farrall Rd.

Most of Lot 102 is a white sand dune of the Yoganup Formation (Ridge Hill Shelf colluvial deposits) inhabited by *Banksia* low woodland over species-rich heath (or species rich heath) of Floristic Community Type (FCT) 20c of the Swan Coastal Plain: *Eastern shrublands and woodlands* of the Forrestfield Vegetation Complex. The northernmost area of Lot 102 is part of the former floodplain of the Blackadder Creek that still connects Lot 102 to the important Talbot Rd Nature Reserve, about 700m to the east. In the south-west of Lot 102, the dune slopes down to merge with the Pinjarra Plain in a swamp-forest of *Melaleuca preissiana* (Guildford Vegetation Complex) on the peaty soils of Bush Forever Area 309. The wetland of BFA309 is maintained by seepage out of the Lot 102 dune. BFA 309 and the dune aquifer upslope from the wetland comprise the intact headwaters of a former tributary of the Blackadder Creek that (until recent development) traversed the extensive palusplain west of Farrell Rd.

To the west of Farrall Rd, Lot 427 (the northern part of a MUW palusplain) has already been excavated to about 2m below the natural contour. This excavation was carried out ahead of the final approvals to provide wetland fill for the first stage of the subdivision, immediately south of Lot 427. A very large volume of additional filling material will be required to bring Lot 427 up to its former natural contour, and then to achieve the final design levels for this part of the subdivision. The Servicing and Infrastructure Report for the project states that Lot 102 "will be excavated to take sand from that area to add to the fill of the land west of Farrall Rd. The eastern part of the" [Lot 102] "land will finish close to the levels at the edge of the railway".

The current Development Plan for the subdivision is thus predicated on the total removal (from most of Lot 102) of all the current landforms, sediments, aquifer(s) and native vegetation; primarily to supply sand as wetland fill for Lot 427 west of Farrall Rd.

Despite the limitations of a one season (winter) survey, the current assessment found a number of high conservation values, as listed below, in Lot 102.

1. Rarity

- Matter of National Environmental Significance (MNES): A representative occurrence of the EPBC –Act listed Threatened Ecological Community: *SCP FCT 20c: Eastern shrublands and woodlands* (Endangered) of the Forrestfield Vegetation Complex on the Ridge Hill Shelf.
- A fully vegetated palusplain wetland representative of the Guildford Vegetation Complex—Bush Forever Area 309— at the junction of Pinjarra Plain and Ridge Hill Shelf.

- MNES: An area of critical forage habitat of the EPBC – Act listed Carnabys Black Cockatoo significant in terms of EPBC Act referral. This includes the *Eastern woodlands and shrublands of the SCP TEC* (above); other *Banksia* woodland of the SCP (EPBC Act listing- pending); Marri woodland; and other forage species (*Eucalyptus tottiana*, Jarrah); and defined nesting and roosting habitat.
- Low-lying *Banksia attenuata* woodlands or shrublands- PEC (Priority 3) in good condition. This vegetation is also part of the *Banksia* woodlands of the SCP currently being assessed for EPBC Act listing.
- All vegetation in good (or better) condition in Lot 102 was representative of either the Forrestfield or Guildford Vegetation Complexes of the eastern SCP. Both Vegetation Complexes (of vegetation condition equivalent to that found in Lot 102) were designated for conservation in the whole- of-government Bush Forever agreement. Conservation of these vegetation complexes are an EPA priority due to their critically low reservation levels (<0.5% and 1% respectively) in the Perth to Peel Region.
- Lot 102 also included populations of several flora species of regional conservation significance.

2. Habitat Diversity

- Palusplain wetland, fully vegetated with a closed swamp-forest on peaty soils;
- Species-rich, low open *Banksia* woodland and heath on white colluvial sand;
- *Banksia* spp. woodland over *Adenanthos cygnorum* open scrub. This is native bird habitat that is now uncommon locally and throughout suburban Perth.
- Mature Marri woodland over open scrub.
- Mature Jarrah, Pricklybark and Sheoak trees with numerous large *Macrozamia fraseri* (cycads) in a parkland- cleared setting.

3. Connectivity

Biodiversity Linkage 126. Lot 102 and one of the most important conservation areas of the PMR (Talbot Rd Reserve) are connected via the vegetation of Blackadder Creek; and other significant stands of mature, Marri trees immediately north of Lot 102; with Biodiversity Linkage 126 that extends from the Darling Range to the Swan River along Jane Brook. This close linkage increases the conservation significance of all of the vegetation of Lot 102. The intact swamp forest of BFA 309, the species-rich *Banksia* open woodland and shrubland of FCT20c, the other *Banksia* spp. woodland and the Marri woodland of Lot 102 are also significant biodiversity resources (some of which are not represented elsewhere in Biodiversity Linkage 126) that greatly enhance Biodiversity Linkage 126

4. Sustainability

The FCT20c vegetation in Lot 102 occurred in about 2.52ha of two core areas of native vegetation in good to excellent condition (that also included either FCT21c or the swamp forest of BFA309). The two cores were linked and buffered by another 1.31ha of degraded condition vegetation of the FCTs 20c and 21c and open Marri forest. In addition 4.45ha of parkland cleared native vegetation contributed values such as large trees not found in the better condition classes of vegetation in Lot 102 surrounded the areas above.

The total area of about 8.3 ha of native vegetation in Lot 102 in various condition classes was comparable to many other viable SCP conservation reserves.

5. Environmentally Sensitive Areas (ESAs)

Bush Forever Area 309 (which also meets the criteria for Conservation Category Wetland) is an ESA as defined under the WA Environmental Protection Act.

Conclusions

The current study provided new and important information about the high conservation values of Lot 102 that were unfortunately overlooked and/or underestimated in the proponent assessment of the development. The results of the current study with regard to the occurrence of the EPBC Act

listed Threatened Ecological Community and the Priority Ecological Community within Lot 102 and the vegetation condition assessment were determined after a more detailed sampling of the vegetation than was contained in all previous surveys. It was also clear that the proponent assessment had misinterpreted some of the important habitat factors in Lot 102.

The Development Plan currently under consideration was drawn up before the new information of the conservation values and their landform, soils and hydrological habitats was available. Thus this plan failed to adequately protect (or sustainably manage) the Matters of National Significance, the Bush Forever Area 309 (Conservation Category Wetland) and other conservation values within Lot 102.

In this development plan, the proponents are proposing that a core area of high conservation value in Lot 102: an EPBC Act-listed TEC and the contiguous Bush Forever Area 309- all in good to excellent condition (representative of the rare and poorly- reserved Forrestfield and Guildford Vegetation Complexes, respectively) is counted as part of the total area that they are contributing, at their discretion, to 'public open space'.

The other core area of the TEC and some PEC vegetation in good condition (both representative of the rare and poorly- reserved Forrestfield or Guildford Vegetation Complexes, respectively) and all of the other native vegetation in lesser condition that links this to the core area above, is currently earmarked for sand mining to provide wetland fill for the development west of Farrall Rd.

If this proposition is allowed it would constitute inappropriate land uses for all of the high conservation areas of Lot 102. Not only is a part of the TEC and all of the PEC and linkage / buffering native vegetation being proposed for sand mining , but also the remaining TEC vegetation and Bush Forever wetland is being traded (at the discretion of the developer) as part of the public open space allocation. This is inappropriate management of conservation lands and transgresses governance precedents for Western Australian conservation lands.

It is thus recommended that:

- The MNES found in Lot 102 in the current survey should be *formally assessed* by the Commonwealth Department of Environment under the provisions of the EPBC Act.
- The Western Australian Department of Parks and Wild life (DPAW) should be requested to re-classify Bush Forever Area 309 from its existing management category (Multiple Use Wetland) to Conservation Category Wetland following advice it has already received from the proponent (Emerge, 2015b) who re-assessed the wetland using the appropriate DPAW protocol.
- The inadequate buffer zone provided in the Development Plan for the BFA 309 wetland and the core TEC area upslope from this wetland should be revised.
- The Development Plan should be revised to remove the serious threat to the groundwater dependent ecosystems of high conservation significance in Lot 102 that are contained in the proposed wholesale landscape modification and consequent alteration of the current hydrological regime of Lot 102.
- The removal of the dune in Lot 102, the realignment of Farrall Rd through Lot 102 and the public open space provisions for the subdivision should be reworked to develop a more

contemporary and environmentally sustainable landscape planning approach. This would also enhance the amenity and marketability of the planned subdivision.

- The outstanding *Eucalyptus tottiana* tree near BFA 309 be nominated for protection on the National Trust Significant Tree Register, or another appropriate register, and afforded appropriate management.

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1.0 Introduction

This study was commissioned by the Blackadder-Woodbridge Catchment Group Inc. (BWCG) to independently investigate the conservation values of the flora and vegetation in Lot 102, Farrell Rd, Stratton in the City of Swan, Western Australia. It was prompted by BWCG concerns that the previous environmental impact assessment studies (including Emerge 2105a and 2015b) carried out for the proponents for an urban housing development including Lot 102, may have significantly overlooked and/or underestimated the occurrence of important conservation values (including the putative occurrence of an EPBC Act-listed Threatened Ecological Community) within Lot 102. There were also concerns that the potential impacts of the proposed development on high conservation values were not sufficiently addressed by proponent.

Lot 102 (8.8 ha) is bordered to the west by Farrall Rd, to the east by the Avon Freight Line railway line cutting and to the north by Blackadder Creek (Appendix A, Figure A1). It is part of a proposed urban housing development (Peet Stratton Pty Ltd and Joe Candeloro) that encompasses a total area of about 88.6 ha extending on both sides of Farrall Rd.

The earth moving for the main part of the development (west of Farrall Rd) on the MUW palusplain wetland (UFI 151536) was already well advanced in late May (2016) when the current flora and vegetation survey commenced: Lot 427, the northern part of the palusplain, had been excavated to about 2m below the natural contour. The vegetated part of this palusplain, that was formerly contiguous with the palusplain of Bush Forever Area 309 in Lot 102 and the original tributary of Blackadder Creek (evident in historical aerial photographs west of Farrall Rd and mapped in the DPAW Wetland Atlas) were totally removed during this excavation. These earth works in the palusplain were carried out to provide wetland fill (supplemented by red mud, a bauxite mining by-product) for the first stage of the subdivision, located immediately south of Lot 427. A very large volume of additional filling material, proposed to be sourced from Lot 102, will be required to bring Lot 427 up to its former natural contour, and then to achieve the final design levels for this part of the subdivision. The Servicing and Infrastructure Report for the project states that Lot 102 “will be excavated to take sand from that area to add to the fill of the land west of Farrall Rd. The eastern part of the” [Lot 102] “land will finish close to the levels at the edge of the railway”. The current development plan (Appendix A, Figure A1) confirms that extensive modifications to the landforms, sediments, hydrology and native vegetation are proposed for Lot 102, as below.

- Removal of all of the native vegetation of Lot 102 north of the existing Bush Forever 309 wetland, in order to mine the sand of the dune to provide wetland fill for the adjoining urban development on Lot 427, west of Farrall Rd.
- Cutting and grading of Lot 102 north of the existing Bush Forever 309 wetland down to the approximate contour of the Avon freight railway line (that is currently situated about five to six metres below the natural land level along the eastern boundary of Lot 102).
- Realignment of Farrall Rd to eastwards across central part of Lot 102 to the railway reserve and then north (parallel to the railway line) to a temporary railway crossing where a future, grade-separated railway crossing is indicated.
- Construction of a noise barrier wall along the railway line to protect the urban housing lots proposed for Lot 102, which will be at AHD level approximately level to that of the railway

and thus no longer protected from the noise of the railway by the slope of a large dune and native vegetation.

- In the south of Lot 102 where the Bush Forever Area 309 wetland is located, the structure plan shows a minimum wetland buffer of 50m reserved around only the northern end of BFA 309. About 0.3 ha of the existing native vegetation east of the wetland will also be retained.
- It is not clear if part of the vegetated area reserved as buffer at the north end of the wetland will be subject to disturbance from earth moving activities (and will thus lose all or part of its current native vegetation) to achieve the required grades for the realignment of Farrall Rd through Lot 102.
- The natural contours of Lot 102 will be modified to such an extent in the proposed development, that the reserved native vegetation area proposed in the south of Lot 102 will (as a result) be up to about 6m above the adjoining part of Lot 102 (where the development is proposed) rather than level with the adjoining part of Lot 102, as it is at present.

The alteration of the ground contours proposed will cause the groundwater from the (immediately adjacent) reserved native vegetation area proposed in the south of Lot 102 to drain north by gravity, following the new steep slope made in the development, rather than west following the natural, existing gentle slope into the wetland, as it does at present. Thus the current hydrological maintenance regime of the groundwater dependent ecosystems east of the wetland, and in the wetland itself, will be significantly altered by the proposed development in Lot 102.

The current study confirmed the shortfalls in the environmental impact assessment carried out in Lot 102 for the proponent with regard to assessing the high conservation values of the flora, vegetation and wetland in Lot 102 and the habitats supporting these values. It is also clear that the surveys carried out for the proponent failed to acknowledge their limitations; they lacked the intensity of field survey, fine scale detail, and experience in the flora and vegetation of the eastern Swan Coastal Plain that were considered necessary to accurately the flora and vegetation of Lot 102.

The current study provided recommendations to address some of the potential impacts to the high conservation values of Lot 102 contained within the current development plans.

2.0 Regional Setting of the Survey Area

2.1 Climate, Geology, Landforms and Soils

The SCP BioRegion experiences a Warm Mediterranean climate with warm dry summers and cool wet winters (Gentili, 1972). The long term rainfall records from the Bureau of Meteorology Station at Midland provide a good indication of the monthly rainfall that can be expected at Lot 102 Farrall Rd.

The long term rainfall records from Midland show that the total rainfall from January to the end of May, 2016 was 208.6mm (Bureau of Meteorology, 2016) compared to the annual mean total of 183.2mm for these months (Table 1, Figure 1). Thus the total rainfall leading up to the current field

survey was somewhat above that usually expected for the area at this time of year. This suggested that the seasonal growth of native species in the Survey Area at the time of the field survey (late May to early June) was not likely to have been delayed by low soil moisture levels.

Table 1: Mean historical monthly rain at Midland compared to rain in 2016 prior to current survey

Years	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean Total Monthly Rainfall (mm)												
1886–2015	9.2	13.1	17.3	41.7	101.9	160.2	163.0	122.1	75.1	47.3	22.9	10.2
2016	23.5	9.4	28.2	48.6	98.9							

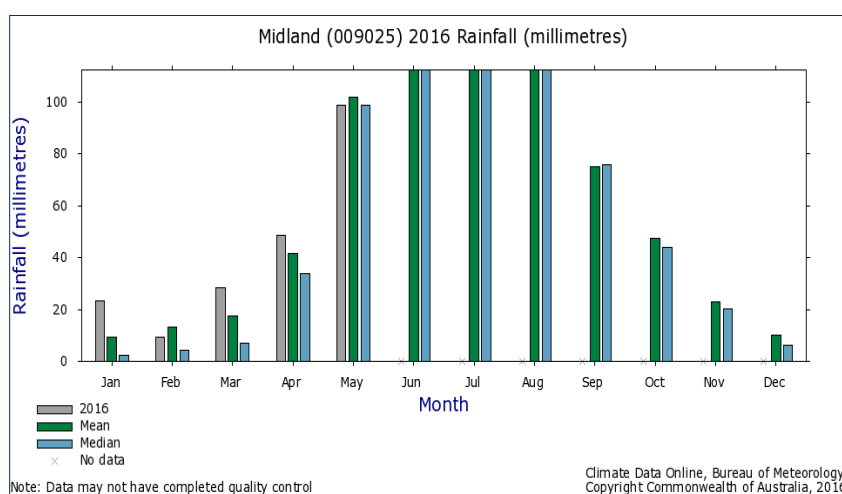


Figure 1: Midland (2016) rain totals for each month compared to means & medians (1886-2015).

Lot 102 Farrall Rd is located on the eastern margin of the Swan Coastal Plain (SCP) about three kilometres west of the current location of the Darling Scarp. The Darling Fault that formed in the Archaean Yilgarn Craton during the Proterozoic Geological Era (Biggs and Wilde, 1980) is the major geological boundary of the region. The fault separated the Yilgarn Craton to the east, from a deep rift valley (that is now the Pinjarra Orogen and overlying Phanerozoic Perth Basin) to the west. However the Darling Scarp has now eroded to the extent that the steep escarpment is about one to three kilometres to the east of its original location the ancient Darling Fault is now obscured by deep overlying sediments.

The Swan Coastal Plain (McArthur and Bettenay, 1960; Playford *et al.*, 1976) comprises a series of major regional landforms that are orientated more or less parallel to the coast. These regional landforms are (from west to east): Quindalup Dunes, Spearwood Dunes, Bassendean Dunes, Pinjarra Plain and the Foothills. Each of these five major landforms of the SCP has experienced a distinct evolutionary history (due to the varying forces that operated during the geological periods that shaped them). Thus each landform now has a very individual signature in terms of the range of edaphic factors/ habitats that it encompasses, and the biodiversity resources it supports at the ecosystem, population and genetic levels.

Farrall Rd straddles the interface of the two regional landforms (the Foothills and the Pinjarra Plain) of the eastern SCP, as described below.

1. The Foothills comprise the remnants of the Ridge Hill Shelf (Low, 1971); a sand-covered platform with a westerly slope of maximum elevation about 200m AHD, dissected by watercourses. The Ridge Hill Shelf was formed during the Pleistocene era marine incursions that cut into the colluvial deposits at the foot of the Darling Scarp. The superficial sediments of the Ridge Hill Shelf in the vicinity of Lot 102 are the Forrestfield Soils of the Yoganup Formation; they include colluvium and alluvium (and minor marine deposits) of poorly sorted, white quartz sands; silts, lateritic clays and gravels. The Ridge Hill Shelf in the vicinity of the Survey Area is traversed by seasonally-inundated channels and floodplains (including Jane Brook, Blackadder and Woodbridge Creeks and the Helena River). In Swan View and Stratton these wetlands are part of the Walyunga (D.1) Suite (Semeniuk, 1987). These channel wetlands are maintained by surface run-off from the Darling Plateau and/or groundwater seepage out of the Ridge Hill Shelf sediments.

2. The Pinjarra Plain is very gently sloping, valley-flat, system formed of silts, clays and other sediments of the Guildford Formation transported by creeks from the Darling Plateau, via the Foothills, and deposited as extensive coalescing alluvial fans (Gozzard, 2007). It also sometimes includes ferricrete and minor calcrete layers developed *in-situ* and small areas of well-sorted, aeolian, quartz Bassendean Sands (as low dunes over the prevailing heavier soils of the alluvial flats). The Pinjarra Plain is predominantly a wetland landscape of palusplains *i.e.* seasonally-waterlogged flats and floodplains (Semeniuk, 1987). In Midvale/ Viveash these wetlands are part of the Swan River (R.2) Wetland Suite (Semeniuk, 1987). The topographical map of Emerge (2015b, Figure 3) shows Lot 102 as a gentle slope, with a south westerly aspect, that grades down from about 25m AHD at the top of the cliff overlooking the railway cutting in the east, to about 19m AHD at Farrall Rd from and hence to an extensive plain west of Farrall Rd.

The soils of Lot 102 were shown in Emerge (2105a, Figure 2) from the fine scale soil mapping of the Department of Agriculture (2002) as listed below.

The upland of Lot 102: 213Fo__Ff1. This designates a Forrestfield (Ridge Hill Shelf) soil: a Quaternary colluvial sand of the Yoganup Formation.

The wetland of Lot 102 (BFA 309) in the south west of Lot 102 and the floodplain of the Blackadder Creek in the far north of Lot 102: **213Pj__Gf3.** This designates a Guildford Formation soil: a Quaternary alluvial silt of the Pinjarra Plain.

[Please Note: There was some confusion in the “Landforms” map of Emerge (2015b, Figure 4) which presented the Churchward and McArthur (1980) soils mapping instead of the landform mapping for the project area; accompanied by an unusual disclaimer attached to this map. However Emerge (2015a) noticed the discrepancy between the broad scale Churchward and McArthur (1980) soils mapping and the more contemporary, fine scale Department of Agriculture (2002) soil landscape mapping that indicated that most of Lot 102 were Forrestfield Soils of the Ridge Hill Shelf landform.]

In the current survey, the two major landforms (Ridge Hill Shelf and Pinjarra Plain) of the eastern Swan Coastal Plain were clearly evident (on aerial photography and in the field at the time of the current survey) as topographic and soil differences between the east and west sides (respectively) of

Farrall Rd. The poorly-sorted, white quartz sands of the slope that encompassed most of Lot 102 (Figure 2) contrasted sharply with the brown-grey muddy sand, mud and clay sediments exposed in stratigraphic profile by the recent excavation in the low-lying palusplain west of Farrall Rd. However there was dark brown, peaty sand to sandy peat in the wetland at the break of the slope (in Bush Forever Area 309) in the far south-west of Lot 102 and grey humic sand in the firebreak adjacent to the wetland and, at same elevation, in a small area just east of Farrall Rd.

The boundary of the Pinjarra Plain geomorphic unit was also evident from topography, given the upper height limit of the (current) Caversham Surface of the Pinjarra Plain documented in Gozzard (2007) in the vicinity of Midvale approximates the elevation at Farrall Rd. It is clear that the Pinjarra Plain landform and soils of the wetlands west of Farrall Rd, transition into Forrestfield Soils, almost immediately east of Farrall Rd (in all but the south west corner of Lot 102 where the BFA wetland is located). The Pinjarra Plain landform and soils do not extend onto the crest of the dune east of the railway line in Stratton, as portrayed in Emerge (2015b, Figure 4) in which they are mapped at least 8m above the maximum Caversham Surface height.

Unfortunately the confusion of habitats in Lot 102 initiated by Emerge (2015b) may have contributed to some of the misinterpretation of vegetation values of Lot 102.



Figure 2: White quartz sand (213Fo__Ff1) of dune in Lot 102 Farrall Rd, as mapped in Dept. of Agriculture (2002).

2.2 Vegetation

The vegetation of the ‘hyperdiverse’ SCP Biogeographical Region (AGDE, 2015) remains poorly known due to its natural complexity and because it has never been comprehensively mapped and classified, despite being of global significance as part of the Global Biodiversity Hotspot of South West Western Australia (Myers *et al.*, 2000; Hopper and Gioia, 2004).

2.2.1 Vegetation Complexes

Hedde *et al.* (1980) characterised a number of vegetation units that were termed Vegetation Complexes of the Perth Region. The Vegetation Complexes were mapped, in the pre-digital age, to correspond to the broad scale geomorphic systems and soil units of the region (Churchward and McArthur, 1980) on the assumption that each Complex included a number of geographically-distributed Sub-Units (*e.g.* North, Central and South, South) comprising various plant communities aggregated in proportions characteristic of that particular Complex. The Vegetation Complexes were

not classified by numerical methods; the vegetation was simply described in structural terms and mapped at the broadest (regional landscape) scale of 1: 250,000. Each Complex, by definition, includes numerous (undescribed) sub- units at the ecosystem (ecological community) scale. The Vegetation Complexes, despite being such high order units of vegetation classification and mapping, remain the only comprehensive tool that is available in the region to assess vegetation variation and conservation.

Lot 102 Farrall Rd, Stratton is located at the junction of the Foothills and the Pinjarra Plain and the Heddle *et al.* (1980) mapping gives a very general indication of the two Vegetation Complexes (Forrestfield and Guildford) in the vicinity of this area. The percentages of the original extent of each Vegetation Complex that now remains in the Perth to Peel Region (PPR) and the percentage of the original extent that is reserved for conservation in the PPR (EPA, 2015) are critically low.

- 1. Forrestfield Vegetation Complex:** (less than 10.3 % of original extent remains in PPR, 1% of original extent in PPR in secure conservation reserves).
- 2. Guildford Vegetation Complex:** (less than 5.4% of original extent remains in PPR, 0.5% of original extent in PPR in secure conservation reserves).

Both of these Vegetation Complexes of the eastern SCP have been repeatedly recognized in government policies as requiring urgent protection, as some of the most rare and threatened vegetation types on the SCP (Government of WA, 2000; EPA, 2015).

It must be recognized that both the Forrestfield Vegetation Complex and the Guildford Vegetation Complex, as vegetation units with less than 10% of their original extent remaining uncleared, meet the international (IUCN) ecological definition of Critically Endangered Ecosystem (David *et al.*, 2013). It follows that all subunits of these two Vegetation Complexes, when in sufficiently good condition to be representative of these Vegetation Complexes, also qualify (in the ecological sense) for Critically Endangered status even if the administrative processes for conservation have not kept pace with international scientific conservation principles.

2.2.2 Floristic Community Types and Threatened Ecological Communities

An early study (Havel, 1975) that recognized the potential of classifying the SCP vegetation using the quantitative analysis of *floristic* data was not expanded into a major, regional scale study until a partial sampling and floristic classification of the southern SCP was carried out by Gibson *et al.* (1994) and a similar study of the Darling Range (Markey, 1997).

The floristic classification studies of the SCP (Gibson *et al.*, 1994; Department of Environmental Protection, 1998, 1999 and 2000; Government of W.A., 2000; and Perth Biodiversity Project, 2010) defined some of the Floristic Community Types (FCTs) of the SCP. The FCTs of the SCP provide a framework that is currently used, in conjunction with detailed field survey, to assess the conservation significance of bushland at the ecosystem (= ecological community) scale in the SCP BioRegion. This contextual data assists in the identification of known Threatened Ecological Communities (TECs) in the bushland areas being assessed and the potential determination of additional, new TECs. However the existing FCTs of the SCP remain as a high order classification because the sample of the vegetation of the SCP that was included their definition was too small to comprehensively scope all of the extant vegetation units in the SCP. Also, the use of the FCTs to

understand the conservation values of the SCP vegetation requires high standards of detailed field survey, taxonomic accuracy, the ability to research botanical synonymy to align datasets, and a sound understanding of plant ecology and phytosociology. The latter skills are in now in short supply in the environmental impact assessment industry in Perth as most tertiary institutions in Australia no longer offer full undergraduate courses in plant ecology and taxonomy. Many vegetation surveys in the SCP have thus incorrectly inferred FCTs in environmental impact assessments or, if they used numerical methods, have invalidly discounted the conservation value of vegetation which they have not been able to assign to one of the existing FCTs of the SCP.

There are 22 Floristic Community Types of the Swan Coastal Plain (FCTs – after Gibson *et al.*, 1994; Department of Environmental Protection 1996, 1998, 1999 and 2000) that have been identified in the Foothills and Pinjarra Plan (Government of W.A., 2000). Thirteen of these FCTs of the Foothills and Pinjarra Plan were identified as Threatened Ecological Communities (Government of W.A., 2000). The FCTs identified (Government of W.A., 2000) as occurring in the Bush Forever Sites located nearest to Lot 102 (Talbot Rd Nature Reserve, Stratton and the Bushmead Bushland, Swan) were:

FCT 3c: *Corymbia calophylla* – *Xanthorrhoea preissii* woodland and shrublands

FCT 20a: *Banksia attenuata* woodlands over species-rich dense shrublands

FCT 20c: Eastern shrublands and woodlands

In addition, **Environmentally Sensitive Areas** (ESAs) are declared by the Western Australia n Minister for Environment under section 51B of the Environmental Protection Act 1986 and are protected under the Environmental Protection (Clearing of Native Vegetation) Regulation 6, 2004. ESAs are declared to prevent incremental degradation of important environmental values such as declared rare flora, threatened ecological communities or significant wetlands. They include the following:

- Defined wetlands that include Ramsar Convention Wetlands, Nationally Important Wetlands, and *Conservation Category Wetlands* (as mapped in DPaW, 2014a) and the areas within 50m any of these wetlands.
- Vegetation within 50m of *Threatened Flora*, to the extent that this vegetation is continuous with the vegetation in which this rare flora is located.
- Areas covered by a *Threatened Ecological Community*.
- *Bush Forever Sites* listed in Bush Forever (2000) except to the extent to which the site may be cleared under a decision of the Western Australia Planning Commission.

Lot 102 Farrall Rd is known to include at least one ESA—**Bush Forever Area 309**—the wetland in the south west corner of Lot 102. This wetland was mapped in the SCP Geomorphic Wetlands Database as part of the Multiple Use Wetland UFI15136 at the time of the Emerge (2015a) assessment. Emerge (2015a) found that BFA 309 should be upgraded to a Conservation Category Wetland.

2.3 Previous Surveys

A flora and vegetation assessment of the proposed development site, east and west of Farrall Rd was conducted by Coffey Environments (2006) in a one visit (spring) survey. This assessment excluded the portion of the current development site to the north of the railway line. The survey

recorded a total of 125 flora species, including 36 (29%) naturalized alien taxa (weeds). There were no listed Threatened or Priority Flora recorded. The assessment identified nine vegetation types throughout the site, and two FCTs of the SCP were inferred in the area: FCT11 – Wet Forests and Woodlands and FCT23a – Central *Banksia attenuata* – *B. menziesii* Woodlands. The majority of the site was considered to be in completely degraded condition with some patches in degraded condition. A small area of good condition vegetation was recorded in the centre of the site and BF 309 was assessed to be in excellent condition.

Emerge (2015a) conducted a one visit (spring) survey over an 88 ha site (including Lot 102) for the proponent of the current proposed development. Four person days were expended for this field survey which recorded a total of 86 native flora taxa (and 72 naturalized alien taxa *i.e.* weeds) in 88ha. There were two quadrats sampled in the upland vegetation of Lot 102 for the FCT analysis. The total number of species recorded in each of the two quadrats sampled in the upland of Lot 102, ranged from 33 to 40 taxa per 100m². There was a mean of 36.5 spp. per 100m² recorded in these two quadrats. The data from the two quadrats was used to investigate the FCTs of the vegetation in Lot 102 by multivariate analysis.

The DPAW and Commonwealth Department of Environment database searches for Threatened and Priority Flora within a 5 km radius of Lot 102 and for Matters of National Environmental Significance (MNES) in the vicinity of the Survey Area (Emerge, 2015a) retrieved 21 Threatened Flora and 23 Priority Flora taxa as potentially occurring within their 88ha search area. Although Emerge (2015a) mentioned native 'flora of other conservation significance' (EPA, 2004) in their methods, they did not list any flora of this category to include in a targeted search for the field survey of Lot 102.

There were no Threatened Flora Species recorded in Lot 102 by Emerge (2015a) however a total of six plants of the Priority 3 Species *Isopogon drummondii* were noted and mapped in this area. There were no 'flora of other conservation significance' reported in the Emerge (2015a) field survey results.

Two plant communities, as listed below were mapped by Emerge (2015a, Figure 4) in Lot 102.

1. BaBm – Sparse to open woodland of *Banksia attenuata*, *Banksia menziesii* and *Eucalyptus tottiana* over open shrubland to shrubland of *Adenanthos cygnorum* and *Allocasuarina humilis* over low sparse shrubland to shrubland of *Conostephium pendulum*, *Stirlingia latifolia* and *Hibbertia* spp. over forb and sedgeland of *Lyginia* spp., *Dasypogon bromeliifolius*, *Conostylis aculeata* and *Podotheca gnaphalioides* and herb/grassland of pasture weeds. This community was mapped over most of Lot 102 except for the wetland area of BFA 309 and a small area of *Corymbia calophylla* woodland in the north of the site.

The assessment concluded that this plant community showed highest similarity (38%) in multivariate analysis to the Gibson *et al.* (1994) FCT 21c sites DEJONG-c and HYMUS-03, with lower similarities to FCT 23a (36%) and FCT 20c (33%) also being noted. **FCT 21c is a Priority 3 Ecological Community (PEC).**

2. Mp –Woodland to low open forest of *Melaleuca preissiana*, with emergent *Corymbia calophylla* over sparse shrubland of *Astartea scoparia*, *Marianthus* sp., *Xanthorrhoea preissii* and *Acacia pulchella* over sedgeland to closed sedgeland of *Dielsia stenostachya* and Cyperaceae sp. and open

herbland of *Corynotheca micrantha* subsp. *micrantha*, *Drosera* spp. and *Burchardia congesta*. Understorey layers largely absent in degraded areas and replaced by a closed grass/herbland of pasture weeds. This “plant community” was considered by Emerge (2015a) to “most likely represent FCT 11 – Wet woodlands and shrublands”.

Emerge (2015a) assigned **FCT 21c** to the **BaBm** vegetation in Lot 102 by multivariate analysis.

Most of the vegetation in Lot 102 was mapped as **BaBm** in degraded condition (Emerge 2015b, Figures 4 and 6). Only **1.9ha** (approximately) of Lot 102 was mapped by Emerge (2015a, Figure 6) as vegetation in good to excellent condition in Lot 102. However Emerge (2015a) did not digitally quantify any of the native vegetation units it mapped in Lot 102. Therefore the current study estimated the extent of the vegetation units from the mapping of Emerge (2015a, Figure 6), as listed below.

1. About 0.3ha of Marri woodland in the far north of Lot 102, in degraded condition;
2. About 1.6 ha of **Mp** vegetation in the BFA 309 area, all in excellent condition; and
3. About 0.3ha of **BaBm** vegetation (in a small triangular area directly east of BFA 309) in good condition.

The section of Wetland UFI 15136 that comprised Bush Forever Area 309 was re-assessed by Emerge (2015a) with regard to management category. The BFA309 portion of UFI 15136 was at the time mapped in the DPAW SCP Geomorphic Wetlands Atlas as a Multiple Use Wetland.

Emerge (2015a) assessed Bush Forever Area 309 by the protocol of DPAW (2013) and found it was **Conservation Category Wetland** due to “the dominance of vegetation in good or better condition overall” of this part of the palusplain. It is not known if the Department of Parks and Wildlife have amended the management category of this wetland in the SCP Geomorphic Wetlands Atlas on the basis of this advice, or if they have requested the proponent to supply more data towards such an amendment, or if they have taken no action.

3.0 Methods

The survey and analysis methods adopted in the current vascular flora and vegetation survey were based on:

- *The Western Australian Environmental Protection Authority’s Guidance Statement No. 51 for terrestrial flora and vegetation surveys for environmental impact assessment (EPA, 2004)*

A Level 2 survey method was chosen for Lot 102 Farrall Rd, Stratton because of the substantial total area (8.8ha) of the bush; the high conservation value of all remnant bushland in this part of the City of Swan; and the need to carry out a detailed, quadrat-based survey in order to classify the vegetation at the level of Floristic Community Type (FCT) and to examine Threatened Ecological Community (TEC) status.

The current assessment included an intensive targeted rare flora field survey, detailed quadrat-based floristic sampling, and fine scale vegetation mapping. Due to the time limitations on this survey, the current assessment could not carry out the rare flora and TEC database searches that are

usually included in the desktop survey component of a Level2 survey. However the current survey did consult the list of Threatened and Priority Flora and TEC values retrieved in Emerge (2015a) for the Survey Area. The personnel of the current survey were familiar, from previous surveys, with most of the relevant Threatened and Priority Flora taxa retrieved by Emerge (2015a).

The current assessment did however carry out additional literature searches (not previously carried out by Emerge, 2015a) to compile a list of potential “native flora of other conservation significance” (after the definition of EPA, 2004) for the Foothills regional landform unit. These flora are also sometimes referred to as flora species of regional conservation significance.

Government of Western Australia (2000) listed about 47 taxa of native flora of “other conservation significance” in the Foothills including: *Blancoa canescens*, *Conospermum huegelii*, *Conospermum incurvum*, *Dasypogon obliquifolius*, *Eremaea purpurea*, *Hakea myrtoides*, *Isopogon asper*, *Lambertia multiflora* var. *darlingensis*, *Platysace juncea*, *Synaphea pinnata*, *Stylidium crossocephalum* and *Verticordia nitens*. In addition, Keighery and Keighery (1993) and WA Herbarium (1998-) listed records of other significant species in this category in the nearby Talbot Rd Reserve (including *Acacia auronitens*, *Aristida contorta*, *Astroloma macrocalyx*, *Chamaescilla versicolor*, *Cyathochaeta equitans*, *Grevillea endlicheriana*, *Harperia lateriflora*, *Hibbertia commutata*, *Jacksonia restioides* and *Stylidium affine*). This list was used in the targeted flora searches conducted in the current field survey of Lot 102 in addition to the Threatened and Priority Flora list retrieved in the database searches carried out by Emerge (2015a).

The results of the current field survey were analysed after only a single (winter) season of survey. At least two seasons of survey and two or more visits per site are required (EPA, 2004) for a Level 2 (detailed) survey. EPA (2004) states that any constraints or limitations that may influence that may influence the outcomes of flora and vegetation surveys conducted for environmental impact assessment be identified and acknowledged in reporting. This issue was addressed in Section 3.3.

3.1 Field Survey

A detailed field survey of the upland of Lot 102 (and a reconnaissance level survey of the wetland within the block) was carried out over two person days (May 29 and June 12, 2016).

Numerous transects were walked during the two days in the field through the entire area of the upland of Lot 102 to choose quadrat sites, to opportunistically record flora and habitats and ground-truth aerial photographs. The upland vegetation types of Lot 102 were sampled using the bounded quadrat method: a total of 12 quadrats (each 100m² in area) were surveyed in this area. This approach enabled the compilation of a comprehensive flora inventory for the upland, targeted searches of habitat that could potentially harbour rare flora, the mapping of vegetation types (on structure and dominant species), vegetation condition mapping, and data collection in a format suitable for a numerical analysis of the Floristic Community Types (FCTs).

The vegetation structure and vegetation condition scales used in this study (Tables 3 and 4, respectively) were based on those outlined in the Government of W.A. (2000) Bush Forever guidelines.

The vegetation types present were interpreted and ground-truthed using colour aerial photography at a scale of 1: 2,500.

Data recorded in each sampling quadrat:

- Location (GPS coordinates);
- Vegetation structure description using height, foliage projective cover and life-form of the dominant species in each vegetation layer (as per Table 3);
- Maximum height for each vascular flora taxon within the quadrat;
- Abundance of each vascular flora taxon within the site, expressed as foliage projective cover class. [Class n = one small individual or < 0.5% for annual herbs, Class 1 = <2%; Class 2 = 2%-10%; Class 3 = >10% -30%; Class 4 = >30%-70%; Class 5 = >70%];
- Vegetation condition (Table 4)
- Estimated time since last fire (as per Table 5);
- Landform and surface sediments (soils);
- Aspect ; and natural litter and bare ground cover

Table 2: Vegetation Structure

Life Form and Height	Canopy Cover			
	Dense 70% - 100%	Mid - Dense 30% - 70%	Open 10% - 30%	Sparse 2% - 10%
Trees 10-20m	Closed forest	Open forest	Woodland	Open woodland
<10m	Low closed forest	Low open forest	Low woodland	Low open woodland
Shrubs 2-6m	Closed scrub	Scrub	Open scrub	Tall open shrubs
<2m	Closed heath	Heath	Open heath	Low open shrubs
Grasses, herbs rushes or sedges	Closed grasses etc.	Grasses etc	Open grasses etc	Sparse grasses etc.

¹ The mallee life-form is used for eucalypts that are multi-stemmed at ground level and usually less than 10 m in height.

Table 3: Vegetation Condition

Condition	Description of Vegetation
1. Pristine	No obvious signs of disturbance.
2. Excellent	Vegetation structure characteristic of the vegetation type remains intact, disturbance affects individual species only, and weeds are at very low abundance and mainly not highly invasive species.
3. Very good	Vegetation structure altered somewhat; obvious signs of disturbance, but recovering. Some highly invasive weeds may be present at low abundance.
4. Good	Vegetation structure and floristic composition modified significantly by disturbance but ability to regenerate is retained (e.g. recruitment of native species from soil seed bank). Some highly invasive weeds may be present at low to moderate abundance.
5. Degraded	Vegetation structure and floristic composition severely impacted by disturbance; scope for regeneration but not to a state approaching good condition without significant management. Some highly invasive weeds may be present at moderate to high abundance.
6. Completely Degraded	Vegetation structure of all layers no longer intact e.g. isolated native trees or shrubs over understorey almost exclusively composed of weeds ('parkland cleared').
Not Bushland	No native vegetation remaining.

Table 4: Estimates of time since last fire derived from vegetation observations

Time since last fire	Common vegetation attributes after fire in the SCP BioRegion
0-2 years	Vegetation cover & litter usually sparse & bare ground abundant. Dead shrubs, standing or fallen. Some species with distinctive juvenile foliage (e.g. bi-pinnate leaves on phyllodinous wattles) or foliage sprouting from lignotubers or epicormic buds. Species favoured by fire (e.g. <i>Xanthorrhoea</i> & <i>Anigozanthos</i>) may flower most abundantly at one year post-fire. Seedlings of all vegetation layers present (if veg. was in v. good condition pre-fire). Flora may be dominated by native species (or their seedlings) that are favoured by fire (e.g. wattles, annual grasses e.g. <i>Austrostipa compressa</i> , <i>Anigozanthos</i> spp, <i>Calandrinia</i> spp., native daisies or other herbs e.g. <i>Trachymene coerulea</i>); or dominated by weeds.
2-5 years	Vegetation structure altered or regenerating (some species may be denser or shorter than expected). Natural leaf litter- low -moderate. Burn scars & maybe some blackened bark evident on some larger shrubs & trees. Many species not mature yet (i.e. not flowering or fruiting) - count the annual series of fruits on serotinous species or annual branching series. Species composition may resemble the original vegetation or may still be altered due to temporary dominance by the (now thinning) species favoured by fire.
>5years	Vegetation cover as expected for this type of vegetation. Natural leaf litter- moderate-abundant. Most species mature & some flowering/ seeding for the first time since fire. Some deeper burn scars still be evident on trees. Dead trees & tall shrubs may still be emergent from regenerating canopy. Little or no evidence of damage on other layers.
No evidence of recent fire	No burn scars evident. Vegetation mature and some species may be senescent- dead branches. Post fire ephemerals e.g. <i>Anthocercis</i> , <i>Tersoonia</i> , <i>Cassytha</i> , some wattles & peas, some grasses & annuals, may be completely absent & some annuals may be sparse. Natural leaf litter layer usually very low and some bare ground present in good condition bush. Branch litter may be variable or high and may show signs of long term decomposition processes e.g. abundant fungi (in season).

3.2 Analysis of Data

The floristic data of the 12 quadrats sampled in this survey were classified via a multivariate analysis using the R Software Package against the Gibson *et al.* (1994) data obtained in an extensive quadrat-based survey of the SCP ('The SCP Dataset').

To ensure as much consistency as possible, the data collection methods, survey intensity, nomenclature of the flora taxa recorded and analysis methods used in the current survey at Stratton were standardized (as much as possible) to match those of Gibson *et al.* (1994).

The main differences in the methods used between the two studies were:

1. Gibson *et al.* (1994) did not collect abundance data for the taxa in their quadrats whilst the current survey collected abundance data (to enable a more complete description of vegetation type and condition). This difference was overcome by only using the presence/absence data from the current survey in the analysis.
2. The quadrats in the current survey were visited once (in early winter), whilst those of the SCP Dataset were visited at least twice in the main flowering period (e.g. late winter to early spring, and again in mid-to-late spring). This difference between the methods was the only major limitation of the current survey, as discussed Section 3.3.
3. It was necessary to test for any differences in method between the Gibson *et al.* (1994) floristic classification (which used the PATN Software to define a large number of FCTs of the SCP that now form the theoretical basis of most of the TECs recognized in the SCP Bio Region) and the methods of the current multivariate analysis classification using the R Software. Thus a test run was first carried out in the R Software, using only the full SCP Dataset. This analysis confirmed the groupings of sites recovered in the original study and thus it was verified that the R Software (and the statistical

methods used in the current analysis) were comparable to the original methods used in Gibson *et al.* (1994).

4. The botanical nomenclature used in the SCP Dataset 22 years ago was often very different to the current nomenclature of WA Herbarium (1998-). In the current analysis, the names of the taxa recorded in the field survey of Lot 102 were aligned (as accurately as possible) with that of the SCP Dataset. For most names, this involved researching the synonymy of these taxa using WA Herbarium (1998-) and other taxonomic resources (*e.g.* The Australian Plant Names Index).

Unfortunately some of the names of flora taxa in the test datasets often cannot be reliably aligned with names in the SCP Dataset. There are many cases that present taxonomic alignment problems. These include: names not fully determined in the test survey; names not fully determined in the SCP Dataset and outdated names of taxa in the SCP Dataset for which voucher specimens were not lodged in the WA Herbarium and which are thus not available for checking; and unpublished taxa names. Such uncertain names are best removed from both SCP and test datasets as indeterminate taxa ('indets') prior to analysis of the test data.

The FCTs originally derived by Gibson *et al.* (1994) from the SCP Dataset are not a set of immutable standards that all subsequent researchers of the vegetation of the SCP should attempt to 'shoe-horn' their data into in order to gain some understanding of the conservation values of their test sites. Unfortunately most multivariate analyses of FCTs of test sites on the SCP fail to realize that almost always, if a certain mass of new data (even if correctly aligned for taxonomy) is inserted into the SCP Dataset in cluster analysis, it will start to distort the original topology that informed the concepts for FCTs of the SCP (that were developed from the SCP Dataset alone). It is thus important to conduct a number of alternative analyses, using different methods, on test data and compare the results obtained against the ecological setting in which the field data was obtained to begin to overcome some of the shortfalls of our currently insufficient knowledge of the complex vegetation patterns of the SCP.

It may be possible to assign FCTs quickly and easily without a great deal of thought in the future when a sufficient quantity of high quality floristic, structural and abiotic data has been successfully integrated into DPAW databases of the SCP. Meanwhile test sites from the many vegetation types that were not sampled at all (or inadequately) in Gibson *et al.* (1994) and test sites that add to the range of currently defined FCTs will continue to present ambiguity in FCT analysis in the SCP Bioregion.

The methods used in the current analyses were are listed below.

1. Nearest Neighbour Analysis: Bray-Curtis Distance. This was used to compile a dissimilarity matrix to examine the most similar SCP Dataset quadrats for each test quadrat.
2. Hierarchical Agglomerative Clustering: The Complete Linkage method and the Bray-Ward distance coefficient were explored to build dendrograms to explore the relationship of the test quadrats to the SCP Dataset clusters. A number of alternative clustering analyses were carried out:
 - Single Site Insertion (SSI). Each quadrat of the (aligned) test dataset (minus weeds and 'indets') was classified individually (without adding the data from the other 11 test sites) vs. the SCP Dataset

(minus weeds and the same 'indets' as removed from the test dataset) to visualize the effect of each site on the Gibson *et al.* (1994) FCT groupings.

- A series of Multiple Site Insertions of test data to progressively increase the challenge to the integrity of the SCP Dataset clusters was also used.
- A ten site (aligned) test dataset of Lot 102 (minus weeds and 'indets') was inserted into the SCP Dataset (minus weeds and the same 'indets' as removed from the test dataset).
- The Bushmead (nominally FCT20c in English and Blyth, 2000) quadrat bushm02, sourced from Keighery *et al.* (2012) was also aligned and inserted (minus weeds and 'indets') vs. the ten FAR1-FAR-10 test sites and the SCP Dataset (minus weeds and the same 'indets' as removed from the FAR and Bushmead test datasets).

3. Interdisciplinary (Ecological) Interpretation. One of the most powerful tools in understanding FCTs is the informed examination of statistical test results in the light of the ecological settings inhabited by the relevant FCTs of the SCP Dataset and the test sites. The final assignment of FCTs, or decisions to not assign any of the available FCTs of the SCP to test sites, should always aim to integrate both ecological and statistical evidence. The results of both statistical methods (Nearest Neighbour and Clustering) used in the current study to examine FCT relationships were examined against the ecological data from Lot 102 and elsewhere on the SCP to interpret any differences in the results of the statistical methods.

In the SCP, the (now defunct) Perth Biodiversity Project (2010) previously provided some detailed ecological and floristic data from Reference Sites for most of the FCTs of the SCP from the sites where the FCTs were originally defined. These FCT Reference Sites could also be visited to learn more, thus assisting botanists to build the knowledge and judgement required to make valid decisions in FCT assignment. Abiotic and biotic environmental factors (including climate, geology, aspect, topography, regional and fine scale landforms, soil texture and organic matter content, depth to water table, water and soil chemistry, time since last fire, disturbance and inter-species competition) are highly informative with regard to FCT assignment. However the compilation and evaluation of ecological evidence in project areas requires additional time, effort and resources (that are usually not available in commercially competitive EIA projects) to be expended on (interdisciplinary) literature searches, field and laboratory investigations. This additional time and resources is not usually available in commercially competitive EIA projects. Also in such projects, botanists that are commonly deployed for the field component of an assessment, often have little involvement in the taxonomic determinations/ alignments, abiotic assessments or FCT analysis of these projects. The latter tasks are often sub-contracted to other consultants and engineering/IT staff who may have minimal botanical training. Thus much of the on-site information from the project may not be conveyed to the analysts performing the statistical tests. The EPA (2004) guidelines for flora and vegetation surveys states that senior (multi-skilled and experienced) botanists be involved in all aspects of a project; including fieldwork, taxonomy and data analysis. However, in practice, this is rarely the case.

Finally it should be remembered that Floristic Community Type (FCT) is not always the chief or only determinant of a Threatened Ecological Community (TEC). This can clearly be seen in TECS such as

the Muchea Limestone of the SCP TEC (and the Holocene Swales of the SCP TEC) that include a range of floristic assemblages (the full range of which were not sampled in Gibson *et al.*, 1994) however all TECs should be viewed as ecosystems (that encompass the biota, habitats and ecological processes that characterize them) rather than simply floristic assemblages.

3.3 Survey Limitations and Constraints

The EPA (2004) Guidance Statement 51 that currently provides the standards required for Flora and Vegetation Surveys conducted as part of environmental impact assessment in WA, stipulate that consultants should identify and report on factors that may have limited and constrained the validity of their surveys.

The factors recommended to be examined in each survey “as standard” in the limitations section (EPA, 2015) are addressed below with regard to the current survey.

- Availability of contextual information at a regional and local scale: small but significant limitation. Although there were considerable *regional flora* data available (WA Herbarium, 1998-) these were often incomplete as most authoritative surveys (including those carried out by DPAW and its predecessors) sampled only a small subset of the vegetation that was confined to public lands. There is also scientific uncertainty associated with the DPAW data due to incomplete vouchering in the WA Herbarium of taxa recorded in all surveys and many unresolved taxonomic issues that continue to confound vegetation analyses based on these data. These issues will no doubt persist for some time to come due to the huge (but relatively poorly-studied) flora of the hyper-diverse, SCP Bioregion.

The *regional vegetation* data available were less complete than the flora data, as previous vegetation mapping in the region has been confined to structural descriptions (Heddl *et al.*, 1980 Vegetation Complexes) mapped at very broad scales. The only extensive surveys of vegetation at finer scales in the region (Gibson *et al.*, 1994; Markey, 1997 and subsequent DEP and DPAW surveys are all acknowledged as identifying only the higher order Floristic Community Types of the region. They do not adequately scope the large diversity of the vegetation types of the SCP Bioregion. Also these data are confined to point sources (quadrat sites) only and there have been few, if any, published attempts to accurately map the spatial extent of the FCTs defined in these studies, even in the individual reserves where they were first defined.

As with most areas of the SCP in the Perth Metropolitan Region (PMR) there were few pre-existing data of the *flora and vegetation at a local scale*, except those provided Keighery and Keighery (1993), Gibson *et al.* (1994) and Emerge (2015a). The investigation of locally significant remnant vegetation of the PMR based on the Vegetation Complexes (Del Marco *et al.*, 2004 and the Perth Biodiversity Project, 2010) instigated Local Authority biodiversity conservation plans but sourcing such data, if it is available for the City of Swan, was unfortunately beyond the scope of the current study. The current survey aimed to verify the accuracy and validity of Emerge (2015a) and to update the local context of Keighery and Keighery (1993) and Gibson *et al.* (1994).

- Competency/experience of the team carrying out the survey, including experience in the region surveyed: no limitation. The consultant carrying out the current survey was a tertiary-qualified botanist with over 22 years of professional experience (including four years as a Senior Technical

Officer at the WA Herbarium) in plant ecology and taxonomy who has authored a number of peer-reviewed, scientific publications on the flora and vegetation of South-West Western Australia.

- Proportion of flora recorded and/or collected and any identification issues: minor limitation. A small number of species noted in the Survey Area (e.g. some atypical plants of *Acacia sessilis* with longer peduncles than in the type description; sterile *Haemodorum spicatum* and other sterile monocots) required verification in the WA Herbarium. A small number of taxa that were sterile during the season of survey (including *Thysanotus manglesianus/patersonii*, *Cyathochaeta* sp. and *Caesia ?micrantha*) were not able to be reliably determined to the rank of species. Whilst most environmentally significant weeds were noted, a comprehensive weed inventory of the Survey Site was not compiled as this was beyond the scope of the study and not possible due to time and resource constraints.
- Effort and extent (appropriate area fully surveyed): minor limitation. The field survey focussed mainly on the *Banksia* and heath assemblages of the Survey Area as these were central to the main issues under review in this study. The field survey was carried out in a total of two days by a highly experienced botanist who was familiar with most native and weed species in a vegetative state, as they occurred in the Survey Area in winter. This was sufficient to traverse the entire 7.2 ha of the upland area of the Survey Area via transects spaced 20m or less apart, to survey 12 quadrats in the upland and to opportunistically record flora throughout the upland. The 1.6 ha of wetland was traversed via only one transect and the flora species encountered were recorded opportunistically without quadrat sampling. All of the native species recorded in (Emerge, 2015a) in the wetland (except *Aotus gracillima* and *Gastrolobium ebracteolaum*) were also recorded in the current survey and a number of additional records were also made. It was apparent that this wetland included a very distinctive vegetation assemblage that was, most probably, not previously sampled in the SCP Dataset. However it was beyond the scope of the current survey to sample and carry out FCT analysis on this vegetation.

A targeted field search for all potential Threatened and Priority Species recovered in the desktop survey of Emerge (2015a) and for all 'other species of conservation significance' compiled in the current survey from the literature, was carried out. The field survey found a number of the taxa in these categories. A species accumulation curve was constructed for the native taxa recorded in the quadrats used to sample the upland *Banksia* and heath inhabited assemblages of the Survey Area. It was concluded that additional quadrat-based survey (at this time of the year) was not likely to add significantly to the total flora inventory of the upland flora assemblage. However additional quadrat survey in the northern area of Lot 102 may have identified more vegetation in good condition due to the difficulties of mapping such vegetation in the Survey in a winter survey (see also Section 5.2.1.1: Indicators of good to excellent condition bushland in Lot 102)

- Disturbance during survey that may have affected survey e.g. fire, flood or clearing: no limits.
- Suitable timing/weather/season: potentially high limitation. The limited scope of the current assessment, that required high quality data (the equivalent of that resulting from a Level 2 field survey) to be collected in a less-than-optimal season, was the main limitation identified in this study. In general, at least two separate field visits (in appropriate seasons) are required to adequately characterize the species-rich, flora values of the remnant bushlands of the eastern Swan Coastal

Plain in the detail required for multivariate analysis of Floristic Community Type. The field survey of Lot 102 Stratton (that included the detailed survey of 12 quadrats and opportunistic survey of the entire 8.8 ha site) was conducted in a total of only two days in late May and early July. This included only one visit to all of the 12 survey quadrats.

It is an inescapable fact that many native species of the SCP do not germinate until later in winter or in spring. Thus these species would not be detected in an early winter survey. Another cohort of native perennial taxa (particularly most grasses and many other monocots such as sedges, twine rushes and *Lomandra* spp.) and many geophytes (e.g. orchids) do not develop diagnostic vegetative characters, or flowers, until spring or early summer. It is difficult to accurately record and quantify all the taxa (particularly the native grasses and native annuals) that will become more evident in spring (Figure 3).



Figure 3: Large contrast in vegetation of closely matched sites in Lot 102 in spring compared with winter illustrate the potential to underestimate total species –richness in understorey and vegetation condition due to season of survey. (Spring is shown in 3A and 3B, at the peak of the flowering season and early winter in 3C and 3D, when most vegetation is still dormant and sterile after the summer/autumn drought.)

Thus the current survey was likely to have underestimated the general plant biodiversity of the Survey Area and the numbers of species in each quadrat. Also some inaccurate determinations may have been made. Some additional indicator taxa that assist in defining FCTs (e.g. *Neurachne alopecuroidea* and *Thysanotus glaucus* with regard to FCT 20c) are likely to have occurred in the Farrall Rd sites but may have been overlooked in the current survey due to their immaturity and lack of conspicuous parts such as flowers in early winter. Also some inaccurate determinations may have been made. **This limitation should be viewed as a potentially important factor in the influencing the outcomes of the current FCT analysis.**

A mitigating factor to this potential underestimation was the early break of the rainy season in 2016 and the above average rainfall received in the months before the survey.

4. Results: Flora

The DPAW and Commonwealth Department of Environment database searches for Threatened and Priority Flora within a 5 km radius of Lot 102 and for Matters of National Environmental Significance (MNES) in the vicinity of the Survey Area (Emerge, 2015a) retrieved 21 Threatened Flora and 23 Priority Flora taxa as potentially occurring within the search areas. There were eight Threatened Species (*Andersonia gracilis*, *Caladenia huegelii*, *Conospermum undulatum*, *Drakaea elastica*, *Drakaea micrantha*, *Eucalyptus x balanites*, *Synaphea* sp. Pinjarra Plain (A. S. George 17182) and *Thelymitra stellata*) and six Priority Species (*Acacia ridleyana*, *Cyathochaeta teretifolia*, *Isopogon drummondii*, *Picris wagenitzii*, *Stylidium longitubum* and *Thysanotus glaucus*) that were particularly targeted in the current field survey as the significant taxa most likely to occur in the habitats that occurred in the Survey Area.

In addition, the literature search of the current study found another 59 taxa of native 'flora of other conservation significance' (as defined by EPA, 2004), otherwise known as flora species of regional significance, in the Pinjarra Plain and Foothills regional landforms (Keighery and Trudgen, 1992; Keighery and Keighery, 1993; WA Herbarium, 1998-; and Government of Western Australia, 2000) that could potentially occur in the vicinity of Lot 102. These taxa included *Acacia auronitens*, *Aristida contorta*, *Astroloma macrocalyx*, *Blancoa canescens*, *Chamaescilla versicolor*, *Conospermum huegelii*, *Conospermum incurvum*, *Cyathochaeta equitans*, *Dasypogon obliquifolius*, *Eremaea purpurea*, *Grevillea endlicheriana*, *Hakea myrtoides*, *Harperia lateriflora*, *Hibbertia commutata*, *Jacksonia restioides*, *Isopogon asper*, *Lambertia multiflora* var. *darlingensis*, *Platysace juncea*, *Synaphea pinnata*, *Stylidium affine* *Stylidium crossocephalum* and *Verticordia nitens*. These taxa were also targeted in the current field survey.

Government of Western Australia (2000) another 47 taxa of native 'flora of other conservation significance' (after the definition of EPA, 2004) which are otherwise known as flora species of regional significance in the Pinjarra Plain and Foothills regional landforms, that occur in the vicinity of Lot 102, including: *Blancoa canescens*, *Conospermum huegelii*, *Conospermum incurvum*, *Dasypogon obliquifolius*, *Eremaea purpurea*, *Hakea myrtoides*, *Isopogon asper*, *Lambertia multiflora* var. *darlingensis*, *Platysace juncea*, *Synaphea pinnata*, *Stylidium crossocephalum* and *Verticordia nitens*. Keighery and Keighery (1993) and WA Herbarium (1998-) also list records of other significant

species in this category in the Talbot Rd Reserve (including *Acacia auronitens*, *Aristida contorta*, *Astroloma macrocalyx*, *Chamaescilla versicolor*, *Cyathochaeta equitans*, *Grevillea endlicheriana*, *Harperia lateriflora*, *Hibbertia commutata*, *Jacksonia restioides* and *Stylidium affine*).

There were a total of two person days expended in early winter on the current field survey of the 8.8 ha of Lot 102. A total of 106 native flora taxa (and 28 naturalized alien taxa *i.e.* weeds) were recorded in Lot 102 (Appendix B). The most species-rich, native, vascular plant families recorded in the current survey of Lot 102 were the Fabaceae (17 taxa); Myrtaceae (15 taxa); Proteaceae and Haemodoraceae (8 taxa each); and Asparagaceae (7 taxa).

There were 12 quadrats surveyed in detail in the upland vegetation of Lot 102. The total number of species recorded in each of the 10 quadrats in good condition vegetation in the upland of Lot 102 ranged from 19 to 55 taxa per 100m². There was a mean of 38.8 spp. per 100m² in the good condition quadrats. The data from these 12 quadrats was used to investigate the FCT of the vegetation east of the wetland in Lot 102.

At least 20 native plant species recorded in Lot 102 were known forage plants of the EPBC Act-listed (Threatened) Carnabys Black Cockatoo and/or Red-tailed Black Cockatoos (Appendix B). Red-tailed Black Cockatoos were observed in Lot 102 during the current field survey. Major sources of food for Carnabys Cockatoos in Lot 102 included the seeds, flowers and nectar, and invertebrates associated with *Banksia attenuata*, *Banksia menziesii*, *Banksia ilicifolia*, *Banksia dallanneyi*, *Corymbia calophylla*, *Eucalyptus marginata*, *Eucalyptus rudis*, *Eucalyptus todtiana* and *Jacksonia furcellata* (DPAW, 2011, Valentine *et al.*, 2013, Johnston, 2014). However many other native plants are known to be utilized by Carnabys Black Cockatoo. The mature *Banksia* woodland in the mid-north west of Lot 102 was at optimal seral stage (Valentine *et al.*, 2013) for the high production of seeds, an important forage resource for Carnabys Black Cockatoo. The bushland of Lot 102 was assessed as significant habitat for this species given that excessively high cumulative loss of habitat of these birds that has already occurred on the SCP and is further highly threatened.

There were 12 plants of the Priority 3 Species: *Isopogon drummondii* recorded in Lot 102 (Table 5). The location of these plants were mapped (Appendix A: Figure A2) to illustrate the distribution of this species in relation to the vegetation units mapped in Lot 102.

There were also five “other flora species of conservation significance” (Figure 4) as defined in EPA (2004) and otherwise known as flora species of regional significance, recorded by this survey in Lot 102, as listed below.

- *Acacia auronitens*. The occurrence of this low shrub in Lot 102 is a rare, disjunct population outside of its main range north which extends north from Cataby on the Eneabba Sandplain. This wattle was recorded in the species-rich heath of the mid- east, upper slope of the Survey Area where it was not common. It was not flowering at the time of the field survey and thus quite inconspicuous. Prior to the current survey, this species was only known in the Perth Metropolitan Region (PMR) from three locations: Midland Junction, Swan View and the Talbot Rd Nature Reserve. It has been extirpated at the former Midland and Swan View locations by urban development. The remaining extant population of *Acacia auronitens* at Talbot Rd/ Lot 102 Farrall Rd represents a southern range

extension of about 100 km from the only other known location of this species, just south of the Moore River, in the Perth Sub Region.

- *Banksia ilicifolia*. Apart from its occurrence in Lot 102, this tree has been extirpated from the Blackadder- Woodbridge Creek Catchment. It is a keystone species of Banksia woodland because it flowers almost continually throughout the year and thus provides a rare source of nectar to native birds and honey possums that depend on it, at crucial times of the year. It is also a valuable forage species of the Endangered Carnabys Black Cockatoo.
- *Dasypogon obliquifolius*. This low, shrubby, perennial herb is regionally rare in the PMR. The population at Lot 102 and Talbot Rd Reserve is a significant, disjunct population outside of its main range north of the Moore River on the Eneabba Sandplain or, more rarely, the Dandaragan Plateau. In the PMR this species is limited to several populations in small bush remnants on the eastern side of the SCP.
- *Drosera zonaria*. This flat- rosetted, clonal, geophytic herb does not flower very often and is regionally rare in the PMR. Its main range extends from east of the Darling Range, through the Wheatbelt (where it is also uncommon) to Esperance. In the Perth Subregion it is confined to a handful of populations on the eastern side of the SCP, including Hartfield Park and the Alison Baird Flora Reserve in the Brixton St Wetlands. The population in Lot 102 is very significant as this species does not occur in the Talbot Rd Nature Reserve and is thus poorly reserved.
- *Jacksonia restioides*. This small shrub is as re-seeder after fire and is quite abundant in Lot 102 but regionally rare that in the PMR. In the Perth Subregion of the SCP it is confined to a few populations on the eastern side of the SCP where it is at the extreme western edge of its range.

Table 5: Location coordinates: *Isopogon drummondii* individuals

No.	Latitude	Longitude
1	-31.878760°	116.034790°
2	-31.878740°	116.034780°
3	-31.878720°	116.034760°
4	-31.878640°	116.035040°
5	-31.878430°	116.034950°
6	-31.877130°	116.034860°
7	-31.876910°	116.034650°
8	-31.876910°	116.034640°
9	-31.876230°	116.034710°
10	-31.876150°	116.034590°
11	-31.876170°	116.034550°
12	-31.874660°	116.034180°



4A. *Drosera zonaria*. Few populations extant in PMR, none in Talbot Rd Reserve, most in eastern SCP.



4B. *Isopogon drummondii* (Priority 3). Restricted to few small populations, Ridge Hill Shelf landform



4C. *Acacia auronitens*. In Lot 102 this is part of the Talbot Rd Reserve population, only extant population in PMR.



4D. *Jacksonia restioides* in Lot 102 is part of Talbot Rd Reserve population, few in PMR, all eastern SCP.



4E. *Banksia ilicifolia* a keystone species now extirpated elsewhere in B-W catchment.



4F. *Dasypogon obliquifolius* in Lot 102 is part of Talbot Rd population, one of the few in PMR, all in eastern SCP.

Figure 4: Native flora species of other conservation significance (after definition of EPA, 2004) in the Forrestfield Vegetation Complex Vegetation of Lot 102. [4A. Photo: C T, 2016. 4B. Photo: PC, 2015. 4C. Photo: B. Maslin, WorldWideWattle. 4D. Photo: PC, 2015. 4E. Photo: PC, 2015. 4F. Photo: Atlas of Living Aust, 2016].

Prior to urban development, the contiguous bushland of the Ridge Hill Shelf landform between the Jane Brook and Helena River (now all cleared of native vegetation except for the Talbot Rd Reserve and Lot 102) linked these two areas in a long, shared evolutionary history. Thus the flora species shared by these two areas today (such a *Acacia auronitens*, *Dasypogon obliquifolius*, *Isopogon drummondii*, *Jacksonia restioides* and many more common species) evolved as single geographical populations. They remain today as single genetic populations, although recently split geographically into two parts by intervening development. Most of these uncommon species of the SCP are limited to the eastern side of the plain SCP. Thus in Lot 102 the recording of these species give an early indication, independent of FCT analysis, that Lot 102 is part of the rare Forrestfield Vegetation Complex and of FCT 20c, as in the Talbot Rd Reserve.

A species accumulation curve was constructed for the Survey Area quadrat data of the current survey (Figure 5). This curve showed the increase in cumulative species (taxa) number against the survey effort (the number of quadrats sampled). In the field survey, the total number of taxa recorded in quadrats (101) was about 75% of the taxa recorded in the entire survey. The current survey recorded many more native species in the upland of Lot 102 than were recorded in the survey of Emerge (2015a). There were only two native species (*Austrostipa elegantissima*, a showy grass most evident in early summer and *Levenhookia stipitata*, a tiny annual species only evident in spring) recorded by Emerge (2015a) in the upland of Lot 102 that were not recorded in the current survey. Considering that the Bush Forever Area 309 was not sampled in quadrats due to the limited scope of the survey, and that there was a levelling of the species accumulation curve after eight quadrats, the quadrat survey effort of the current study was considered adequate.

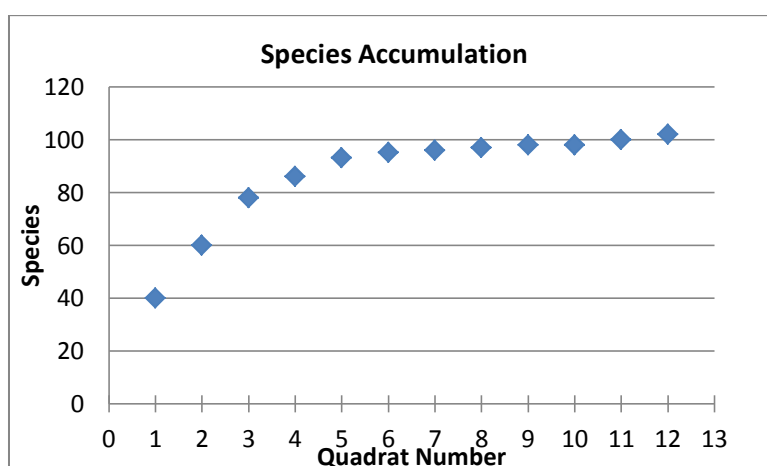


Figure 5: Species accumulation curve for quadrats FAR-1 to FAR-12 in Lot 102

5.0 Results: Vegetation

5.1 Desktop Vegetation Survey

The Australian Government Department of Environment (DoE) and the WA Department of Parks and Wildlife (DPaW) list ecosystems that are rare and subject to threats as Threatened Ecological Communities (TECs). TECs are assessed and determined by DoE and DPaW under the same ecological principles (David *et al.*, 2013) used for Red List Ecosystems by the International Union for the

Conservation of Nature (IUCN, 2015). The most common categories under which Western Australian TECs are listed are: Critically Endangered, Endangered, or Vulnerable.

The Australian Government Department of Environment assesses the TEC proposals referred to it (by DPaW, and in more recent years, by community groups such as Gondwana Link and the Urban Bushland Council) and then lists those nominations that comply with the international criteria as TECs (Matters of National Conservation Significance) under the EPBC Act, 1999.

Threatened Ecological Communities do not have the same statutory protection as Threatened Species under Western Australian Wildlife Conservation Act 1950. TECs listed by DPaW require endorsement by the Western Australian Minister prior to their nomination to DoE for listing and protection under the EPBC Act.

The Western Australian Department of Parks and Wild life (DPaW) maintains a database of TECs and Priority Ecological Communities (PECs). The Priority Ecological Communities have been endorsed by the Western Australian Threatened Species and Communities Scientific Committee as meeting the criteria for TECs but are, as yet, to be endorsed as TECs by the Environment Minister of Western Australia. The PECs are grouped into four categories (Priority One, Priority Two, Priority Three and Priority Four). Priority Ecological Communities have no statutory protection under either WA State or Commonwealth legislation.

A search of the DoE and DPaW databases for TECs and PECs within a 10km radius of Lot 102 Farrall Rd was conducted by Emerge (2015a) records of three TECs listed under the EPBC Act; and five TECs (and one PEC) listed only by DPaW (Table 6). Three of the TECs (FCT20a, FCT20b and FCT 20c) that are most relevant to the Ridge Hill Shelf setting of the upland of Lot 102 are discussed below.

1. TEC–FCT 20a: This FCT was first recovered by Gibson *et al.* (1994) in the floristic classification of the SCP Dataset. It was the most species-rich, *Banksia* woodland FCT of the SCP Dataset with a mean species-richness of 67.4 spp. per 100 m². However this TEC was characterised by Gibson *et al.* (1994) on the basis of only five occurrences. More occurrences have been found recently.

Table 6: Threatened Ecological Communities within 10km of Lot 102 (database search results)

FCT	Name of TEC	DPaW: TEC/PEC	EPBC Act: TEC
SCP 3a	<i>Corymbia calophylla</i> - <i>Kingia australis</i> woodlands on heavy soils, Swan Coastal Plain	TEC: Critically Endangered	Endangered
SCP 3c	<i>Corymbia calophylla</i> - <i>Xanthorrhoea preissii</i> woodlands and shrublands, Swan Coastal Plain	TEC: Critically Endangered	Endangered
SCP 20a	<i>Banksia attenuata</i> woodlands over species-rich, dense shrublands	TEC: Endangered	
SCP 20b	<i>Banksia attenuata</i> and/or <i>Eucalyptus marginata</i> woodlands of the eastern side of the Swan Coastal Plain	TEC: Endangered	
SCP 20c	Shrublands and woodlands of the eastern side of the Swan Coastal Plain	TEC: Critically Endangered	Endangered
5 (Markey, 1997)	Central Northern Darling Scarp Granite Shrubland Community	PEC: Priority 4	

However the TEC of FCT 20a was characterised by Gibson *et al.* (1994) on the basis of only five occurrences. More occurrences have been found recently. This TEC appears to have a bi-modal distribution on the SCP with more occurrences in the Spearwood Dunes than in the eastern SCP

(Pinjarra Plain and Foothills). The relationship between the vegetation currently considered as FCT 20a in these diverse settings remains unclear (Tauss and Associates, 2015).

The settings inhabited by FCT 20a are listed below (with the names of the Gibson *et al.*, 1994 sites in which they were recorded are explained below).

1. Deep, well drained, quartz sand (aeolian Spearwood Sands) on the Spearwood Dunes (Karrakatta Central and South Vegetation Complex). Occurrences were recorded at Landsdale Farm School (LAND-1), Marangaroo Golf Course (GOLF-1) and the Koondoola Regional Bushland (KOON-1, KOON-2) in the City of Wanneroo. A number of other known occurrences were later found at Mariginiup (Tauss, 2009), Malaga to Gngara (DPAW, unpublished data) and Dianella (Tauss and Associates, 2015).
2. Deep, well drained, quartz sands (aeolian Bassendean Sands or Foothills colluvial deposits) over the Guildford Formation (Southern River Vegetation Complex) or Ridge Hill Shelf (Forrestfield Vegetation Complex) with occurrences (respectively) at Dundas Rd (M53) and the Agriculture Protection Board Facility (APBF-1, APBF-2) in Forrestfield in the Shire of Kalamunda. FCT 20a in this setting was also later recorded on the Ridge Hill Shelf at Sultana Rd West Bushland, Welshpool Rd Bushland, Maida Vale Reserve, Hawkevale Bushland and Bushmead Bushland; and at Pioneer Park, Forrestfield and Queen Park Bushland (Government of W.A., 2000).

Species that were present with high consistency (*i.e.* in 50% or more of the sites sampled in Gibson *et al.*, 1994) in FCT 20a of the Spearwood Dunes were *Alexgeorgea nitens*, *Amphipogon turbinatus*, *Banksia attenuata*, *Bossiaea eriocarpa*, *Burchardia congesta*, *Allocasuarina humilis*, *Conostephium pendulum*, *Cyathochaeta equitans*, *Dampiera linearis*, *Daviesia nudiflora*, *Daviesia triflora*, *Drosera menziesii* subsp. *penicillaris*, *Eremaea pauciflora*, *Hemiandra pungens*, *Hibbertia huegelii*, *Hypolaena exsulca*, *Lomandra hermaphrodita*, *Mesomelaena pseudostygia*, *Monotaxis grandiflora*, *Patersonia occidentalis*, *Petrophile linearis*, *Philothea spicata*, *Scaevola repens*, *Schoenus curvifolius*, *Stirlingia latifolia*, *Stylidium araeophyllum/neurophyllum*, *Stylidium calcaratum*, *Stylidium piliferum*, *Synaphea spinulosa* and *Xanthosia huegelii*.

The eastern SCP (on aeolian Bassendean Sands or colluvial Forrestfield Sands) included additional species that never occur in the more calcareous Spearwood Sands sites. Since only a few eastern SCP occurrences were sampled in Gibson *et al.* (1994), the species of high consistency for the latter were not included in the overall list of species of high consistency for this FCT. Such species included *Conospermum undulatum*, *Dasypogon obliquifolius*, *Isopogon drummondii*, *Lambertia multiflora* var. *darlingensis* and *Mesomelaena tetragona*.

The FCT20a sites of the Eastern Swan Coastal Plain of the SCP Dataset were shown to have a closer floristic affinity to the FCT 20b and FCT 20c sites of the SCP Dataset than with the Spearwood Dunes FCT20a sites of the SCP Dataset (Tauss and Associates, 2015). In this multivariate analysis, 21 additional FCT 20a test sites from the Spearwood Dunes were inserted into the SCP Dataset for cluster analysis. As a result, the three SCP 20a sites of the eastern SCP (M53, APBF.1, and APBF.2) of the SCP Dataset, clustered with seven other sites of the SCP dataset (card1, card2, card5, card6, brick2, talb8 and talb9) rather than with the four Spearwood Dunes FCT 20a sites of the SCP Dataset. The seven sites (card1, card2, card5, card6, brick2, talb8 and talb9) that clustered with M53, APBF.1, and APBF.2 were part of the Forrestfield Vegetation Complex and were located at Cardup, Byford

and Talbot Rd Reserve on the eastern SCP; they were all classified in Gibson *et al.* (1994) as either FCT 20b or FCT 20c.

The breakup of the original SCP Dataset FCT 20a cluster (that included both Spearwood Dunes and eastern SCP sites) only occurred when data of multiple Spearwood Dunes test sites (that individually clustered with FCT 20a in Single Site Insertions into the SCP Dataset) were inserted as a group (Multiple Site Insertion) into the SCP Dataset for floristic classification. This breakup of the SCP Dataset FCT 20a cluster was a logical outcome consistent with the relative paucity in the SCP Dataset of Eastern SCP FCT 20a sites and the clear floristic differences between the Spearwood Dunes and Eastern SCP FCT 20a occurrences evident in Gibson *et al.* (1994).

FCT 20b and FCT 20c (Gibson *et al.*, 1994); two rare and species-rich *Banksia* woodland types of the Forrestfield Vegetation Complex in the Foothills of the eastern Swan Coastal Plain are discussed below.

b. FCT 20b: This vegetation was described as “*Banksia attenuata* and/or *Eucalyptus marginata* woodlands of the eastern side of the Swan Coastal Plain” (Gibson *et al.*, 1994). It is a DPaW listed (Endangered) TEC that occurs in the Forrestfield Vegetation Complex (on deep colluvial sands) of the Ridge Hill Shelf or in the Southern River Vegetation Complex (on deep Bassendean Sands overlying the Guildford Formation) at the base of the Darling Scarp. It usually comprises a low *Eucalyptus marginata*-*Banksia attenuata* canopy over a species-rich shrub layer that includes *Hakea stenocarpa*, the perennial herb *Conostylis setosa* and the sedge *Mesomelaena pseudostygia*.

The sites from which FCT 20b was described in Gibson *et al.* (1994) were: BRICK2 (in the Brickwood Reserve and Adjacent Bushland, BFA at Byford), BURND01 (Burnside Road Nature Reserve, 15 km ESE of Pinjarra) and CARD1, CARD2, CARD5, CARD6, CARD8 and CARD9 (Cardup Nature Reserve and Adjacent Bushland, BFA at Cardup) and YARL04 (Yarloop). All of these sites, except BURND01, were located in the eastern SCP on the Ridge Hill Shelf. BURND01 was in the eastern SCP on the Pinjarra Plain.

a. FCT 20c: This vegetation was described as “Shrublands and woodlands of the eastern side of the Swan Coastal Plain” (Gibson *et al.*, 1994). It is an EPBC Act-listed TEC (Endangered) that occurs that occurs in the Forrestfield Vegetation Complex (on deep colluvial sands) of the Ridge Hill Shelf and also extends marginally onto the adjacent Swan Coastal Plain. It occurs as a shrubland or a woodland of *Banksia attenuata* and *Banksia menziesii*, sometimes with *Allocasuarina fraseriana*, over a low shrub layer that may include *Adenanthos cygnorum*, *Allocasuarina humilis*, *Bossiaea eriocarpa*, *Hibbertia huegelii*, *Isopogon drummondii*, *Lambertia multiflora* var. *darlingensis*, *Scaevola repens* var. *repens*, *Allocasuarina humilis*, *Bossiaea eriocarpa*, *Hibbertia hypericoides* and *Stirlingia latifolia*. A suite of herbs including *Burchardia congesta*, *Conostylis aurea*, *Lomandra hermaphrodita*, *Patersonia occidentalis* and *Trachymene pilosa*; and the sedges *Mesomelaena pseudostygia* and *Lyginia barbata* usually occurs in the community. The weeds **Gladiolus caryophyllaceus* and **Ursinia anthemoides* are also common.

Thus FCT was described from Keighery and Keighery (1993) and Gibson *et al.* (1994) from sites: talb2, talb3, talb5, taln6, talb7, talb8, talb 9, talb10 and talb11 (in the Talbot Rd Nature Reserve and Adjacent Bushland, BFA at Stratton/ Swan View) and was later recorded (DEP, 1996) at a second

occurrence (in site bushm02) at the Bushmead Bush Forever Area in Hazelmere (English and Blyth 2000). Both occurrences are located on the Ridge Hill Shelf. The Talbot Rd occurrences had a mean species richness (including weeds) per 100 m² of 64, whilst the Bushmead occurrence was more degraded with species richness (including weeds) per 100 m² of 31.

It was concluded in Tauss and Associates (2015) that further study (by the survey and multiple insertion of more eastern SCP and Ridge Hill Shelf sites into the SCP Dataset) would probably yield interesting insights into the very close relationships of the Gibson *et al.* (1994) FCT 20a, FCT 20b and FCT 20c sites of the eastern SCP to each other. It may be appropriate, after further study, to amend the nomenclature of the FCT 20a sites of the eastern SCP, FCT 20b and FCT 20c to reflect their unique ecological and evolutionary history in this area which is the oldest part of the SCP.

5.2 Field Vegetation Survey

5.2.1 Vegetation Units and Vegetation Condition

The vegetation of Lot 102 was sampled in detail in 12 x100m² quadrats in the upland (dune) and also opportunistically along transects throughout the entire area (including the wetland of BFA 309). There were five structural vegetation units (Figure 6) mapped in Lot 102 (Appendix A: Figure A2) by ground truthing the photo-tones of colour aerial photographs, comparing the ground truthing notes to data collected in quadrats (Appendix C) and on transects, and then extrapolating from the areas verified.

The condition of the vegetation in the *five structural vegetation units* of Lot 102, as listed below, varied from excellent to completely degraded *i.e.* 'parkland cleared' (Appendix A: Figures A2 and A3; Figure 7).

1. **Bm-srh:** *Banksia menziesii* low open woodland over species- rich open heath ; over open rushes and sedges, and species- rich perennial herbs (Figure 6A). This unit also occurred in Lot 102 as a species-rich, open heath formation on white to grey, well-drained colluvial quartz sand (Forrestfield Soil 213Fo__Ff1).

Common associates of this vegetation included: *Acacia applanata*, *Acacia auronitens*, *Acacia huegelii*, *Acacia sessilis*, *Adenanthos cygnorum*, *Amphipogon turbinatus*, *Arnocrinum preissii*, *Banksia attenuata*, *Banksia dallanneyi* subsp. *dallanneyi*, *Burchardia congesta*, *Caladenia flava* subsp. *flava*, *Calytrix angulata*, *Chamaescilla corymbosa*, *Chordifex sinuosus*, *Conostephium pendulum*, *Conostylis aculeata*, *Conostylis aurea*, *Corynotheca micrantha* var. *micrantha*, *Dampiera linearis*, *Dasypogon bromeliifolius*, *Dasypogon obliquifolius*, *Desmocladus fasciculatus*, *Drosera macrantha* subsp. *macrantha*, *Drosera menziesii* subsp. *penicillaris*, *Drosera zonaria*, **Ehrharta calycina*, *Eremaea pauciflora* var. *pauciflora*, *Gompholobium tomentosum*, *Haemodorum laxum*, *Hemiandra pungens*, *Hibbertia hypericoides*, *Hypolaena exsulca*, *Isopogon drummondii*, *Jacksonia floribunda*, *Jacksonia furcellata*, *Jacksonia restioides*, *Leporella fimbriata*, *Lomandra caespitosa*, *Lomandra hermaphrodita*, *Lomandra spartea*, *Lyginia barbata*, *Lyginia imberbis*, *Macrozamia fraseri*, *Melaleuca trichophylla*, *Mesomelaena pseudostygia*, **Monoculus monstrosus*, *Patersonia occidentalis*, *Phlebocarya filifolia*, *Podotheca gnaphalioides*, *Trachymene pilosa*, *Scaevola repens* var. *repens*, *Schoenus caespititius*, *Scholtzia involucreta*, *Stirlingia latifolia* and *Verticordia densiflora*.

This vegetation varied from degraded to excellent condition and it inhabited most of the mid- to upper slope of white quartz sand on the dune of Lot 102, between Farrall Rd and the railway. The vegetation in very good to excellent condition coincided with areas of minimal soil disturbance in the south-east of Lot 102 and also in the mid north-east of the block. It was remarkably free of the naturalized alien cormous species that have invaded much of Perth's bushlands and are some of the most difficult weeds to control in such situations. Any dead *Banksia* trees that were probably due to recent drought years, not dieback, as juvenile *Banksia* trees were usually recruiting well around these sites.

It was difficult in the current season of survey to quickly choose locations suitable to sample the 'low shrubland form' of this vegetation in quadrats and to map the condition of this unit in the mid north-east of Lot 102. In early winter, the dormant Perennial Veldt Grass tufts that inhabited this area, when viewed from a distance, often obscured an abundant cover and species-richness of dormant native taxa. Further detailed sampling of quadrats in this vegetation in spring may be informative.

Mp: *Melaleuca preissiana*- *Eucalyptus rudis* low closed forest over mid-dense to dense *Dielsia stenostachya*-*Cyathochaeta* ?*avenacea* rushes and sedges (Figure 6B). Common associates of this vegetation included: *Acacia saligna*, *Astartea scoparia*, *Burchardia* sp., *Caesia* ?*micrantha*, *Corymbia calophylla*, *Drosera* sp., *Hibbertia racemosa*, *Hypocalymma angustifolium* subsp. SCP (GJK 16777), *Jacksonia furcellata*, *Kennedia prostrata*, *Melaleuca raphiophylla*, *Microlaena stipoides*, *Phlebocarya ciliata*, *Pterostylis sanguinea*, *Viminaria juncea* and *Xanthorrhoea brunonis*.

This area of wetland comprises Bush Forever Area 309. The vegetation was in very good to excellent condition and it inhabited a seasonally waterlogged flat (palusplain) of black sandy peat/ peaty sand over muddy sand and clay (Guildford Formation soil 213Pj__Gf3) at the base of the dune (in the far south west corner of Lot 102) immediately adjacent to Farrall Rd. The trunks of the Modong paperbark trees were still blackened from a cool fire in 2010. This wetland may have been prescribed- burnt at regular intervals but there are few or no signs of excessive fire in most of the wetland. The species richness is high for this type of vegetation and the vegetation structure remains undisturbed, except adjacent to Farrall Rd where there is an early stage weed invasion by *Watsonia* sp. in small localized areas. Soil disturbance in this unit was minimal apart from occasional small pit made by native Quenda. Nutrient enrichment was not evident, judging by the healthy dense stands of the native rush *Dielsia stenostachya* (highly sensitive to the adverse effects of nutrient enrichment) that dominated the understorey in most of this wetland. There were however several large dead or dying *Eucalyptus rudis* trees at the southern extreme of this vegetation that appear to have been disturbed due to recent work in the area associated with the proposed development.

3. Bi-m-a: *Banksia ilicifolia*- *B. menziesii*- *B. attenuata* low open woodland to woodland; over patchy scrub to tall open shrubs, low open shrubs, sparse to open native perennial herbs, and open to mid-dense naturalized alien grasses (Figure 6C & 6D). Common associates included *Acacia huegelii*, *Adenanthos cygnorum*, *Banksia attenuata*, *Banksia menziesii*, *Billardiera fraseri*, *Conostephium pendulum*, *Conostylis aurea*, *Dasypogon bromeliifolius*, *Drosera zonaria*, **Ehrharta calycina*, *Eremaea pauciflora* var. *pauciflora*, *Eucalyptus todtiana*, *Gompholobium tomentosum*, *Haemodorum spicatum*, *Hemiandra pungens*, *Hibbertia hypericoides*, *Jacksonia floribunda*, *Jacksonia furcellata*, *Jacksonia sternbergiana*, *Macrozamia fraseri*, *Phlebocarya ciliata*, *Podotheca*

gnaphalioides, *Scholtzia involucrata*, *Stirlingia latifolia*, *Thelymitra crinita*, *Thysanotus sparteus* and *Xanthorrhoea brunonis*.

This vegetation was patchy and varied from good to degraded condition. It inhabited shallow humic quartz sand (213Fo__Ff1 over 213Pj__Gf3) with a relatively high water table in spring that occurred on the lower slope of the dune in the mid-west area of Lot 102 (adjacent to Farrall Rd).

The good condition understorey of this unit was of moderate species richness and it was usually located on undisturbed soil in close proximity to clumps of healthy mature *Banksia* trees surrounded by tall open shrubs or scrub of native species and abundant, recently- recruited juvenile *Banksia*. This naturally regenerating *Banksia* vegetation formed a fine-scale mosaic with adjacent mid-dense stands of naturalized alien grasses on the more disturbed soils.

4. Cc: *Corymbia calophylla* (Marri) woodland to open forest <20m; over tall open shrubs and mid-dense grasses naturalized alien grasses and herbs (Figure 6E). Common associates of this vegetation included *Acacia saligna*, *Adenanthos cygnorum*, **Arundo donax*, **Chamaecytisus palmensis*, **Ehrharta calycina*, *Gompholobium tomentosum*, *Jacksonia furcellata*, *Jacksonia sternbergiana*, **Leptospermum laevigatum*, **Oxalis pes-caprae* and *Xanthorrhoea preissii*.

This vegetation inhabited shallow, re-worked sand (and other materials) over muddy alluvium (213Pj__Gf3) in the north of Lot 102 associated with Blackadder Creek and was almost contiguous with the remnant woodland along the creek. The soils of this area were obviously disturbed due to the various earthworks carried out for road and rail construction in the past and the understorey was dominated by naturalized alien grasses and herbs. However this vegetation had a healthy canopy that included a number of very old, tall trees, native avifauna habitat trees and a tall shrub layer that included both native and naturalized alien tall shrubs.

5. Em-Et-Af: *Eucalyptus marginata*, *E. todtiana* and *Allocasuarina fraseriana* trees in a 'parkland cleared' setting over open to mid-dense **Ehrharta calycina*, **Eragrostis curvula*, **Melinis repens* and other naturalized alien grasses, or bare sand. Common associates of this vegetation included *Adenanthos cygnorum*, *Dasypogon bromeliifolius*, *Jacksonia furcellata*, *Jacksonia sternbergiana*, *Lyginia barbata*, *Macrozamia fraseri* and *Xanthorrhoea preissii* (Figure 6F). This vegetation inhabited most of the area of Lot 102 that was not occupied by Vegetation Unit 1 (above) on white colluvial quartz sand (Forrestfield soil **213Fo__Ff1**.) It was most prevalent in the mid-west area, north of the wetland of Lot 102 where historical photographs indicated old tracks and the dumping of soils associated with the construction of the railway in the early 1960s. Although this vegetation was classed as completely degraded bush (disturbed soil and species-poor, weed invaded understorey) it included many healthy, large native trees, cycads & grass trees. Patchy stands of tall native shrubs provided native avifauna habitat. One of the *Eucalyptus todtiana* (Figure 6F) located near the BFA 309 (31° 52.692'S; 116° 2.057'E) was a rare and exceptional example of this species. This healthy mature *Eucalyptus todtiana* had a tree habit (single trunk at ground level) rather than the mallee habit (multiple trunk) that is usually the norm for this species. It was more than 16m in height, thus it was probably the tallest example of this species remaining in the Perth Metropolitan Region (Marchant *et al.*, 1987). This tree should be nominated to the Significant Tree Register of the National Trust and given special protection and management in the current development.



6A. Bm-srh Low open *Banksia* woodland, species-rich open heath & rushes, sedges, native herbs. White sand, upper slope. [Photo PC 2015]



6B. Mp *M. preissiana* low, closed forest over dense native rushes & sedges. Peaty sand over clay in BFA 309 palusplain [Photo PC, 2007]



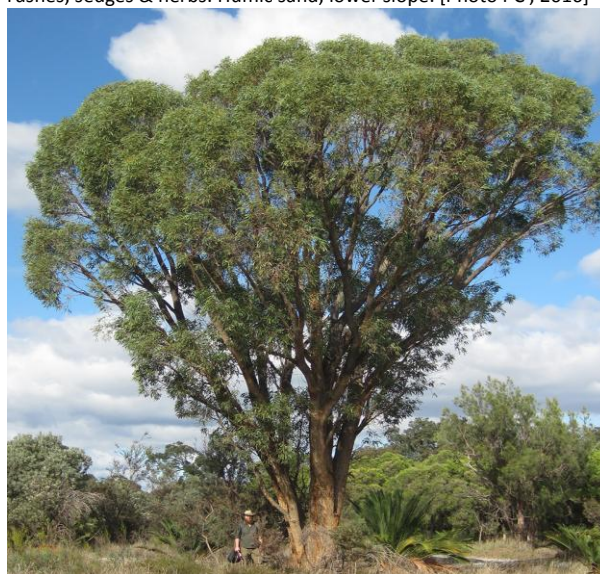
6C. Bi-m-a Mature *Banksia ilicifolia*- *Banksia* spp. woodland <12m over native scrub, low open shrubs, open alien grasses, sparse rushes, sedges & herbs. Humic sand, lower slope, SCP FCT21c (PEC)



6D. Bi-m-a Naturally regenerating *Banksia* spp. low woodland, low & tall open shrubs to patchy scrub, open alien grasses, sparse native rushes, sedges & herbs. Humic sand, lower slope. [Photo PC, 2016]



6E. Cc *Corymbia calophylla* open forest- woodland <20m over tall open shrubs on the alluvial soils associated with Blackadder Creek.



6F. Et-Em-Af Outstanding and unusual tree form of *Eucalyptus totidiana* (> 16m) in 'parkland cleared' bushland, near BFA309.

Figure 6: Vegetation units illustrating the range of structural/floristic elements and habitat diversity in Lot 102

Indicators of good to excellent condition bushland in Lot 102

- Moderate to high native species richness, up to 55 taxa per 100m² in some areas.
- The absence in about 95% of the bushland (and very low abundance elsewhere) of cormous/bulbous/tuberous weeds (e.g. **Asparagus asparagoides*, **Romulea rosea*, **Sparaxis* sp. and **Watsonia* spp.) that usually seriously threaten Perth's urban bushlands.
- No indicators of recent fire in the upland areas. High biomass of the patchy shrub thickets to about 3m was good shelter for native avifauna from predators, floral biodiversity of the understorey provided a variety of food resources for birds, reptiles and invertebrates and low layers of natural leaf and wood litter (unburnt for many years), and small naturally bare patches of sand (not colonized by weeds as they are in poor condition bushland) were also excellent fauna habitat values.
- Structural complexity and integrity in most of the vegetation (i.e. the multiple vegetation layers expected in this type of bush were intact, species-rich and healthy). The tree layer in the low-lying *Banksia* **Bi-m-a** unit, in particular, was healthy and luxuriant indicating the integrity of the shallow proteoid root zone around the *Banksia* trees and good water supply.
- The soil integrity retained around 'islands' of adult *Banksia* trees in the **Bm-srh** unit and **Bi-m-a** vegetation, bordering degraded vegetation. These islands were marked by native plants within them regenerating naturally, despite the adjacent narrow linear corridors of disturbed soil and more dense weedy grasses such as **Ehrharta calycina* (Figure 7) . The islands were noted as retaining significant soil seed banks of native species in the undisturbed soil around clumps of parent trees where an unexpected high rate of juvenile *Banksia* recruitment from seed and a number of native re-seeder shrubs (including *Acacia applanata*, *Acacia huegelii*, *Billardiera fraseri*, *Boronia ramosa*, *Calytrix angulata*, *Daviesia triflora*, *Eremaea pauciflora*, *Gompholobium tomentosum*, *Hibbertia huegelii*, *Hibbertia racemosa*, *Hovea trisperma*, *Isopogon drummondii*, *Jacksonia floribunda*, *Jacksonia furcellata*, *Jacksonia restioides*, *Jacksonia sternbergiana*, *Kennedia prostrata*, *Melaleuca trichophylla*, and *Scholtzia involucrata*) and perennial herbs (including *Arnocrinum preissii*, *Conostylis aculeata*, *Conostylis aurea*, *Hypolaena exsulca*, *Lomandra* spp., *Phlebocarya ciliata* and *Thelymitra crinita*) were recruiting. This was unusual as in most Perth bushlands impacted by soil disturbance and **Ehrharta calycina* proliferation, it is usually mainly the hardy re-sprouter species that survive. This indicated that Lot 102 may have escaped some of the multiple and frequent disturbances (logging, clearing, grazing and fire) that characterize many of Perth's urban bushlands.

The assessment of vegetation condition in upland Lot 102 during the current winter survey required more time and attention to detail at a fine scale than is usually required. This was due to a number of tree islands, as explained above, that from a distance might have been considered in degraded condition but which, on closer viewing, proved that the natural regeneration which is the hallmark of good condition bushland (Table 3) in Government of WA (2000) was operating. More time should have been allowed in the current survey to more accurately map the condition of such areas in the current survey.



Figure 7: Naturally regenerating islands of good condition *Banksia* low woodland, vegetation units **Bm-srh** (left) & **Bi-m-a** (right), despite intervening linear areas of higher soil disturbance & more dense weedy grasses.

5.2.2 Floristic Community Type Analyses

The upland vegetation sampled in the field survey as quadrats (Appendix C: Quadrats 1-12) was classified using numerical multivariate analyses of the floristics and then evaluating the results against ecological evidence from field observations in each vegetation unit.

The wetland vegetation unit (**Mp**) in BFA 309, the Marri vegetation unit (**Cc**) and the parkland cleared vegetation (**Et-Em-Af**) of Lot 102 were not sampled as quadrats and were thus not included in the floristic classification. The floristic classification of the vegetation of BFA309 was beyond the scope of the current study. The Marri and the parkland cleared vegetation units were not amenable to floristic classification due to their depauperate native understorey composition.

The botanical nomenclature of the taxa recorded in the 12 x Lot 102 quadrats in the current survey (test dataset) was aligned with that of the Gibson *et al.* (1994) SCP Dataset after the removal of all weed names from both datasets. The native taxa (*Thysanotus patersonii* / *manglesianus*) that could not be reliably identified to the rank of species in the current survey were also removed from the test data (Appendix D: Table D1) and the SCP Dataset before further analyses was carried out.

a. Nearest Neighbour Analysis

The Nearest Neighbour Analyses (Appendix D; Tables D2-D15) based on Bray Curtis Dissimilarity showing the three nearest neighbours for each FAR site and bushm02 (Table 9) found:

- All the test dataset quadrats of the **Bm-srh** vegetation unit in upland Lot 102 in good condition or better (FAR-1, FAR-2, FAR-3, FAR-4, FAR-5, FAR-6, FAR-8, FAR-10 and FAR-11) had **FCT 20c** quadrats of the Talbot Rd Reserve (talb7, talb3, or talb11) of the SCP Dataset as their Nearest Neighbour.

Most of these sites (FAR-1, FAR-2, FAR-3, FAR-4, FAR-5, FAR-8 and FAR-11) also had FCT 20c as their two nearest neighbours, and three (FAR-1, FAR-4 and FAR-8) had FCT 20c as all three nearest neighbours. The other sites that formed third nearest neighbours with FAR-2, FAR-3, FAR-5, FAR-6, FAR-7 and FAR-sites were FCT 20a site M53 FCT23a sites WHITE-1 and BULL-3 of the SCP Dataset.

[Note: M53, BULL-3 & WHITE-1 also clustered more closely to the FCT 20c sites of the SCP Dataset (than they did in Gibson *et al.*, 1994) when FAR data was inserted in to the SCP Dataset (Section 5.2.2.2 below). The M53 FCT 20a site clustered within the FCT 20c cluster when several of the FAR single site insertions were made into the SCP Dataset. The FCT23a sites WHITE-1 and BULL-3 consistently clustered with the FCT 20a sister group of FCT 20c when FAR sites were inserted into the SCP Dataset.]

- The **FAR-12** quadrat had **FCT 21c** of the SCP Dataset as all three Nearest Neighbours

FL-5 and FL-6 were eastern SCP sites (at Forrestdale Lake Nature Reserve) on low lying, quartz sand dunes over Guildford Formation, east of the lake. DEJONG-c was a similar site in Dennis de Young Reserve west of Forrestdale Lake. The vegetation of FL-5, DEJONG-c and FL-6 is mapped as Southern River Complex; the FAR-12 site is mapped as Guildford Complex (Government of WA, 2000). Each of the four sites are located on the lower slope of a quartz sand dune over the Guildford Formation.

The more degraded species-poor quadrats of Lot 102 (**FAR-7** and **FAR-9**) were (respectively) closest to: PLINE-3 **FCT 21a** Marri-Jarrah well drained south of Gingin Airfield (quartz sand dunes over Guildford Formation); and card11 **FCT 6** a weedy site on the Ridge Hill Shelf at Cardup (south of Perth) located near FCT 20b vegetation.

Table 9: Summary of Nearest Neighbour Analysis (NNA)

Test Quadrat	Species Richness	Nearest SCP Dataset site & FCT	Bray-Curtis Dissimilarity of nearest SCP Dataset site	Second nearest SCP Dataset site & FCT	Third nearest SCP Dataset site & FCT
FAR-1	33	talb7 20c	0.57	talb11 20c	talb10 20c
FAR-2	45	talb3 20c	0.58	talb10 20c	WHITE-1 23a
FAR-3	43	talb3 20c	0.57	talb7 20c	M53 20a
FAR-4	47	talb7 20c	0.51	talb9 20c	talb3 20c
FAR-5	39	talb11 20c	0.56	talb10 20c	BULL-3 23a
FAR-6	32	talb7 20c	0.59	DEJONG-c 21c	WHITE-1 23a
FAR-7	15	PLINE-3 21a	0.74	talb5 20c	M53 20a
FAR-8	22	talb7 20c	0.62	talb11 20c	talb5 20c
FAR-9	11	card-11 6	0.71	TRIG-4 28	talb7 20c
FAR-10	29	talb7 20c	0.61	MELA-6 23b	WHITE-1 23a
FAR-11	16	talb7 20c	0.68	talb11 20c	TRIG-4 28
FAR-12	16	FL-5 21c	0.70	DEJONG-c 21c	FL-6 21c
bushm02	29	card-7 21a	0.64	M53 20a	low06a 21c

KEY
 FAR-1-FAR-11: Lot 102. *Banksia* woodland over species rich shrubs/herbs. Colluvial sand, R H Shelf
 FAR-12: Lot 120. *Banksia ilicifolia*/ *Banksia* spp. woodland. Humic sand > Guildford Formation
 talb- 3, 5, 7, 9, 10 & 11 (FCT20c): Talbot Rd NR. Eastern shrublands & woodlands. Colluvial sand, R H Shelf
 M53 FCT20a: Dundas Rd BFA. Species -rich *Banksia* woodland. Bassendean Sand (S10) > G. Formation
 DEJONG-c FCT21c: DeYoung Reserve BFA. Low-lying *Banksia* woodland. Bass. Sand (S8) > G. Formation
 FL-5 FCT 21c: Forestdale Lake NR. Low-lying *Banksia* woodland. Bass. Sand (S8) > G. Formation
 Low 06a FCT 21c: Lowlands NR. Low-lying *Banksia* woodland. Bass. Sand (S8) > G. Formation
 BULL-3 FCT 23a: East SCP (Bullsbrook). *Banksia* woodland. Colluvial sand of Ridge Hill Shelf
 WHITE-1 FCT 23a: Whiteman Park. *Banksia* woodland. Bassendean Dunes (S8)
 card-11: FCT 6: Cardup N.R. Weedy dominated site on heavy soil-colluvium of Ridge Hill Shelf
 PLINE-3 FCT 21a: South of Gingin Airfield. Marri-Jarrah. Well-drained Bassendean Sand (S8)
 MELA-6 FCT23b: Melaleuca Park. *Banksia* woodland. Well-drained Bassendean Sand (S8)
 card-7 FCT21a: Cardup N.R. *B. attenuata*–*E. marginata* woodland. Well-drained sand

The Bushmead (**bushm02**) site NNA showed it had highest similarity with card-7 **FCT 21a**, a *Banksia attenuata*–*Eucalyptus marginata* woodland site in well-drained sand at the Cardup Nature Reserve on the Ridge Hill Shelf. However this FCT 21a site was only marginally less dissimilar than M53 **FCT 20a** site of the eastern SCP and a low lying site of **FCT 21c** at Lowlands Nature Reserve in the eastern SCP.

b. Clustering Analyses

To further explore the floristic relationship of the FAR quadrats to each other by clustering, an analysis of the FAR-1 to FAR-10 sites alone without the (without SCP Dataset) was carried out. The main division in this clustering was between the quadrats (FAR-1, FAR-2, FAR-3, FAR-4, FAR-5, FAR-6 and FAR-10) with the high native species-richness and good to excellent condition vegetation and the quadrats (FAR-7 and FAR-9) that were species poor and in degraded condition (Figure 8). This was consistent with the sites FAR-1, FAR-2, FAR-3, FAR-4, FAR-5, FAR-6 and FAR-10 all sharing one or more of the Talbot Rd Reserve FCT 20c sites as their nearest neighbours (Table 9 and Appendix D; Tables D2, D3, D4, D5, D6, D7, D9, D11) whilst FAR-7 and FAR-8 had more common or weedy eastern SCP site FCTs as their nearest neighbours (Table 9).

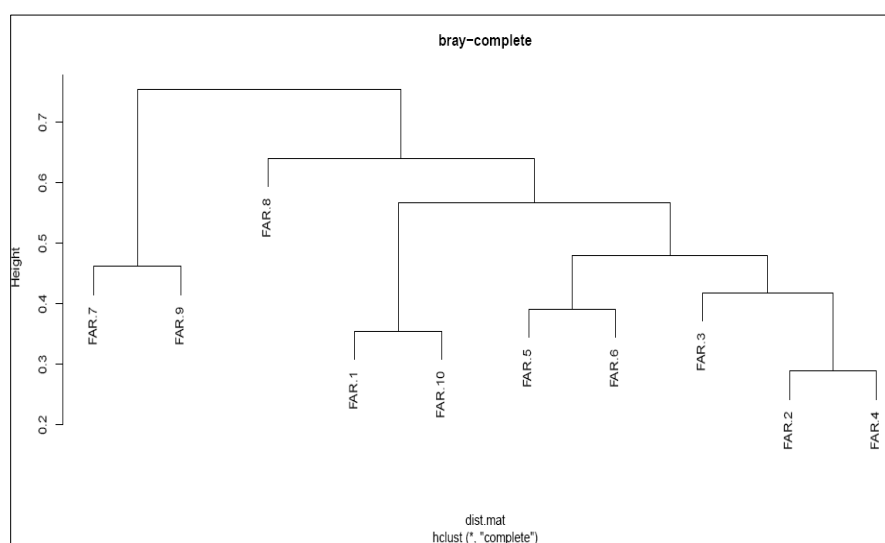


Figure 8: Multivariate Floristic Classification of the FCT 20c sites of Lot 102 test dataset (without Gibson *et al.*, 1994 data).

Single Site Insertion of test sites into the SCP Dataset

The single site insertion of FAR sites into the Gibson *et al.* (1994) SCP Dataset (Appendix D, Figures D1 to D12) showed that many of the FAR sites in **Bm-srh** vegetation in good or better condition (FAR-1, FAR-2, FAR-3, FAR-8 and FAR-10) clustered with **FCT20c** sites from Talbot Rd Reserve (Table 10) and had a sister group comprising (mostly or exclusively) of the Gibson *et al.* (1994) **FCT20a** sites. However FAR-4 and FAR-5 clustered with **FCT20a** and the sister group was comprised of all the **FCT 20c** sites of the SCP Dataset.

FAR-1, FAR-2, FAR-3, FAR-8, and FAR-10 clustered strongly with **FCT 20c** sites of Gibson *et al.* (1994) in Single Site Insertion analyses. The sister group of this FCT20c -dominated cluster in each case included only eastern SCP sites, mainly FCT 20a.

Two FCT 23a sites (BULL-3 and WHITE-1) of Gibson *et al.* (1994) moved into the sister group cluster of FCT 20a sites when FAR-1 or FAR-2 were used in Single Site Insertion. BULL-3 was from colluvial sand of Ridge Hill Shelf (at the Bullsbrook Nature Reserve, 5 km N of Pearce Airforce Base) and

WHITE-1 was from Whiteman Park (on quartz Bassendean Sand over the Guildford Formation). YULE-3, a site from quartz sand over Guildford Formation at Kenwick on the eastern SCP, also moved into the FCT 20c- dominated cluster when FAR-2, or FAR-3 or FAR-10 were inserted.

Table 10: Summary of Single Site Insertion clustering patterns

Quadrat	Clusters with SCP Dataset FCT	SCP Dataset sister group
FAR-1	All FCT20c	FCT20a BULL-3,WHITE-1 FCT23a
FAR-2	FCT20c YULE-3 FCT21c	FCT20a BULL-3,WHITE-1 FCT23a
FAR-3	FCT20c YULE-3 FCT21c M53 FCT20a	FCT20a BULL-3,WHITE-1 FCT23a
FAR-4	FCT20a BULL-3,WHITE-1 FCT23a	All FCT20c
FAR-5	FCT20a BULL-3,WHITE-1 FCT23a	All FCT20c
FAR-6	FL-5& FL-6 FCT21c card-11FCT6	CARD8&9 FCT20b YULE-3 FCT21c
FAR-7	card-11FCT6 FCT20b YULE-3 FCT21c	22, 6, 21c, 23b
FAR-8	FCT20c YULE-3 FCT21c	FCT20a & many other sites
FAR-9	card-11FCT6 CARD8&9 FCT20b	YULE-3 FCT21c & more FCT21c
FAR-10	FCT20c YULE-3 FCT21c	FCT20a BULL-3,WHITE-1 FCT23a
FAR-11	PLINE-6 FCT22, PLINE-4 FCT4, card-11FCT6 & PLINE-7 21c	22, 23b and 21a sites
FAR-12	PLINE-6 FCT22, PLINE-4 FCT4, card-11FCT6 & PLINE-7 21c	22, 23b and 21a sites

KEY

FAR-1-FAR-11: Lot 102. Banksia low woodland over species rich shrubs/herbs. Colluvial sand of Ridge Hill Shelf
 FAR-12: Lot 120. *Banksia ilicifolia*/ *Banksia* spp. low woodland. Humic sand > Guildford Formation
FCT20c: Talbot Rd NR. Eastern shrublands & woodlands. Colluvial sand, Ridge Hill Shelf
M53 (FCT20a): Dundas Rd BFA. Species -rich *Banksia* woodland. Bassendean Sand (S10) > Guildford Formation
YULE-3 (FCT21c): Brixton St Wetlands. Low-lying *Banksia* woodland. Bass. Sand (S8) > Guildford Formation
FL-5&6,TWIN-7&8,low-6a&PLINE-7 (FCT 21c): Forestdale Lake NR, Twin Swamps, Lowlands, & S. of Gingin Airfield. Low-lying *Banksia* woodland with *E. rudis* and *M. preissiana*. Bassendean Sand (S8) > Guildford Formation
BULL-3 (FCT 23a): East SCP (Bullsbrook). *Banksia* woodland. Colluvial sand of Ridge Hill Shelf
WHITE-1 (FCT 23a): Whiteman Park. *Banksia* woodland. Bassendean Dunes (S8)
CARD8 & CARD9 (FCT 20b): Banksia attenuata&/or Eucalyptus marginata woodlands-colluvium Ridge Hill Shelf
card-11(FCT6): Weedy dominated site on heavy soil-colluvium of Ridge Hill Shelf
PLINE-6(FCT22):South of Gingin Airfield. *Banksia ilicifolia*- *B. attenuata* woodland. Bassendean Dunes (S8)
PLINE-4 (FCT4): *Melaleuca preissiana*- *Banksia ilicifolia* damplands Bassendean Dunes (S8)

FAR-4 and **FAR-5** clustered with FCT 20a (even though their Nearest Neighbour sites were talb-7 and talb-11 respectively, both FCT 20c sites). The sister groups of the clusters that included the FAR-4 and FAR in this dendrogram were clusters exclusively made of FCT 20c sites.

FAR-6 was unusual as it did not cluster with either the FCT 20c or FCT 20a clusters of the SCP Dataset even though, in Lot 102 it was located immediately adjacent to sites that did. FAR-6 clustered with **FCT21c** (Low lying Banksia woodlands) and **FCT6** (weedy sites of the eastern SCP) but its nearest neighbour site was talb-7 (FCT 20c). The sister group of the FAR-6 cluster included FCTs 6, 20b & 21c (all were sites from the eastern SCP).

The pattern of FAR sites clustering with either FCT 20c or 20a sites of the SCP Dataset (and having FCT20a or FCT 20c sites, respectively, cluster as a sister group at the same level) was disrupted further when the more degraded and/or species poor **FAR-7** and **FAR-9** sites were inserted one by one into the SCP Dataset. These sites tended to cluster with **FCT 6** which is common for weedy sites of the eastern SCP, or FCT 21c or FCT 20b sites (the latter being a FCT of the Ridge Hill Shelf) due to the influence of the few remaining native species of the eastern SCP or generalist hardy species that these sites included.

FAR-11 and **FAR-12** presented a very similar clustering pattern with PLINE-6 **FCT22** (*Banksia ilicifolia* woodlands) PLINE-4 **FCT4** (*Melaleuca preissiana* damplands) and PLINE-7 **FCT 21c** sites (Low-lying *Banksia* woodland with *E. rudis* and *M. preissiana*) in Bassendean Sands over the Guildford Formation south of Gingin Airport and FCT 6 weedy sites of the eastern SCP .

It was unfortunate that time was not available to analyse **bushm02** as a Single Site Insertion in the SCP Dataset.

Multiple Site Insertion of test sites into the SCP Dataset

The multiple site insertion of FAR sites into the Gibson *et al.* (1994) SCP Dataset (Appendix D, Figures D13 to D19) showed that the addition of up to five sites (FAR-1, FAR-2, FAR-3, FAR-8 and FAR-10 all together) into Gibson *et al.* 1994 preserved these sites within the FCT 20c cluster that they grouped with individually in the single site insertion (Appendix D, Figures D13 to D16).

However the addition of either FAR-4 or FAR-5 with the above five sites moved the entire FAR group of sites out of the FCT 20c cluster (Appendix D, Figures D17 and D18). Thus all the Gibson FCT 20c and FT 20a sites were now more closely linked together with each other (with an additional two sites BULL-3, of the Ridge Hill Shelf; and WHITE-1 of Bassendean Sand over Guildford Formation, in the FCT 20a cluster), than to a sister group that included all the FAR-1 to FAR-10 sites.

The progressive addition of the sites FAR-6 to FAR-10 into the SCP Dataset (Appendix D, Figures D19 and D20) continued this pattern into the 10 site insertion dendrogram (Figure 9).

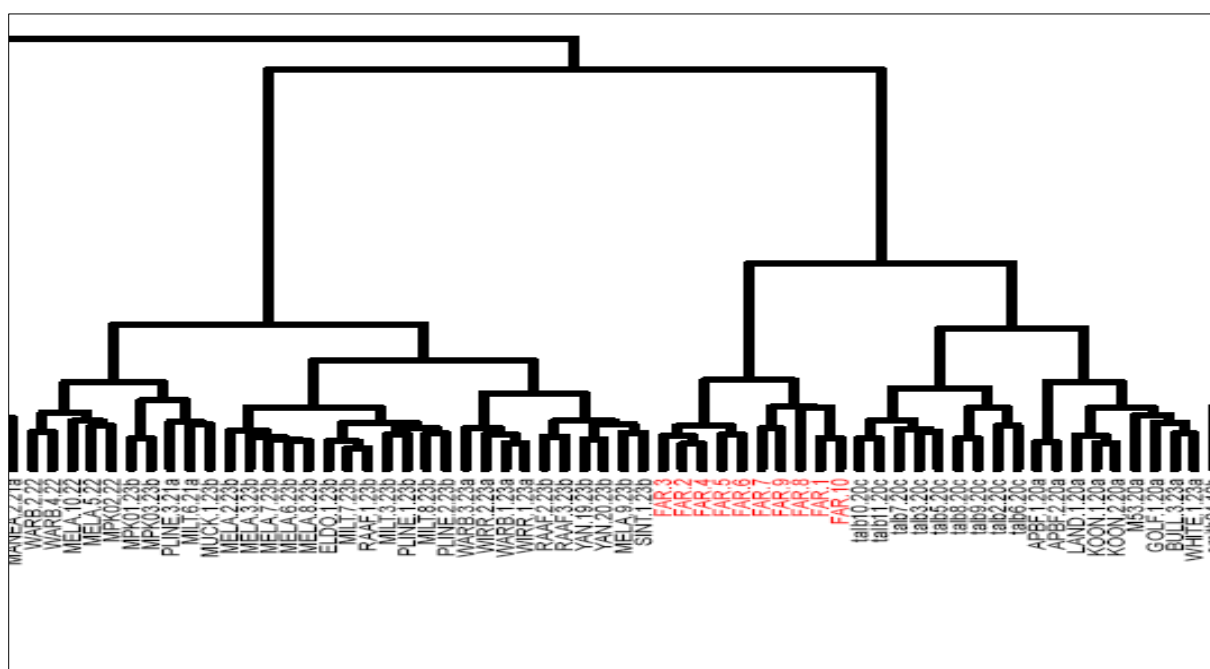


Figure 9: Ten Site Insertion of the Lot 102 quadrats Banksia woodlands and shrublands quadrats into the Gibson *et al.* (1994) SCP dataset: The Lot 102 sites clustered strongly with each other and so formed a sister group to the Gibson FCT20c and FCT 20a cluster. This relationship illustrates the strong similarities of the FAR sites to each other. This similarity moves the group as a whole out of the FCT 20c/ FCT 20a cluster of Gibson *et al.* 1994, whilst individually most of the FAR sites (except the degraded FAR-7 and FAR -9) cluster within the FCT 20c + FCT 20a cluster of Gibson *et al.*, 1994.

Another site, a relatively species-poor quadrat from the Bushmead Bush Forever Area in Hazelmere (**bushm02**) was not included in the original SCP Dataset of Gibson *et al.* (1994) but was reported in English and Blyth (2000) as part of **FCT20c**. The data for this quadrat were later updated with regard to taxonomy in Keighery *et al.* (2012). The bushm02 site (Keighery *et al.*, 2012 data) when added to the ten, Lot 102 quadrats into the SCP dataset clustered (in the Bray-Ward clustering method) with **FCT 21c** sites. However when this bushm02 analysis was repeated with Complete Linkage clustering was employed there was a different result (Appendix D; Figure D22). The bushm02 site clustered with card-11 (FCT6) of the Ridge Hill Shelf, within the 10 site FAR group cluster. The sister group of the FAR and bushm02 cluster, comprised all of FCT20c sites of Talbot Rd, the three eastern SCP FCT

20a sites (APBF-1 , APBF-2 and M53), two FCT23a sites (BULL-3 and WHITE-1), YULE-3 FCT21c, and some card FCT20b and a BRICK FCT20b sites of the Ridge Hill Shelf.

c. Ecological evidence in FCT assignment

The development and condition of the vegetation in Lot 102 can be tracked via a Landgate aerial photography series of the Swan View- Stratton-Midvale suburbs of the last 60 years that portray the history of the vegetation in the area now protected as the Talbot Rd Nature Reserve, Lot 102 and the former palusplain west of Farrall Rd.

The fertile, seasonally-wet palusplain west of Farrall Rd was cleared of much of its former native vegetation for farming well before the urban development commenced in the area. However, before the early 1960s the vegetation of the Talbot Rd bushland and Lot 102 were both, most obviously, intact and contiguous. It is however evident from the historical aerial photographs that whole area, including the Talbot Rd bushland and Lot 102, has been devastated several times by bushfire since the 1960s; the soils of the area were most clearly visible at these times. There have also been a number of vehicle tracks through the whole area whose impacts on the native vegetation are still visible in Lot 102. However although both areas may have been grazed there are no signs of major vegetation clearing for agriculture in either Talbot Rd or Lot 102; the very infertile, well drained white quartz sands that prevail in these two areas were not suitable for crops or for high quality pasture, unlike the abundant alluvial soils nearby.

The old vehicle tracks and later, the dumping of sand associated with the building of the Avon Freight railway in the early 1960s fragmented the original native vegetation in the central area of Lot 102. However prior to this fragmentation, the entire sand slope of Lot 102 (that in the current survey was mapped as Bm-srh) was relatively homogeneous in historical photographs; very comparable with the *Banksia* vegetation in the vicinity of Talbot Rd; and continuous with the latter. All of the sand slope of Lot 102 mapped as Bm-srh in the current survey, in historical photographs, also had a photo tone that corresponded approximately (except for perhaps a slightly greater density of *Banksia* trees in the past) to the *current* photo-tone of the best condition vegetation now in the vicinity of quadrats FAR-2, FAR-3, FAR-4, FAR-5 and FAR-6.

Significantly, the woodland and heath areas in the Talbot Rd Reserve where the defining FCT 20c (TEC) quadrats of Gibson *et al.* (1994) are located, appear on historical photographs to be continuous with, and of almost identical photo tone to, the upland of Lot 102 where this FCT was investigated in the current survey.

The current flora survey found that there were several flora species that are otherwise very uncommon in the PMR (*Acacia auronitens*, *Dasypogon obliquifolius*, *Isopogon drummondii* and *Jacksonia restioides*) but typical of FCT 20c, that are shared by Lot 102 and the Talbot Rd Reserve. The best explanation for this occurrence is that these uncommon species developed as single populations in the same type of vegetation shared by Lot 102 and Talbot Rd before these two areas were recently split geographically into two parts by intervening development.

Most of the quadrats sampled in this study (**FAR-1 to FAR-11**) occurred in a relatively homogenous habitat in Lot 102: a gentle slope (from about 21-25mAHD, Emerge 2105b, Figure 3) of white quartz sand with a westerly aspect deep. However Quadrat **FAR-12** was located lower down the slope than

the other quadrats (below 21m AHD) where the slope breaks and the soils grade down to shallow, humic sand over silt and clay.

Unfortunately there were no quadrats sampled in the peaty sand/sandy peat in BFA 309 wetland, in an almost flat setting (19-21m AHD) at the base of the dune, in the south-west of the block due to the limited scope of the current study.

However, despite the few obvious differences in natural habitat factors between **FAR-1 to FAR-11**, there may be some differentiation in the habitats of these quadrats due to variation along the slope in the depth to the water table. Thus sites on the lower slope probably have a higher mean ground water table than the sites on the upper slope of Lot 102. There may also be some differences in the stratigraphy and hydrology of the habitats, between sites (**FAR-2, FAR-3, FAR-4, FAR-5, FAR-6 and FAR-7**) that are located directly east of the wetland of BFA 309 and sites (**FAR-8, FAR-9, FAR-10, FAR-11, FAR-12**) that were located north of the wetland. The headwater of the former Blackadder tributary is located in the slope east of the BFA 309 wetland. Thus there may be small-scale, local stratigraphic variations in the sediments of the slope east of the BFA 309 wetland, and/or topographic factors east of the wetland that preferentially direct groundwater seepage into the BFA 309 wetland or cause upwelling in the wetland. Similar conditions do not occur in the north of Lot 102, where no wetland is expressed in a very similar topographic setting.

Thus small scale hydrological differences between the two sets of sites (**FAR-2, FAR-3, FAR-4, FAR-5, FAR-6, FAR-7** vs. **FAR-8, FAR-9, FAR-10, FAR-11**) may explain some of their differences in vegetation structure, and to a lesser degree their floristic composition. The open heath structure of the **FAR-1** and **FAR-10** sites that were located north of the wetland vs. the low open woodland over open heath structure of the remainder of the sites (**FAR-2, FAR-3, FAR-4, FAR-5 and FAR-6**) east of the wetland may reflect hydrology differences.

The history of disturbance of various areas of Lot 102 has undoubtedly contributed greatly to floristic and structural differences in the native vegetation of lot 102. The nine sites (**FAR-1, FAR-2, FAR-3, FAR-4, FAR-5, FAR-6, FAR-8, FAR-10 and FAR-11**) that had a FCT 20c site of the SCP Dataset as their nearest neighbour and **FAR-12** (with FCT 21c as its nearest neighbour) were in areas of vegetation that was in good to excellent condition. There were two other sites (**FAR-7** and **FAR-9**) that were located between the two (core) areas of good to excellent vegetation, where higher levels of weed invasion and lower native species richness was more marked and the native vegetation condition in these sites was assessed as degraded. **FAR-7** and **FAR-9** were bordered to the west by even higher levels of soil disturbance and weed invasion such the vegetation condition in the latter areas was assessed as being completely degraded ('parkland cleared').

From historical aerial photos it can be seen that old vehicle tracks and later, the dumping of sand associated with the building of the Avon Freight railway in the early 1960s fragmented the original native vegetation in the central area of Lot 102. However prior to this fragmentation, the entire sand slope of Lot 102 (that in the current survey was mapped as **Bm-srh**) was relatively homogeneous, very comparable with the *Banksia* vegetation in the vicinity of Talbot Rd and continuous with the latter. All of the sand slope of Lot 102 mapped as **Bm-srh** in the current survey also had a photo-tone that corresponded approximately (except for perhaps a slightly greater density of *Banksia* trees in the past) to the current photo-tone of the best condition vegetation which is currently in the vicinity

of quadrats **FAR-2, FAR-3, FAR-4, FAR-5** and **FAR-6**, east of the BFA wetland . Thus on-site evidence, suggests **FAR-7** and **FAR-9** are degraded occurrences of the vegetation that still remains in **FAR-1, FAR-2, FAR-3, FAR-4, FAR-5, FAR-6, FAR-8, FAR-10** and **FAR-11**, rather than representatives of a different floristic community . The low native species number (which comprises mainly the hardy native species that are common to many vegetation units of the SCP) results in **FAR-7** and **FAR-9** showing high similarity and clustering with some of the more common FCTs of the SCP rather than the rare FCT 20c . This result can be seen as simply a default grouping because a (floristic data only) multivariate analysis does not consider the on-site ecological evidence and the disturbance history of the site, as explained above.

For **FAR-11** the NNA suggested FCT 20c was a possibility despite low species richness compared to other sites of Lot 102 (e.g. FAR-1, FAR-2, FAR-3, FAR-10) that were unequivocally assigned to FCT 20c on the basis of NNA and Clustering. However FAR-11 in Single Site Insertion had complex clustering pattern very different to the assigned FCT 20a sites above. Nevertheless, FAR-11 obviously retained enough of the distinctive species typical of FCT20c so in NNA it is most similar to talb 7 and to talb 11 which are both FCT20c sites of the SCP Dataset.

For **FAR-12** the NNA suggests FCT21c despite relatively low species richness. The Single Site Insertion clustering also confirms FCT21c is possible. This concurs with the (lower slope) topographic setting, humic soil, eastern SCP location, and high canopy cover of this quadrat. FCT21c is also feasible when considering the relatively low species richness recorded in FAR-12 compared to the FCT20c sites in Lot 102: FCT21c has a natural, mean species-richness that is 37% lower than that of FCT20c (Gibson *et al.*, 1994) . The 16 native species recorded in FAR-12 is well within the species richness known for good condition occurrences of FCT21c.

The Bushmead (**bushm02**) site was not visited to record ecological data. However it was known to be relatively species- poor. Thirty native species per 100m² were reported in Keighery *et al.* (2012). However the species composition of bushm02 was rather enigmatic. In Keighery *et al.* (2012) bushm02 included *Schoenus efolius*, a strong indicator of low- lying *Banksia ilicifolia* woodlands. However in English and Blyth (2000) the site included *Tricostularia exsul* (syn. = *Lepidosperma exsul*) a species of well drained sands, instead of the superficially similar *Schoenus efolius*. *Tricostularia exsul* has been recorded in well drained sands in Banksia woodland in the Talbot Rd Reserve and on the Ridge Hills Shelf at Hazelmere (WA Herbarium, 1998-).

6.0 Discussion

6.1 Floristic Community Types

Most of the evidence from Single Site Insertion Clustering and Nearest Neighbour Analysis and ecological data supported FAR-1, FAR-2, FAR-3, FAR-4, FAR-5, FAR-6, FAR-8, and FAR-10 being assigned to the FCT20c (Table 11) as it was defined in Gibson *et al.* (1994).

In the Multiple Site Insertion Clustering (Appendix D, Figure D22) ten sites of Lot 102 and the bushm02 site clustered together and the sister group to the latter was a cluster that included all of the FCT 20c sites of the SCP Dataset. However this is a commonly observed result: the test sites of a

survey area that is being investigated by clustering methods for FCT are usually highly cohesive *i.e.* they share distinctive floristic components that draw these sites together as a group and move each test site away from clustering with their Nearest Neighbours of the SCP Dataset. This cohesiveness of the test sites (when compared to the SCP Dataset) can be attributed to factors such as the ecological distance decay effect, small habitat differences in the test vs. SCP Dataset survey areas, disturbance history of test vs SCP Dataset survey areas and taxonomic error. Thus insertion of a group of highly cohesive test sites into the SCP Dataset for clustering often results in test site clustering together as a sister group outside of the Gibson *et al.*(1994) cluster that each of these sites individually grouped with in Single Site insertion. Therefore Multiple Site Insertion Clustering is often contrary and if used without other methods to provide insights, can be of limited use in FCT assignment.

A synthesis of the various Clustering and Nearest Neighbour analyses (and the ecological evidence) indicated that FCT 20c was the best applicable Floristic Community Type of Gibson *et al.* (1994) for FAR-1, FAR-2, FAR-3, FAR-4, FAR-5, FAR-6, FAR-8, FAR-10 and FAR-11 (Table 11). This conclusion was almost unequivocal for FAR-1, FAR-2, FAR-3, FAR-8 and FAR-10. FAR-7 and FAR-9 were obviously degraded, very species-poor examples of FCT 20c rather than the other group they might have been assigned to (by default) on floristic data alone.

FAR-11 retained enough of the distinctive species typical of FCT20c so in NNA it was most similar to talb 7 and to talb 11; both were FCT20c sites in Gibson *et al.* (1994). In Single Site Insertion it had an unclear result with FCT21c also in the mix, despite FAR-11 being a well-drained site high on the slope. FAR-11 was assessed, on NNA and habitat, as a relatively species- poor FCT 20c site.

FAR-12 differed clearly from all others sites assessed with regard to habitat as it was the only low-lying, site with organic soil and it had a much more dense canopy of the trees and tall native shrubs than other sites that shaded the understorey. FAR-12 was in good condition despite its species-poor understorey, partly due to the abundance of the ground cover species: *Phlebocarya ciliata*, a native species not recorded elsewhere in the quadrats sampled in Lot 102, and *Hemiandra pungens*. All of these factors and NNA were consistent with FCT21c. It was unfortunate that more time was not available to analyse FAR-11 and FAR-12 in the Multiple Site Insertion, although that type of analysis proved to be the least informative in this study for other sites.

The clustering of FAR-4 and FAR-5 with FCT20a in the Single Site Insertion analyses for these quadrata (whilst the nearest neighbours of these sites were FCT20c sites) may be explained by the inadequate sampling in the SCP Dataset of the FTC 20a sites of the Eastern SCP.

Tauss & Associates (2015) found that the FCT20a cluster of the SCP dataset was broken up with the insertion of 21 additional very species-rich Spearwood Dunes test sites. The additional FCT 20a Spearwood sites moved the (few) original eastern SCP (including Ridge Hill Shelf FCT20a sites) out of the FCT20a cluster and they then clustered with FCT20b and FCT20c sits of the SCP Dataset. This indicated that some FCT20a sites of the SCP Dataset were more similar to FCT20c than previously thought.

Table 11: Synthesis of evidence for FCT assignment to Lot 102 sites and Bushmead 02.

Quadrat	Native spp. 100m ⁻²	NNA FCT	10 or 11 Site Insertion Cluster FCT	Single Site Insertion Cluster FCT	Ecological Data	Synthesis
FAR-1	33	20c	In sister group to 20a & 20c	20c	20c	20c
FAR-2	45	20c	“	20c	20c	20c
FAR-3	43	20c	“	20c	20c	20c
FAR-4	47	20c	“	20a	No ecological data to support 20a rather than 20c	20c Eastern SCP FCT 20a sites poorly sampled in SCP Dataset.
FAR-5	39	20c	“	20a	No ecological data to support 20a rather than 20c	20c Eastern SCP FCT 20a sites poorly sampled in SCP Dataset.
FAR-6	32	20c	“	21c/6	Several individual species lost in site disturbance history. Vegetation condition good & not weedy as per FCT 6. Site not low-lying as per FCT21c	20c Eastern SCP FCT 20a sites poorly sampled in SCP Dataset
FAR-7	15	21a	“	6/21c/20b	Degraded	20c (degraded)
FAR-8	22	20c	“	20c/21c	Lower spp. richness but site not low-lying as per FCT	20c
FAR-9	11	6	“	6	Degraded 20c	20c (degraded)
FAR-10	29	20c	“	20c	20c	20c
FAR-11	16	20c	n/a	22/ 4/ 6/ 21c	Species lost in site disturbance history. Vegetation condition good & not weedy as per FCT 6. Site not low-lying as per FCT 21c. Includes FCT20c indicator	20c (spp. poor)
FAR-12	16	21c	n/a	22/ 4/ 6/ 21c	Low-lying site, soils, mid-dense tree canopy, good condition despite being species poor	21c
bushm02	29	21a/	In sister group to 20a & 20c	n/a	Insufficient data. Site disturbance & low lying site may be responsible for 21a/21c in NNA.	?20c (spp. poor) unresolved taxonomic ambiguity.

A similar thing appeared to be happening when either FAR-4 or FAR-5 were analyzed by Single Site Insertion into the SCP Dataset. Both FAR-4 and FAR-5 lacked many of the species of high consistency for FCT20a of the Spearwood Dunes as listed by Gibson *et al.* (1994) including *Alexgeorgea nitens*, *Banksia attenuata*, *Cyathochaeta equitans*, *Daviesia nudiflora*, *Monotaxis grandiflora*, *Schoenus curvifolius*, *Stylidium araeophyllum*, *Stylidium neurophyllum*, *Stylidium calcaratum*, *Stylidium piliferum*, *Synaphea spinulosa* and *Xanthosia huegelii*. However one or both of the FAR-4 and FAR-5 sites in Lot 102 included many species of higher consistency with FCT20c and/or 20b including *Acacia applanata*, *Anigozanthos manglesii*, *Banksia dallanneyi* subsp. *dallanneyi*, *Chamaescilla corymbosa* var. *corymbosa*, *Isotropis cuneifolia* subsp. *cuneifolia*, *Leporella fimbriata*, *Scaevola repens*, *Scholtzia involucrata* and *Schoenus caespitius*.

Many distinctive species of the eastern SCP (e.g. *Acacia auronitens*, *Acacia sessilis*, *Dasypogon obliquifolius*, *Isopogon drummondii* and *Jacksonia restioides*) that were present in only a few sites of FCT20c and/or the eastern FCT20a sites of the SCP Dataset are not listed in Species Groups O, P and Q (Gibson *et al.*, 1994; Table 12): the high consistency species of FCT20a, 20b and 20c as the eastern SCP FCTs were not as extensively sampled as other parts of the plain in that study. Thus when these

uncommon species occurred in FAR sites they did not influence the clustering strongly, even though they found close sites with these less common species in them in Nearest Neighbour Analysis.

FAR-6 was a site of well- drained, white quartz sand, with vegetation condition in good condition. It was not low-lying or weedy (as are FCT21c and FCT6) with which FAR-6 clustered in Single Site Insertion. Therefore Single Site Insertion result did not make much sense. FAR-6 was a relatively species-rich quadrat and included distinctive eastern SCP species (*Acacia sessilis*, *Jacksonia restioides* and *Isopogon drummondii*) usually only in FCT 20a or 20c in the SCP Dataset. FAR-6 did not cluster with either FCT20c or 20a in SSI despite a Nearest Neighbour of FCT20c Nearest Neighbour. This, similar to the explanation for FAR-4 and FAR-5 clustering with FCT20a in SSI, can be partially explained by the inadequate sampling of some FCTs in the eastern SCP. Very few sites that included the more uncommon species of the eastern SCP were sampled in the SCP Dataset, thus their presence in FAR-6 could not be expected to greatly influence the clustering of FAR-6.

The clustering of FAR-6 in the Single Site Insertion analysis can also be partially explained by the absence of species such as *Mesomelaena pseudostygia* in FAR-6, probably due to a small local disturbance in the past in the vicinity of this site. *Mesomelaena pseudostygia* is of high consistency in the SCP Dataset in FCT 20c sites and it might have been expected to occur in FAR-6, as it is very common to dominant in the understorey in Lot 102.

The Bushmead (**bushm02**) site clustering with all the FAR FCT20c sites in the 11 site insertion but in NNA it showed highest similarity with FCT22, FCT21c and FCT20a sites of the SCP Dataset. The species composition of bushm02 was enigmatic. Keighery *et al.* (2102) included *Schoenus efoliatus*, a strong indicator of low- lying *Banksia ilicifolia* woodlands in bushm02. In English and Blyth (2000) the site included *Tricostularia exsul* (syn. = *Lepidosperma exsul*) a species of well drained sands. These two species are superficially similar and may have been confused. Otherwise the bushm02 quadrat may have been placed such that it straddled two units. Either of these possibilities may have been responsible for this mixed result observed in NNA vs. Clustering. It was unfortunate that more time was not available to analyse bushm02 as a Single Site Insertion in clustering. With the answers to these questions not available, bushm02 was interpreted in the current study as a relatively species poor FCT20c site of the Ridge Hill Shelf, consistent with the 11 Site Insertion clustering result and the interpretation of English and Blyth (2000).

6.2 Extent of Significant Bushland in Lot 102

The extent of the vegetation units in Lot 102 that were determined in the current study to have high conservation significance were measured digitally. Almost all of the 8.8ha of Lot 102, except for the fire breaks and some overgrown tracks in the block was inhabited by vegetation that qualified under the definition of Native Vegetation in Bush Forever criteria (Government of WA, 2000).

There were two core areas of rare, very poorly reserved native vegetation of the Guildford and Forrestfield Vegetation Complexes within Lot 102 in good to excellent condition. There were also additional areas of vegetation of the same types as in the core areas, but in degraded condition, that linked and buffered the two cores areas (Appendix A: Figures A2 & A3) as described below.

- **South Core Area:** In the south of Lot 102, the 1.6ha of **Bush Forever Area 309: Mp—*Melaleuca preissiana*** low closed forest and at least 0.5ha of contiguous **TEC: Eastern Shrublands and Woodlands**

(SCP FCT20c) located upslope from the BFA309 wetland, that together formed at least **2.1 ha** of excellent to good condition native vegetation.

- **North Core Area:** In the mid to north area of Lot 102, there was another block of vegetation that comprised about 0.20ha of the **TEC: Eastern Shrublands and Woodlands (SCP FCT20c)** and the contiguous 0.22ha **PEC: Low lying Banksia attenuata woodlands or shrublands (SCP FCT21c)** that together formed about **0.42ha** of good condition native vegetation.
- **Linkage and buffer vegetation:** The two core areas of high conservation-value vegetation above were connected by and flanked by additional vegetation of the same types in degraded condition. For the north core, crucial local linkage of the rare vegetation of Lot 102 to the Talbot Rd Reserve was provided, via Marri forest with healthy canopy but degraded understorey and Blackadder Creek. For the south core degraded vegetation of FCT20c provided a link with the north core. Regional linkage was through Regional Biodiversity Linkage 126 along Jane Brook (see Section 6.3). The degraded condition vegetation of Lot 102 served the functions of ecological linkage between the core areas and the buffering of the core areas of vegetation against further disturbance, and it supplied additional biodiversity and native fauna habitat. There was a total of about **1.84ha** of this linkage and buffer vegetation of FCT 20c, FCT 21c, and Marri around the core areas.

Table 12: Areas of Structural & Floristic Vegetation Units in Lot 102

Structural Unit	Floristic Unit	Vegetation Complex	TEC/PEC	Condition	Area (ha)	Total Area (ha)
1. Bm-srh	FCT20c	*Forrestfield	EPBC Act-listed TEC (End)	V. Good to Excellent Good Degraded	0.334 0.367 1.307	2.008
2. Mp (BFA 309)	Not sampled or analysed	**Guildford		V. Good to Excellent	1.600	1.600
3. Bi-m-a	FCT21c	Guildford	WA listed PEC (P3)	Good Degraded	0.216 0.241	0.457
4. Cc	Not sampled or analysed	Forrestfield		Degraded	0.289	0.289
5. Et-Em-Af	n/a	Forrestfield/ Guildford		Completely Degraded	4.446	4.446

*Forrestfield Vegetation Complex: <10.3 % original extent, 1% conserved in PPR.

**Guildford Vegetation Complex: <5.4% of original extent, 0.5% conserved in PPR

In total about 0.77ha of vegetation representative of the Forrestfield Vegetation Complex & 1.82ha of vegetation representative of the Guildford Vegetation Complex was found in Lot 102 (Table 13).

Table 13: Areas of representative Forrestfield & Guildford Vegetation Complex vegetation in Lot 102

Structural Unit	Vegetation Complex	TEC/PEC	Condition	Area (ha)	Total Area (ha)
1. Bm-srh	Forrestfield	EPBC Act- TEC	V. Good to Excellent Good	0.334 0.367	0.701
Total Forrestfield Complex					0.701
2. Bi-m-a 3. Mp (BFA 309)	Guildford	WA PEC Not assessed	Good V. Good to Excellent	0.216 1.600	
Total Guildford Complex					1.816
Total area of eastern SCP vegetation			Good to Excellent		2.517 ha

6.3 Ecological Linkages

Connectivity between areas of natural habitat is anticipated to be one of the crucial determinants for biodiversity survival under fluctuating climatic conditions and increasing anthropogenic stress on the biota (NRMMC, 2010). Ecological Linkage Corridors (also referred to as Greenways) are designed to increase connectivity by linking regionally significant native vegetation and other natural habitat such as Bush Forever Areas and Conservation Category Wetlands with smaller locally significant native vegetation via recreation areas, parks and other public open spaces. Ecological linkage corridors are not necessarily continuous native vegetation, they are effective for various classes of biota (e.g. birds) when the width of the discontinuities (e.g. roads) between various stands of vegetation are appropriate to those biota.

Lot 102 is located in a strategic position with regard to the opportunity to increase the connectivity of the Talbot Rd Reserve (one of the most important Bush Forever Site of the SCP) with the larger National Parks of the Darling Range and the Swan River. Lot 102 is connected by the Marri at its northern end (via the former Blackadder Creek floodplain that extends as remnant stands of Marri and other trees and wetlands to John Stone Park and Farrall Oval) to the Jane Brook which is part of Biodiversity Linkage 126 (WA Government, 2000; Perth Biodiversity Project, 2010). The remaining tree corridors along Blackadder Creek, Woodbridge Creek and Jane Brook function as highways along which birds and insects, in particular, can shelter from predators, forage and maintain the movement of genetic material such as pollen and seeds between the Darling Range, the Talbot Rd Reserve, Lot 102 and the Swan River. The native trees and other remnant vegetation of Biodiversity Linkages should be conserved, and replanted where appropriate, to enhance connectivity as they provide additional resources for the native biodiversity of the areas they connect, maintain the resilience of remnant ecosystems and enable them to respond more effectively to challenges such as climate change (NRMMC, 2010).

The Guildford and Forrestfield Vegetation Complexes are now depleted to a critically endangered level in the PMR and there are few, if any remaining opportunities to conserve any more large areas of these Complexes. For example in the City of Swan, as in most areas of the PMR, all remaining large areas of these Vegetation Complexes that are no already reserved have been cleared. Unfortunately small but highly representative and sustainable areas of these Vegetation Complexes have often been developed in the past in the PMR due to a lack of understanding of the role of **cumulative loss** of small areas of rare native vegetation and the further fragmentation of biodiversity linkages as one of the most serious threats to biodiversity in the highly cleared eastern SCP.

In order to meet the EPA (2015) conservation targets for the Guildford and Forrestfield Vegetation Complexes in the PMR, it is now critical to conserve the smaller, viable areas of vegetation such as Lot 102 that are in good to excellent condition and representative of these Complexes. This is particularly so when these areas bring additional conservation values such as TEC, PEC, Bush Forever and Conservation Category Wetland vegetation and a high diversity of native fauna habitats; are located within existing native vegetation buffers; and are part of Regional Biodiversity Linkages.

6.4 Review of Previous Survey

The current study confirmed the shortfalls in the environmental impact assessment carried out in Lot 102 for the proponent with regard to the high conservation values of the flora, vegetation and wetland in Lot 102. It is clear that the surveys carried out for the proponent failed to acknowledge their limitations; they lacked the intensity of field survey, fine scale detail, and experience in the flora and vegetation of the eastern Swan Coastal Plain that were considered necessary to accurately characterise the landforms, flora and vegetation of Lot 102.

The proponents Environmental Assessment and Management Strategy Report (Emerge 2015b) was inaccurate in portraying the landform and soil types of Lot 102 (see Figure 4: Landforms , p.60). The Guildford Formation wetland soils were depicted in (Emerge 2015b) as extending east of Farrall Rd into Lot 102 and beyond the railway into the suburb of Stratton. In the current field survey, it was evident that the soils in Lot 102 (apart from the BFA 309 wetland and the alluvial soils in the Marri woodland associated with Blackadder Creek were predominantly colluvial, well drained white quartz sands of the Forrestfield unit. The updated, accurate soils mapping for the area by the Department of Agriculture was presented in Emerge (2015a) however this data was ignored in Emerge (2015b).

Unfortunately the confusion of habitats in Lot 102 by Emerge (2015b) probably contributed to the misinterpretation of the conservation value of the native vegetation Lot 102. The accurate identification of landforms, soils and hydrological factors is an essential prerequisite for the valid assessment of conservation values and is particularly important in the survey, mapping and analysis of Floristic Community Types and Threatened Ecological Communities. These factors should also be correctly described to enable adequate Structure Plans and management plans, that protect both the property values of prospective householders and any high conservation-value, native vegetation that may be reserved adjacent to developments.

The spring flora and vegetation survey conducted for the proponent, over an 88 ha site (including Lot 102 by Emerge (2015a) claimed to be a Level 2 (detailed) Survey. It was conducted at an optimal season of survey. However it did not include at least two distinct seasons of survey and at least two visits to each quadrat, as required by EPA (2004) for a Level 2 survey. The Emerge (2015a) survey did not acknowledge any limitations and/or constraints on their survey.

The results of the Emerge (2015a) spring survey were evaluated against those of the current winter field survey (Table 14), as listed below.

- Emerge (2015a) was able to locate and map only six of the twelve plants of the Priority 3 Species *Isopogon drummondii* plants recorded by the current survey in Lot 102. All 'other flora species of conservation significance' (EPA, 2004) in Lot 102 were overlooked by Emerge (2015a) except *Banksia ilicifolia* (which was recorded but not attributed to this category of significant flora). The current flora survey reported five species in this category 'other flora species of conservation significance' in Lot 102; this was important evidence that the vegetation of Lot 102 included the highly significant Forrestfield Vegetation Complex and it was also crucial in the correct interpretation of the FCT analyses.

- Only two replicate upland quadrats (Q1 and Q2) were sample surveyed in the upland that were used to investigate FCT in Lot 102 by Emerge (2015a). The current study sampled 12 quadrats for the same purpose.
- The low total number of native species recorded by Emerge (2015a) in each of the two quadrats (Q1 and Q2) sampled in the upland Lot 102 constituted the only data used to investigate the FCTs of this vegetation.
- Emerge (2015a) was not able to recognize the features of good condition vegetation in the upland of Lot 102. Had they been able to do so they could have placed their test quadrats (and found sites for replicate quadrats) to more effectively sample more of the good to excellent condition vegetation available in order to more successfully investigate FCTs in Lot 102.
- The low total inventory of native flora taxa for the whole study area recorded by Emerge (2015a) which thus failed to record (or misidentified) a large number of native species that the current survey recorded in Lot 102 including *Acacia auronitens*, *Acacia applanata*, *Acacia huegelii*, *Acacia sessilis*, *Arnocrinum preissii*, *Banksia dallanneyi* subsp. *dallanneyi*, *Boronia ramosa* subsp. *anethifolia*, *Caladenia flava*, *Calandrinia corrigioloides*, *Calytrix angulata*, *Conostylis aurea*, *Cyathochaeta* sp., *Dasyopogon obliquifolius*, *Desmocladius fasciculatus*, *Drosera macrantha* subsp. *macrantha*, *Drosera zonaria*, *Haemodorum laxum*, *Hibbertia huegelii*, *Hovea trisperma* subsp. *trisperma*, *Isotropis cuneifolia* subsp. *cuneifolia*, *Jacksonia restioides*, *Leporella fimbriata*, *Leucopogon conostephioides*, *Lomandra caespitosa*, *Lomandra hermaphrodita*, *Lomandra preissii*, *Lomandra spartea*, *Macrozamia fraseri*, *Microlaena stipoides* *Phlebocarya ciliata*, *Scaevola repens* var. *repens*, *Thysanotus sparteus*, *Schoenus caespititius*, *Verticordia densiflora* and *Xanthorrhoea brunonis*. Many of these species omitted by Emerge (2015a) were also important evidence that the vegetation of Lot 102 included the highly significant Forrestfield Vegetation Complex and FCT 20c and were crucial in the correct interpretation of the FCT analyses. Had Emerge (2015a) been able to notice these species and/or identify them correctly they may have been able to assess the conservation significance of the vegetation Lot 102 more successfully.
- One of the most striking features of the Emerge (2015a) survey was its difficulty in recognizing and sampling good condition vegetation in the upland of Lot 102. This may have been due partly to the low intensity of the field survey. Had Emerge (2015a) spent more time investigating the vegetation or perhaps had more experience in vegetation variation, it may have found more sites for replicate quadrats and sampled the best condition vegetation available in Lot 102. This may have allowed it to investigate FCTs, and to map vegetation type and condition more effectively.
- In the Desktop Assessment, Emerge (2015a; Figure 3) flagged the important Regional Biodiversity Linkage that was provided by the Jane Brook between the Darling Range and the Swan River.

However Emerge (2015a) failed to appreciate that, in accord with the principles of ecological linkages, Lot 102 was actually part of the Jane Brook Regional Biodiversity Linkage (with Blackadder and Woodbridge Creeks and the Talbot Rd Reserve).

This inadequate treatment of ecological linkage was similar to the manner in which Emerge (2015a) dealt with other background data including 'other flora species of conservation significance' (EPA, 2004) that were mentioned in the background survey but abandoned when it was required that they investigate them in the field and evaluate the data collected on site against the desktop data. This

served to further underestimate the conservation values of the native vegetation of Lot 102 in the conclusions of Emerge (2015a).

Table 14: Comparative data from the flora & vegetation surveys of Emerge (2015a) and the current survey for Lot 102, Farrall Rd Stratton

	Coffey (2006)	Emerge (2015a)	Tauss & Associates (2016)
Survey Type	Spring – one visit	Spring – one visit	Winter – one visit
Size of survey area	>80ha	88ha	8.8ha
Intensity of field survey	n/a	4 person days	2 person days
Total flora inventory	99 native spp.	86 native spp.	106 native spp.
Quadrats sampled in upland of Lot 102	n/a	2	12
<i>Isopogon drummondii</i> individuals found	0	6	12
'Other species of cons. Sig.' (EPA, 2004) for Ridge Hill Shelf recorded in inventory	n/a	1	5
FCT method	Inference	Numerical analysis	Numerical analysis
FCTs assigned to upland of Lot 102	FCT 23a	FCT 21c	FCT 20c and FCT 21c
Native spp. per quadrat in good or better condition vegetation	n/a.	PEC- FCT 21c: 33 to 40 taxa per 100m ²	TEC-FCT 20c: 21-55 per 100m ² PEC- FCT 21c: 21 per 100m ²
Vegetation area in good to excellent condition in Lot 102	n/a	About 1.9ha	More than 2.5ha
Other values reported	n/a	CCW in Bush Forever 309	See Section 6.5 below

In summary, although conducted at an optimal season of the year, the Emerge (2015a) survey was conducted at a much lower intensity and with less expertise demonstrated than is usually required in a Level 2 assessment of the eastern SCP flora and vegetation. However there were no limitations and /or constraints reported or acknowledged for the survey. Although the intensity of the survey may have been low and the limitations not reported because of external pressures and the constraints of time lines and budgets, it should be understood that the EPA (2004) guidance statement provides a degree of protection for practitioners in circumstances beyond their control.

The Emerge (2015a) flora and vegetation survey results and conclusions were thus not as accurate or full as could be expected with regard to the conservation values of Lot 102. Many of the important values of Lot 102 and potential impacts on values were unfortunately overlooked and/or underestimated in this assessment.

6.5 Summary of conservation values found by the current survey

Despite the limitations of a one season (winter) survey, as outlined in Section 3.4, the current assessment found a number of high conservation values, as listed below, in Lot 102.

1. RARITY

- **MNES:** A representative occurrence of the EPBC–Act listed Threatened Ecological Community: SCP FCT20c: Eastern shrublands and woodlands (Endangered) of the Forrestfield Vegetation

Complex on the Ridge Hill Shelf. At least 0.7ha in good to excellent condition and 2.01ha (in total) of FCT20c vegetation was found within Lot 102.

- Bush Forever Area 309. A fully vegetated palusplain wetland (1.6ha) in very good to excellent condition) representative of the Guildford Vegetation Complex at the junction of Pinjarra Plain and Ridge Hill Shelf.
- **MNES:** An area of critical forage habitat of the EPBC – Act listed Carnabys Black Cockatoo significant in terms of EPBC Act referral (DSEWPaC, 2012). This included at least **1.4ha** of *Banksia* and other forage habitat in the EPBC Act listed FCT20c vegetation and in the FCT21c *Banksia* woodlands of the SC P (EPBC Act listing- pending) in good or better condition and in the mature *Corymbia calophylla* (Marri) woodland of Lot 102.

An additional **1.55ha** of *Banksia* forage woodland, mostly with very good canopy but degraded understory was also present. There were also many other forage plants for Carnabys Cockatoo in Lot 201, including mature trees of *Eucalyptus todtiana* and *E. marginata* in the **4.45ha** of parkland cleared areas of Lot 102.

An area of about **0.3ha** of (defined) nesting and roosting habitat in the Marri woodland of Lot 102 complemented the forage habitats.

- All vegetation in good (or better) condition in Lot 102 was representative of either the **Forrestfield or Guildford Vegetation Complexes** of the eastern SCP. Both Vegetation Complexes (of vegetation condition equivalent to that found in Lot 102) were designated for conservation in the whole- of-government Bush Forever agreement. Conservation of these vegetation complexes are also an EPA priority due to their critically low reservation levels (<0.5% and 1% respectively) in the Perth to Peel Region.
- Lot 102 also included populations of at least five flora species of regional conservation significance some of which are not present elsewhere in the Regional Biodiversity Linkage area.

2. HABITAT DIVERSITY

- Palusplain wetland, fully vegetated in excellent to very good condition, with a closed swamp-forest on peaty soils;
- Species rich, low open *Banksia* woodland and heath on white sand, including small patches of naturally bare sand, not infested with weeds that is valuable for reptiles and other native fauna;
- *Banksia* spp. woodland to low open woodland over *Adenanthos cygnorum* scrub: valuable native bird habitat that is now uncommon locally and throughout suburban Perth.
- Mature Marri woodland over open scrub.
- Mature Jarrah and Pricklybark trees with *Macrozamia fraseri* (cycads) in a parkland- cleared setting.

3. CONNECTIVITY

Biodiversity Linkage 126 (along Jane Brook) connected Lot 102 and the Talbot Rd Reserve, via the vegetation of Blackadder Creek and other significant stands of mature, Marri trees immediately north of Lot 102, with the Darling Range and the Swan River. This close linkage increased the conservation significance of all of the vegetation of Lot 102. The intact swamp forest of BFA 309, the species-rich *Banksia* open woodland and shrubland of FCT20c, the other *Banksia* spp. woodland and the Marri woodland of Lot 102 are also significant biodiversity resources (some of which are not

represented elsewhere in Biodiversity Linkage 126) that greatly enhance this regional linkage . Additional local linkage to the Swan River is provided via Woodbridge Creek.

4. SUSTAINABILITY

- The FCT20c vegetation in the best condition in Lot 102 occurred as two core areas: the south core (with the contiguous vegetation of BFA 309) was **2.1ha** in good to excellent condition and the north core (with the contiguous vegetation of FCT 21c) was **0.42ha** in good to excellent condition.
- The two core areas had additional, contiguous zones of vegetation in degraded condition: FCT20c (for the south core) and FCT20c, FCT 21c and Marri (for the north core) thus an additional **1.31ha** with a protective buffer and linkage function for the two core areas.
- In total there was a more or less contiguous area of about **3.83ha** of native vegetation in Lot 102 with an additional **4.45ha** of parkland cleared native vegetation that contributed values such as large trees not found in the better condition classes of vegetation in Lot 102.

This total area of about **8.3 ha** of native vegetation in various condition classes was comparable to many other viable conservation areas on the SCP, especially if some basic conservation measures such as exclusion of vehicles, containment of foot and bicycle traffic in defined paths and basic weed control were implemented in it.

5. ENVIRONMENTALLY SENSITIVE AREAS

Bush Forever Area 309 (which also meets the criteria for Conservation Category Wetland) is an ESA as defined under the WA Environmental Protection Act.

7.0 Conclusions

The current study provides new and important information about the high conservation values of Lot 102 that were unfortunately overlooked and/or underestimated in the proponent assessment of the development. The results of the current study were determined by multivariate analysis after more detailed sampling of the vegetation than was contained in all previous surveys. The current Development Plan for the proposed subdivision was drawn up before the new information was available and thus failed to adequately protect the Matters of National Significance, the Bush Forever Area 309 Conservation Category Wetland and other conservation values within Lot 102.

Also, it would be most irregular to grant core areas of high conservation value (such as BF A 309 and the TEC vegetation in good to excellent condition upslope from this in Lot 102) for developers to include , at their discretion, as a contribution to the land they delineate as 'public open space' in a development. Such rulings could be seen as a transgression of governance precedents.

It is thus recommended that:

- The MNES found in Lot 102 should be *formally assessed* by the Commonwealth Department of Environment under the provisions of the EPBC Act.
- The Department of Parks and Wild life should be requested to re-classify Bush Forever Area 309 from its existing management category (Multiple Use Wetland) to Conservation Category Wetland following advice received from the proponent (Emerge,2015b) that the wetland had been re-assessed using the appropriate DPAW protocol. DPAW does not yet appear to have commented on

the Emerge (2015a) re-assessment; it may be that the proponent needs to submit a formal application (with some additional data) to complete this process. The management category of this wetland should have been formally resolved prior to the structure plan consideration by the WAPC, in order to provide full and correct advice to the statutory process.

- The inadequate buffer zone provided in the Development Plan for the BFA 309 wetland and the core TEC area upslope from this wetland should be revised. The buffer zone should provide at least 50m of undeveloped land (not including roads) around the north- east, west and south boundaries of the wetland and all of the FCT 20c vegetation (mapped in the current survey in good or better condition) upslope from the wetland. It must be understood that whilst the “hard edge” of a road (as proposed in the Development Plan), may provide a firebreak around a wetland and a convenient management boundary, it brings adverse impacts (such as the heat island effect, polluting exhaust and brake lining products, and decreased rainfall infiltration due to sealed and compacted soil surfaces) into the ecologically important inter-zone between the wetland and its hinterland. A road, for these and other reasons, does not constitute an ecologically valid buffer zone around a wetland.
- The Development Plan should be revised to remove the serious threat to the groundwater dependent ecosystems of high conservation significance in Lot 102 posed by the major landscape removal proposed in this plan for the area north-east and north of BFA 309. In the Development Plan the proposed new contours of the land will divert the direction and reduce the volume of groundwater discharge from the sand dune aquifer in Lot 102, that currently maintain the wetland of BFA 309 and adjacent TEC vegetation. This alteration in the current hydrological regime of the native vegetation should not be allowed.
- The removal of the dune in Lot 102, the realignment of Farrall Rd through Lot 102 and the public open space provisions for the subdivision should be revoked to develop a more marketable, contemporary and environmentally sustainable landscape planning approach that would enhance the subdivision.
- The outstanding *Eucalyptus totidiana* tree near BFA 309 be nominated for protection on the National Trust Significant Tree Register, or another appropriate register, and afforded appropriate management.

The retention of the dune in Lot 102 would provide the noise abatement benefits for residents sought by the current plan in the form of a noise reduction wall.

Expanded buffer zones (extended around all three of the available boundaries of the wetland and the core TEC area upslope from this) would mitigate the need for fire protection building code zones sought by the current plan in some areas.

The public open space currently proposed as a number of isolated ‘pocket parks’ in the subdivision could also be consolidated into a larger, more attractive park in Lot 102 with mature native trees. This park, with an immediately available nature and wildlife focus, and the future addition of a playground and walking and cycling trails winding through the current parkland cleared areas in Lot 102, would bring far greater amenity value for future residents than the current plan.

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Appendix

A

Maps

ATTACHMENT 5

FARRALL ROAD LOCAL STRUCTURE PLAN

Part Two: Explanatory Report





Figure 2: Lot 102 Quadrats (FAR-1 to FAR-12) and Vegetation

KEY: *Melaleuca preissiana* low closed forest on palusplain FCT 20c: Eastern shrublands & woodlands *Banksia ilicifolia*-*Banksia* spp.-*Eucalyptus todtiana* low woodland on lower dune slope Marri woodland associates with alluvial soils of Blackadder Creek *Isopogon drummondii* locations



Figure A3: Vegetation Condition

KEY: Very Good to Excellent Good Degraded *Isopogon drummondii* P3
 Other (unshaded areas) – 'parkland cleared' bushland

1448m² of good condition in FAR-1 area plus 504m² in FAR-11 total = 1952m² in core area 2

Appendix

B

Flora Inventory

Vascular Flora Inventory of Lot 102 Farrall Rd, Stratton WA

Family	Genus and species + (subspecies or variety, if applicable). Total for Lot 102 is 134 taxa (inc. 28 weeds). *Indicates a naturalized alien species (weed)	Upland	Wetland	Black Cockatoo Forage species
Anacardiaceae	* <i>Schinus terebinthifolius</i>		*	
Araliaceae	<i>Trachymene pilosa</i>	*	*	
Asparagaceae	* <i>Asparagus asparagoides</i>	*	*	
	<i>Chamaescilla corymbosa</i> var. <i>corymbosa</i>	*	*	
	<i>Lomandra caespitosa</i>	*		
	<i>Lomandra hermaphrodita</i>	*		
	<i>Lomandra preissii</i>	*		
	<i>Lomandra spartea</i>	*		
	<i>Thysanotus sparteus</i>	*		
	<i>Thysanotus manglesianus/patersonii</i> (sterile at time of survey)	*	*	
Asteraceae	* <i>Arctotheca calendula</i>	*		
	* <i>Hypochaeris glabra</i>	*	*	
	* <i>Monoculus monstrosus</i>	*		
	<i>Podotheca gnaphalioides</i>	*		
	* <i>Sonchus oleraceus</i>	*		
	* <i>Ursinia anthemoides</i> subsp. <i>anthemoides</i>	*		
Casuarinaceae	<i>Allocasuarina fraseriana</i>	*		*
	<i>Allocasuarina humilis</i>	*		*
Colchicaceae	<i>Burchardia congesta</i>	*		
	<i>Burchardia</i> sp. (sterile at time of survey)		*	
Crassulaceae	<i>Crassula colorata</i>	*		
Cyperaceae	<i>Cyathochaeta</i> sp. (sterile at time of survey)		*	
	<i>Schoenus caespititius</i>	*		
	<i>Mesomelaena pseudostygia</i>	*		*
Dasypogonaceae	<i>Calectasia narragarra</i>	*		
	<i>Dasypogon bromeliifolius</i>	*		
	<i>Dasypogon obliquifolius</i>	*		
Dilleniaceae	<i>Hibbertia huegelii</i>	*		
	<i>Hibbertia hypericoides</i>	*		
	<i>Hibbertia racemosa</i>	*	*	
Droseraceae	<i>Drosera menziesii</i> subsp. <i>penicillaris</i>	*		
	<i>Drosera macrantha</i> subsp. <i>macrantha</i>	*	*	
	<i>Drosera pallida</i>	*		
	<i>Drosera zonaria</i>	*		

Family	Genus and species +(subspecies or variety, if applicable)	Upland	Wetland	Black Cockatoo Forage Species
Ericaceae	<i>Conostephium pendulum</i>	*		
	<i>Leucopogon conostephioides</i>	*		
Fabaceae	<i>Acacia applanata</i>	*		
	<i>Acacia auronitens</i>	*		
	<i>Acacia huegelii</i>	*		
	<i>Acacia saligna</i>	*	*	*
	<i>Acacia sessilis</i>	*		
	<i>Bossiaea eriocarpa</i>	*		
	* <i>Chamaecytisus palmensis</i>	*		
	? <i>Eutaxia virgata</i> (sterile at time of survey)		*	
	<i>Gompholobium tomentosum</i>	*		
	<i>Jacksonia restioides</i>	*		
	<i>Hovea trisperma</i> var. <i>trisperma</i>	*		
	<i>Isotropis cuneifolia</i> subsp. <i>cuneifolia</i>	*		
	<i>Jacksonia floribunda</i>	*		
	<i>Jacksonia furcellata</i>	*	*	*
	<i>Jacksonia restioides</i>	*		
	<i>Jacksonia sternbergiana</i>	*		*
	<i>Kennedia prostrata</i>	*	*	
	<i>Viminaria juncea</i>		*	
Geraniaceae	* <i>Pelargonium capitatum</i>	*		
	* <i>Erodium</i> sp.	*		*
Goodeniaceae	<i>Dampiera linearis</i>	*		
	<i>Scaevola repens</i> var. <i>repens</i>	*		
Haemodoraceae	<i>Anigozanthos humilis</i> subsp. <i>humilis</i>	*		
	<i>Anigozanthos manglesii</i> subsp. <i>manglesii</i>	*		
	<i>Conostylis aculeata</i>	*		
	<i>Conostylis aurea</i>	*		
	<i>Haemodorum laxum</i>	*		
	<i>Haemodorum spicatum</i>	*		
	<i>Phlebocarya ciliata</i>	*	*	
	<i>Phlebocarya filifolia</i>	*		
Hemerocallidaceae	<i>Arnocrinum preissii</i>	*		
	<i>Caesia</i> ? <i>micrantha</i> (sterile at time of survey)		*	
	<i>Corynotheca micrantha</i> var. <i>micrantha</i>	*		
Iridaceae	* <i>Gladiolus caryophyllaceus</i>	*		
	<i>Patersonia occidentalis</i> var. <i>occidentalis</i>	*		
	*? <i>Sparaxis bulbifera</i> (sterile at time of survey)	*		
	* <i>Romulea rosea</i> var. <i>australis</i>	*		
	* <i>Watsonia</i> sp. (sterile at time of survey)	*	*	

Family	Genus and species + (subspecies or variety, if applicable)	Upland	Wetland	Black Cockatoo Forage Species
Lamiaceae	<i>Hemiandra pungens</i>	*		
Loranthaceae	<i>Nuytsia floribunda</i>	*		*
Lyginiaceae	<i>Lyginia barbata</i>	*		
	<i>Lyginia imberbis</i>	*		
Myrtaceae	<i>Astartea scoparia</i>	*	*	
	<i>Calytrix angulata</i>	*		
	<i>Corymbia calophylla</i>	*	*	*
	<i>Eremaea pauciflora</i> var. <i>pauciflora</i>	*		
	<i>Eucalyptus marginata</i> subsp. <i>marginata</i>	*		*
	<i>Eucalyptus todtiana</i>	*		*
	<i>Eucalyptus rudis</i> subsp. <i>rudis</i>	*	*	*
	<i>Hypocalymma angustifolia</i> subsp. Swan Coastal Plain (GJ Keighery 16777)	*	*	
	<i>Leptospermum erubescens</i>	*		
	* <i>Leptospermum laevigatum</i>	*		
	<i>Melaleuca preissiana</i>	*	*	
	<i>Melaleuca raphiophylla</i>	*	*	
	<i>Melaleuca seriata</i>	*		
	<i>Melaleuca trichophylla</i>	*		
	<i>Scholtzia involucrata</i>	*		
	<i>Verticordia densiflora</i> var. ? <i>densiflora</i> (sterile at time of survey)	*		
Orchidaceae	<i>Caladenia flava</i> subsp. ? <i>flava</i> (sterile at time of survey)	*		
	* <i>Disa bracteata</i>	*		
	<i>Leporella fimbriata</i>	*		
	<i>Pterostylis sanguinea</i>	*	*	
	<i>Pyrorchis nigricans</i>	*		
	<i>Thelymitra crinita</i>	*		
Oxalidaceae	* <i>Oxalis pes-caprae</i>	*		
	* <i>Oxalis purpurea</i>	*		
Papaveraceae	* <i>Fumaria</i> sp. (sterile at time of survey)			
Pittosporaceae	<i>Billardiera fraseri</i>	*	*	
Poaceae	<i>Amphipogon turbinatus</i>	*		
	* <i>Arundo donax</i>	*		
	* <i>Avena barbata</i>	*		
	* <i>Briza maxima</i>	*		
	* <i>Bromus diandrus</i>	*		
	* <i>Eragrostis curvula</i>	*		
	* <i>Ehrharta calycina</i>	*		
	* <i>Ehrharta longiflora</i>	*		

Family	Genus and species + (subspecies or variety, if applicable)	Upland	Wetland	Black Cockatoo Forage Species
Poaceae cont.	<i>*Melinis repens</i>	*		
	<i>Microlaena stipoides</i>	*	*	
Portulacaceae	<i>Calandrinia corrigioloides</i>	*		
Proteaceae	<i>Adenanthos cygnorum</i> var. <i>cygnorum</i>	*		
	<i>Banksia attenuata</i>	*		*
	<i>Banksia dallanneyi</i> subsp. <i>dallanneyi</i>	*		*
	<i>Banksia ilicifolia</i>	*		*
	<i>Banksia menziesii</i>	*		*
	<i>Conospermum stoechadis</i> var. <i>stoechadis</i>	*		
	<i>Isopogon drummondii</i>	*		
	<i>Petrophile linearis</i>	*		*
	<i>Stirlingia latifolia</i>	*		
Restionaceae	<i>Desmocladus fasciculatus</i>	*		
	<i>Chordifex sinuosus</i>	*		
	<i>Hypolaena exsulca</i>	*	*	
	<i>Dielsia stenostachya</i>		*	
Rutaceae	<i>Boronia ramosa</i> subsp. <i>anethifolia</i>	*		
	<i>Philotheca spicata</i>	*		
Scrophulariaceae	<i>*Dischisma capitatum</i>	*		
Xanthorrhoeaceae	<i>Xanthorrhoea brunonis</i>	*	*	*
	<i>Xanthorrhoea preissii</i>	*		*
Zamiaceae	<i>Macrozamia fraseri</i>	*		

Appendix

C

Flora Quadrat Data



Location: Lot 102, Farrell Rd Stratton GPS: 31° 52.558'S; 116° 02.081'E	QUADRAT FAR-1
Sediments: Deep, white-pale grey, quartz colluvial sand.	Area: 10m x 10m
Landform: Ridge Hill Shelf, well-drained dune, mid-slope. Aspect: west	Litter Layer: 2-10% , <2cm
Condition: Good. High native species biodiversity in all layers. Heath structure comparable to good sites in Talbot Rd. No recent soil disturbance or fire	Bare Ground: 2-10%
Natural regeneration of native herb & shrub species from seed.	Rocks : nil
Weed cover moderate (<15%) mainly <i>*E. calycina</i> .	Total no. of taxa: 42. Weeds: 6
	Survey Date: 29/05/16 & 12/06/16
	Botanist: C.T.

Vegetation description: *Eremaea pauciflora*-*Allocasuarina humilis*-*Dasypogon obliquifolius* open heath; over *Mesomelaena pseudostygia* sedges; **Ehrharta calycina* perennial grasses; and perennial and annual herbs and geophytes.

spars

Taxon	Cover Class	Max. Ht. (m)	Taxon	Cover Class	Max. Ht. (m)
<i>Acacia auronitens</i>	1	0.5	<i>Hemiantra pungens</i>	1	0.3
<i>Acacia applanata</i>	1	0.4	<i>Hibbertia hypericoides</i>	1	0.5
<i>Adenanthos cygnorum</i> subsp. <i>cygnorum</i>	2	1.5	<i>*Hypochaeris glabra</i>	n	0.01
<i>Allocasuarina humilis</i>	1	1.5	<i>Jacksonia floribunda</i>	2	0.8
<i>Banksia dallanneyi</i> subsp. <i>dallanneyi</i>	2	1	<i>Jacksonia restioides</i>	1	0.4
<i>Bossiaea eriocarpa</i>	1	0.4	<i>Lomandra hermaphrodita</i>	1	0.3
<i>Burchardia congesta</i>	n	0.3	<i>Lomandra preissii</i>	n	0.3
<i>Conostephium pendulum</i>	1	0.4	<i>Lomandra spartea</i>	1	0.3
<i>Conostylis aculeata</i>	1	0.3	<i>Lyginia barbata</i>	n	0.4
<i>Crassula colorata</i>	n	0.01	<i>Melaleuca trichophylla</i>	2	0.5
<i>Dasypogon obliquifolius</i>	2	0.6	<i>Mesomelaena pseudostygia</i>	1	0.5
<i>Daviesia triflora</i>	1	0.5	<i>Melaleuca trichophylla</i>	2	0.5
<i>Drosera menziesii</i> subsp. <i>penicillaris</i>	n	0.3	<i>Mesomelaena pseudostygia</i>	2	0.5
<i>Drosera zonaria</i>	n	0.01	<i>*Monoculus monstrosus</i>	n	0.05
<i>*Ehrharta calycina</i>	2	0.5	<i>Patersonia occidentalis</i> var. <i>occidentalis</i>	1	0.4
<i>Eremaea pauciflora</i> var. <i>pauciflora</i>	2	1.2	<i>Petrophile linearis</i>	2	0.5
<i>*Erodium</i> sp.	n	0.05	<i>Podotheca gnaphalioides</i>	1	0.05
<i>Gompholobium tomentosum</i>	1	0.4	<i>Pyrorchis nigricans</i>	n	0.01
<i>Haemodorum laxum</i>	1	0.5	<i>Thysanotus manglesianus/patersonii</i>	1	0.3
<i>*Gladiolus caryophyllaceus</i>	n	0.3	<i>Trachymene pilosa</i>	n	0.01
<i>Haemodorum spicatum</i>	1	0.4	<i>*Ursinia anthemoides</i> subsp. <i>anthemoides</i>	1	0.05

Cover Classes: n = one small individual or < 0.5% for annual herbs, Class 1 = <2%; Class 2 = 2%-10%; Class 3 = >10% -30%; Class 4 = >30%-70%; Class 5 = >70%. *Indicates naturalized alien taxa (weeds).



Location: Lot 102, Farrall Rd Stratton GPS: 31° 52.726'S; 116° 02.091'E	QUADRAT FAR-2
Sediments: Deep, white-pale grey, quartz sand over colluvium	Area: 10m x 10m
Landform: Ridge Hill Shelf, well-drained dune, lower slope. Aspect: west	Litter Layer: 2-10% , <2cm
Condition: Very Good. High native species biodiversity including trees, shrubs, perennial & annual herbs, rushes, sedges & geophytes. No recent soil disturbance or fire. Regeneration of many native species, including <i>Banksia</i> , native herbs and geophytes evident. A few dead <i>Banksia</i> trees nearby – probably due to recent drought. Weed cover very low (<5%, mainly <i>*E. calycina</i>).	Bare Ground: 2-10%
	Rocks : nil
	Total no. of taxa: 50 Weeds: 4
	Survey Date: 29/05/16 & 12/06/16
	Botanist: C.T.

Vegetation description: *Banksia menziesii* low open woodland over *Adenanthos cygnorum*-*Eremaea pauciflora*-*Allocasuarina humilis* open heath; open *Lyginia barbata* rushes & sedges; sparse **Ehrharta calycina* perennial grasses; and sparse, species –rich, native perennial and annual herbs and geophytes.

Taxon	Cover Class	Max. Ht. (m)	Taxon	Cover Class	Max. Ht. (m)
<i>Acacia applanata</i>	1	0.4	<i>Hibbertia huegelii</i>	n	0.3
<i>Adenanthos cygnorum</i> subsp. <i>cygnorum</i>	2	1.2	<i>Hibbertia racemosa</i>	1	0.3
<i>Allocasuarina humilis</i>	2	1	<i>*Hypochaeris glabra</i>	n	0.01
<i>Amphipogon turbinatus</i>	1	0.3	<i>Isopogon drummondii</i>	2	1
<i>Banksia menziesii</i>	2	3	<i>Jacksonia restioides</i>	1	0.3
<i>Bossiaea eriocarpa</i>	1	0.4	<i>Leporella fimbriata</i>	n	0.01
<i>Burchardia congesta</i>	n	0.3	<i>Leptospermum erubescens</i>	1	0.5
<i>Caladenia flava</i> subsp. <i>?flava</i>	n	0.04	<i>Lomandra hermaphrodita</i>	1	0.3
<i>Calytrix angulata</i>	1	0.3	<i>Lomandra spartea</i>	n	0.2
<i>Chamaescilla corymbosa</i> var. <i>corymbosa</i>	n	0.1	<i>Lyginia barbata</i>	2	0.5
<i>Conostephium pendulum</i>	1	0.4	<i>Lyginia imberbis</i>	1	0.3
<i>Conostylis aurea</i>	1	0.3	<i>Macrozamia fraseri</i>	1	0.5
<i>Crassula colorata</i>	n	0.01	<i>Melaleuca trichophylla</i>	1	0.5
<i>Dampiera linearis</i>	1	0.3	<i>Melaleuca seriata</i>	2	0.5
<i>Dasypogon bromeliifolius</i>	2	0.4	<i>Mesomelaena pseudostygia</i>	n	0.5
<i>Daviesia triflora</i>	1	0.5	<i>*Monoculus monstrosus</i>	n	0.05
<i>Desmodcladus fasciculatus</i>	1	0.3	<i>Petrophile linearis</i>	1	0.4
<i>Drosera menziesii</i> subsp. <i>penicillaris</i>	n	0.4	<i>Podotheca gnaphalioides</i>	1	0.05
<i>Drosera pallida</i>	n	0.4	<i>Pyrorchis nigricans</i>	n	0.01
<i>Drosera zonaria</i>	n	0.01	<i>Schoenus caespititius</i>	1	0.3
<i>*Ehrharta calycina</i>	2	0.4	<i>Scholtzia involucrata</i>	1	0.4
<i>Eremaea pauciflora</i> var. <i>pauciflora</i>	2	1.2	<i>Stirlingia latifolia</i>	2	1
<i>Gompholobium tomentosum</i>	1	0.4	<i>Thysanotus manglesianus/patersonii</i>	1	0.4
<i>Haemodorum spicatum</i>	1	0.3	<i>Trachymene pilosa</i>	n	0.01
<i>Hemianandra pungens</i>	1	0.3	<i>*Ursinia anthemoides</i> subsp. <i>anthemoides</i>	1	0.05

Cover Classes: n = one small individual or < 0.5% for annual herbs, Class 1 = <2%; Class 2 = 2%-10%; Class 3 = >10% -30%; Class 4 = >30%-70%; Class 5 = >70%. *Indicates naturalized alien taxa (weeds).



Location: Lot 102, Farrall Rd Stratton GPS: 31° 52.755'S; 116° 02.098'E	QUADRAT FAR-3
Sediments: Deep, white-pale grey, quartz sand over colluvium	Area: 10m x 10m
Landform: Ridge Hill Shelf, well-drained dune, lower slope. Aspect: west	Litter Layer: 30-70%, <2cm
Condition: Good. High biodiversity in all layers, lower understory layer density than expected. No recent soil disturbance or fire. Natural regeneration of herbs, geophytes and <i>Banksia</i> evident. Total weed cover moderate (<20%, mainly <i>*E. calycina</i>).	Bare Ground: <2%
	Rocks: nil
SCP FCT: 20c (by multivariate analysis)	Total no. of taxa: 51 Weeds: 7
Botanist: C.T.	Survey Date: 12/06/16

Vegetation description: *Banksia menziesii* low open woodland; over open *Macrozamia fraseri* cycads; low open shrubs; sparse *Lyginia barbata*-*Chordifex sinuosus* rushes and sedges; open *Corynotheca micrantha*-*Dasypogon bromeliifolius* perennial herbs, **Ehrharta calycina* grasses and sparse, species-rich annual herbs & geophytes.

Taxon	Cover Class	Max. Ht. (m)	Taxon	Cover Class	Max. Ht. (m)
<i>Acacia applanata</i>	1	0.4	<i>Gompholobium tomentosum</i>	1	0.4
<i>Acacia huegelii</i>	!	0.4	<i>Haemodorum laxum</i>	1	0.4
<i>Arnocrinum preissii</i>	1	0.3	<i>Haemodorum spicatum</i>	1	0.5
<i>Banksia menziesii</i>	2	4	<i>Hovea trisperma</i> subsp. <i>trisperma</i>	1	0.4
<i>Billardiera fraseri</i>	1	0.5	<i>Hibbertia hypericoides</i>	1	1
<i>Bossiaea eriocarpa</i>	1	0.4	<i>*Hypochaeris glabra</i>	n	0.01
<i>Burchardia congesta</i>	1	0.4	<i>Hypolaena exsulca</i>	1	0.4
<i>Calectasia narragarra</i>	1	0.3	<i>Isotropis cuneifolia</i> subsp. <i>cuneifolia</i>	1	0.2
<i>Calytrix angulata</i>	2	0.5	<i>Jacksonia restioides</i>	2	0.4
<i>Chamaescilla corymbosa</i> var. <i>corymbosa</i>	1	0.05	<i>Lomandra caespitosa</i>	1	0.3
<i>Chordifex sinuosus</i>	1	0.4	<i>Lomandra hermaphrodita</i>	1	0.3
<i>Conospermum stoechadis</i> subsp. <i>stoechadis</i>	1	0.5	<i>Lyginia barbata</i>	2	0.5
<i>Conostephium pendulum</i>	1	0.5	<i>Lyginia imberbis</i>	1	0.8
<i>Conostylis aculeata</i>	1	0.4	<i>Macrozamia fraseri</i>	3	2
<i>Corynotheca micrantha</i> var. <i>micrantha</i>	3	0.5	<i>Melaleuca trichophylla</i>	1	0.5
<i>Crassula colorata</i>	n	0.01	<i>*Monoculus monstrosus</i>	1	0.05
<i>Dampiera linearis</i>	1	0.4	<i>Nuytsia floribunda</i>	2	3
<i>Dasypogon bromeliifolius</i>	2	0.4	<i>Petrophile linearis</i>	1	0.4
<i>Daviesia triflora</i>	2	0.5	<i>Phlebocarya filifolia</i>	1	0.4
<i>Desmocladius fasciculatus</i>	1	0.3	<i>Schoenus caespitius</i>	1	0.4
<i>Drosera menziesii</i> subsp. <i>penicillaris</i>	1	0.4	<i>Scholtzia involucrata</i>	2	0.4
<i>Drosera pallida</i>	n	0.4	<i>Stirlingia latifolia</i>	2	1.5
<i>*Dysphania capitatum</i>	1	0.04	<i>Thysanotus sparteus</i>	n	0.5
<i>*Ehrharta calycina</i>	3	0.4	<i>Thysanotus manglesianus/patersonii</i>	1	0.4
<i>*Fumaria</i> sp.	1	0.4	<i>*Ursinia anthemoides</i> subsp. <i>anthemoides</i>	1	0.05
<i>*Gladiolus caryophyllaceus</i>	n	0.3			

Cover Classes: n = one small individual or < 0.5% for annual herbs, Class 1 = <2%; Class 2 = 2%-10%; Class 3 = >10% -30%; Class 4 = >30%-70%; Class 5 = >70%. *Indicates naturalized alien taxa (weeds).



Location: Lot 102, Farrall Rd Stratton GPS: 31° 52.744'S; 116° 02.103'E	QUADRAT FAR-4
Sediments: Deep, white-pale grey, quartz sand over colluvium	Area: 10m x 10m
Landform: Ridge Hill Shelf, well-drained dune, mid slope. Aspect: west	Litter Layer: 30-70%, <2cm
Condition: Excellent. High native species biodiversity in all layers. Vegetation structure intact in all layers: low shrubs mid-dense. No recent soil disturbance or fire. Natural native tree, shrub & annual herb regeneration evident from seed. Weed cover very low (<2% -mainly * <i>E. calycina</i> .) However one plant of * <i>Asparagus</i> .	Bare Ground: <2%
<i>Asparagoides</i> (otherwise rare in Lot 102) present.	Rocks : nil
	Total no. of taxa: 55 Weeds: 7
	Survey Date: 12/06/16
	Botanist: C.T.

Vegetation description: *Banksia menziesii* low woodland; over *Allocasuarina humilis*- *Stirlingia latifolia* – *Hibbertia racemosa* open to mid-dense heath; sparse rushes, sedges and *Dasypogon bromeliifolius* perennial herbs; and open, species –rich annual herbs & geophytes.

Taxon	Cover Class	Max. Ht. (m)	Taxon	Cover Class	Max. Ht. (m)
<i>Acacia applanata</i>	1	0.2	<i>Hibbertia racemosa</i>	3	0.3
<i>Acacia sessilis</i>	1	0.8	<i>Hovea trisperma</i> subsp. <i>trisperma</i>	1	0.5
<i>Adenanthos cygnorum</i> subsp. <i>cygnorum</i>	1	1.5	* <i>Hypochaeris glabra</i>	n	0.01
<i>Allocasuarina humilis</i>	2	2	<i>Hypolaena exsulca</i>	1	0.4
<i>Amphipogon turbinatus</i>	1	0.3	<i>Isotropis cuneifolia</i> subsp. <i>cuneifolia</i>	n	0.05
<i>Anigozanthos manglesii</i> subsp. <i>manglesii</i>	n	0.3	<i>Jacksonia furcellata</i>	1	2
* <i>Asparagus asparagoides</i>	n	1.2	<i>Jacksonia restioides</i>	1	0.3
<i>Banksia menziesii</i>	3	4	<i>Lomandra hermaphrodita</i>	1	0.2
<i>Bossiaea eriocarpa</i>	1	0.3	<i>Lyginia barbata</i>	1	0.5
* <i>Briza maxima</i>	n	0.1	<i>Lyginia imberbis</i>	1	0.3
<i>Burchardia congesta</i>	n	0.3	<i>Macrozamia fraseri</i>	1	0.5
<i>Calectasia narragarra</i>	1	0.3	<i>Melaleuca trichophylla</i>	1	0.4
<i>Calytrix angulata</i>	2	0.3	<i>Mesomelaena pseudostygia</i>	1	0.5
<i>Chamaescilla corymbosa</i> var. <i>corymbosa</i>	2	0.05	<i>Patersonia occidentalis</i> var. <i>occidentalis</i>	1	0.4
<i>Conostephium pendulum</i>	1	0.4	<i>Petrophile linearis</i>	1	0.4
<i>Conostylis aurea</i>	1	0.3	<i>Nuytsia floribunda</i>	2	3
<i>Crassula colorata</i>	n	0.01	<i>Phlebocarya filifolia</i>	1	0.4
<i>Dasypogon bromeliifolius</i>	2	0.4	<i>Podotheca gnaphalioides</i>	1	0.05
<i>Daviesia triflora</i>	1	0.5	<i>Pyrrochis nigricans</i>	n	0.01
<i>Desmocladius fasciculatus</i>	1	0.3	<i>Schoenus caespititius</i>	1	0.3
<i>Drosera menziesii</i> subsp. <i>penicillaris</i>	n	0.4	<i>Scholtzia involocrata</i>	2	0.4
* <i>Ehrharta calycina</i>	n	0.4	<i>Stirlingia latifolia</i>	2	1
* <i>Fumaria</i> sp.	n	0.1	<i>Thysanotus manglesianus/patersonii</i>	n	0.2
<i>Gompholobium tomentosum</i>	1	1	<i>Thysanotus sparteus</i>	n	0.5
* <i>Gladiolus caryophyllaceus</i>	n	0.3	<i>Trachymene pilosa</i>	n	0.01
<i>Haemodorum laxum</i>	1	0.4	* <i>Ursinia anthemoides</i> subsp. <i>anthemoides</i>	1	0.05
<i>Haemodorum spicatum</i>	n	0.3	<i>Xanthorrhoea brunonis</i>	2	1.5
<i>Hibbertia hypericoides</i>	1	0.4			

Cover Classes: n = one small individual or < 0.5% for annual herbs, Class 1 = <2%; Class 2 = 2%-10%; Class 3 = >10% -30%; Class 4 = >30%-70%;

*Indicates naturalized alien taxa (weeds).



Location: Lot 102, Farrall Rd Stratton GPS: 31° 52.731'S; 116° 02.101'E	QUADRAT FAR-5
Sediments: Deep, white-pale grey, quartz colluvial sand	Area: 10m x 10m
Landform: Ridge Hill Shelf, well-drained dune, mid slope. Aspect: west	Litter Layer: 10-30%, <2cm
Condition: Very Good. High native species biodiversity in most layers.	Bare Ground: 2-10%
Vegetation structure +/-intact in all layers except low shrubs- species- rich but quite open. No recent soil disturbance or fire. Banksia tree, low shrub and native annual herb regeneration evident from seed. Weed cover low (<5%, mainly * <i>E. calycina</i>).	Rocks : nil
	Total no. of taxa: 47 Weeds: 5
	Survey Date: 12/06/16
	Botanist: C.T.

Vegetation description: *Banksia menziesii* low woodland; over low open, species –rich *Adenanthos cygnorum* – *Stirlingia latifolia* shrubs; open *Mesomelaena pseudostygia* rushes and sedges ; and open, species- rich native annual herbs & geophytes.

Taxon	Cover Class	Max. Ht. (m)	Taxon	Cover Class	Max. Ht. (m)
<i>Acacia huegelii</i>	1	0.4	<i>Hibbertia hypericoides</i>	1	0.4
<i>Adenanthos cygnorum</i> subsp. <i>cygnorum</i>	2	2	* <i>Hypochaeris glabra</i>	n	0.01
<i>Amphipogon turbinatus</i>	1	0.4	<i>Isotropis cuneifolia</i> subsp. <i>cuneifolia</i>	1	0.2
<i>Banksia dallanneyi</i> subsp. <i>dallanneyi</i>	1	0.5	<i>Jacksonia restioides</i>	1	0.3
<i>Banksia menziesii</i>	3	5	<i>Leporella fimbriata</i>	n	0.07
<i>Boronia ramosa</i> subsp. <i>anethifolia</i>	1	0.4	<i>Leucopogon conostephioides</i>	1	0.4
<i>Bossiaea eriocarpa</i>	1	0.4	<i>Lyginia barbata</i>	1	0.5
<i>Burchardia congesta</i>	1	0.4	<i>Lyginia imberbis</i>	1	0.8
<i>Calandrinia corrigioloides</i>	n	0.02	<i>Melaleuca trichophylla</i>	1	0.4
<i>Calytrix angulata</i>	1	0.3	<i>Mesomelaena pseudostygia</i>	3	0.5
<i>Chamaescilla corymbosa</i> var. <i>corymbosa</i>	2	0.05	* <i>Monoculus monstrosus</i>	1	0.05
<i>Conostephium pendulum</i>	1	0.5	<i>Petrophile linearis</i>	1	0.4
<i>Conostylis aculeata</i>	1	0.4	<i>Philothea spicata</i>	1	0.5
<i>Crassula colorata</i>	n	0.01	<i>Phlebocarya filifolia</i>	1	0.4
<i>Dampiera linearis</i>	1	0.3	<i>Podotheca gnaphalioides</i>	1	0.05
<i>Dasypogon bromeliifolius</i>	1	0.4	<i>Pyrrochis nigricans</i>	n	0.01
<i>Daviesia triflora</i>	2	0.5	<i>Scaevola repens</i> var. <i>repens</i>	1	0.3
<i>Drosera macrantha</i> subsp. <i>macrantha</i>	1	0.6	<i>Stirlingia latifolia</i>	1	1
<i>Drosera menziesii</i> subsp. <i>penicillaris</i>	1	0.4	<i>Thelymitra crinita</i>	n	0.2
*<i>Ehrharta calycina</i>	2	0.4	<i>Thysanotus manglesianus/patersonii</i>	1	0.4
* <i>Erodium</i> sp.	n	0.01	<i>Trachymene pilosa</i>	n	0.01
<i>Gompholobium tomentosum</i>	1	0.4	* <i>Ursinia anthemoides</i> subsp. <i>anthemoides</i>	1	0.05
<i>Haemodorum laxum</i>	1	0.4	<i>Verticordia densiflora</i>	1	0.4
<i>Haemodorum spicatum</i>	1	0.5			

Cover Classes: n = one small individual or < 0.5% for annual herbs, Class 1 = <2%; Class 2 = 2%-10%; Class 3 = >10% -30%; Class 4 = >30%-70%; Class 5 = >70%. *Indicates naturalized alien taxa (weeds).



Location: Lot 102, Farrall Rd Stratton GPS: 31° 52.717'S; 116° 02.093'E	QUADRAT FAR-6
Sediments: Deep, white-pale grey, quartz colluvial sand	Area: 10m x 10m
Landform: Ridge Hill Shelf, well-drained dune, lower slope. Aspect: west	Litter Layer: 10-30%, <2cm
Condition: Good. High native species biodiversity in most layers.	Bare Ground: 2-10%
Vegetation structure intact in most layers however low shrubs & perennial less dense	Rocks : nil
than expected and sedge layer absent. Small localized soil disturbance – fox burrow	Total no. of taxa: 40 Weeds: 7
under thicket. No signs of recent fire. Natural native species regeneration from seed.	Survey Date: 12/06/16
Weed cover moderate (<15%, mainly * <i>E. calycina</i>).	Botanist: C.T.

Vegetation description: *Banksia menziesii* low woodland; over open, species rich *Stirlingia latifolia* – *Allocasuarina humilis* shrubs (with emergent sparse *Adenanthos cygnorum*); over *Lyginia barbata* open rushes; open **Ehrharta calycina* grasses ; and sparse annual herbs and geophytes.

Taxon	Cover Class	Max. Ht. (m)	Taxon	Cover Class	Max. Ht. (m)
<i>Acacia sessilis</i>	1	0.4	<i>Gompholobium tomentosum</i>	1	0.4
<i>Adenanthos cygnorum</i> subsp. <i>cygnorum</i>	2	3	<i>Hypochaeris glabra</i>	n	0.01
<i>Allocasuarina humilis</i>	1	1	<i>Isopogon drummondii</i>	1	1
<i>Amphipogon turbinatus</i>	1	0.3	<i>Isotropis cuneifolia</i> subsp. <i>cuneifolia</i>	1	0.2
<i>Banksia menziesii</i>	3	4	<i>Jacksonia restioides</i>	1	0.3
<i>Burchardia congesta</i>	1	0.3	<i>Leporella fimbriata</i>	n	0.02
<i>Calandrinia corrigioloides</i>	n	0.02	<i>Leptospermum erubescens</i>	1	0.5
<i>Calytrix angulata</i>	1	0.3	<i>Lomandra caespitosa</i>	1	0.3
<i>Chamaescilla corymbosa</i> var. <i>corymbosa</i>	1	0.05	<i>Lyginia barbata</i>	3	0.4
<i>Conostephium pendulum</i>	1	0.5	<i>Lyginia imberbis</i>	1	0.8
<i>Conostylis aculeata</i>	1	0.3	* <i>Monoculus monstrosus</i>	1	0.05
<i>Crassula colorata</i>	n	0.01	<i>Podotheca gnaphalioides</i>	1	0.05
<i>Dampiera linearis</i>	1	0.2	<i>Pyrrochis nigricans</i>	n	0.01
<i>Dasyopogon bromeliifolius</i>	1	0.4	* <i>Romulea rosea</i>	n	0.1
<i>Desmocladius fasciculatus</i>	1	0.3	<i>Scholtzia involucreta</i>	2	0.4
<i>Drosera macrantha</i> subsp. <i>macrantha</i>	1	0.6	* <i>Sparaxis bulbifera</i>	n	0.05
<i>Drosera menziesii</i> subsp. <i>penicillaris</i>	1	0.4	<i>Stirlingia latifolia</i>	2	1.5
<i>Drosera zonaria</i>	n	0.01	<i>Thysanotus manglesianus/patersonii</i>	1	0.4
* <i>Ehrharta calycina</i>	3	0.4	<i>Trachymene pilosa</i>	n	0.01
* <i>Gladiolus caryophyllaceus</i>	n	0.3	* <i>Ursinia anthemoides</i> subsp. <i>anthemoides</i>	1	0.05

Cover Classes: n = one small individual or < 0.5% for annual herbs, Class 1 = <2%; Class 2 = 2%-10%; Class 3 = >10% -30%; Class 4 = >30%-70%; Class 5 = >70%. *Indicates naturalized alien taxa (weeds).



Location: Lot 102, Farrall Rd Stratton GPS: 31° 52.669'S; 116° 02.101'E	QUADRAT FAR-7
Sediments: Deep, white-pale grey, quartz colluvial sand	Area: 10m x 10m
Landform: Ridge Hill Shelf, well-drained dune, mid slope. Aspect: west	Litter Layer: <10%, <2cm
Condition: Degraded. Species depauperate in all layers. Vegetation structure highly altered although still significant total cover of native species. Soil structure undisturbed in many parts but localized patches highly disturbed as evidenced by heavy weed invasion. This site borders on areas known to have been highly disturbed in the past by vegetation clearing, vehicle tracks, sand dumping & probably fire associated with railway construction-in early 1960s. Weed cover high (20-25%), mainly * <i>E. calycina</i>).	Bare Ground: 10-30%
	Rocks : nil
	Total no. of taxa: 23 Weeds: 7
	Survey Date: 12/06/16
	Botanist: C.T.

Vegetation description Low open *Eremaea pauciflora* var. *pauciflora* shrubs with emergent *Adenanthos cygnorum* subsp. *cygnorum* tall open shrubs; over sparse *Mesomelaena pseudostygia* sedges and *Dasypogon bromeliifolius* perennial herbs; with open **Ehrharta calycina* grasses and sparse herbs & geophytes.

Taxon	Cover Class	Max. Ht. (m)	Taxon	Cover Class	Max. Ht. (m)
<i>Adenanthos cygnorum</i> subsp. <i>cygnorum</i>	1	3	<i>Haemodorum spicatum</i>	1	0.5
<i>Bossiaea eriocarpa</i>	1	0.4	* <i>Hypochaeris glabra</i>	n	0.01
<i>Chamaescilla corymbosa</i> var. <i>corymbosa</i>	1	0.05	<i>Hypolaena exsulca</i>	1	0.4
<i>Conostephium pendulum</i>	1	0.5	<i>Jacksonia restioides</i>	1	0.3
<i>Hibbertia hypericoides</i>	1	0.5	<i>Mesomelaena pseudostygia</i>	2	0.5
<i>Eremaea pauciflora</i> var. <i>pauciflora</i>	2	0.8	<i>Melaleuca trichophylla</i>	1	0.5
<i>Dasypogon bromeliifolius</i>	2	0.4	* <i>Monoculus monstrosus</i>	1	0.05
* <i>Dysphania capitatum</i>	1	0.04	<i>Petrophile linearis</i>	1	0.4
* <i>Ehrharta calycina</i>	3	0.4	<i>Podotheca gnaphalioides</i>	1	0.05
* <i>Eragrostis curvula</i>	1	1	<i>Thysanotus manglesianus/patersonii</i>	1	0.4
* <i>Erodium</i> sp.	1	0.02	* <i>Ursinia anthemoides</i> subsp. <i>anthemoides</i>	1	0.05
<i>Haemodorum laxum</i>	1	0.4			

Cover Classes: n = one small individual or < 0.5% for annual herbs, Class 1 = <2%; Class 2 = 2%-10%; Class 3 = >10% -30%; Class 4 = >30%-70%; Class 5 = >70%. *Indicates naturalized alien taxa (weeds).



Location: Lot 102, Farrall Rd Stratton GPS: 31° 52.627'S; 116° 02.090'E	QUADRAT FAR-8
Sediments: Deep, white-pale grey, quartz sand over colluvium	Area: 2m x 50m
Landform: Ridge Hill Shelf, well-drained dune, mid slope. Aspect: west	Litter Layer: 10-30%, <2cm
Condition: Good. This site centred on old fenceline retains remarkable FCT integrity. It retains <i>I. drummondii</i> , <i>B. dallanneyi</i> & <i>C. stoechadis</i> ; all of these are Proteaceae spp. & thus particularly prone to soil disturbance. This was obviously protected from soil disturbance. It borders on areas known to have been highly disturbed in the past by, vehicle tracks, sand dumping & probably fire associated with the railway construction-in early 1960s. Weed cover high (30-35%) mainly <i>*E. calycina</i> .	Bare Ground: 2-10%
	Rocks : nil
	Total no. of taxa: 27 Weeds:6
	Survey Date: 12/06/16
	Botanist: C.T.

Vegetation description: Open heath including *Isopogon drummondii*, *Banksia dallanneyi*, *Acacia sessilis*, *Stirlingia latifolia* and other low shrubs; with sparse native rushes and perennial herbs, in a mid-dense **Ehrharta calycina* perennial grassland.

Taxon	Cover Class	Max. Ht. (m)	Taxon	Cover Class	Max. Ht. (m)
<i>Acacia applanata</i>	1	0.4	<i>Haemodorum spicatum</i>	1	0.5
<i>Acacia sessilis</i>	1	0.5	<i>*Hypochaeris glabra</i>	n	0.01
<i>Allocasuarina humilis</i>	1	1	<i>Isopogon drummondii</i>	1	1.4
<i>Anigozanthos humilis</i> subsp. <i>humilis</i>	n	0.2	<i>Lomandra caespitosa</i>	1	0.3
<i>Banksia dallanneyi</i> subsp. <i>dallanneyi</i>	1	1	<i>Lyginia barbata</i>	1	0.5
<i>Burchardia congesta</i>	1	0.3	<i>Melaleuca trichophylla</i>	1	0.4
<i>Calytrix angulata</i>	2	0.4	<i>*Monoculus monstrosus</i>	1	0.05
<i>Chordifex sinuosus</i>	1	0.4	<i>Patersonia occidentalis</i> var. <i>occidentalis</i>	1	0.4
<i>Conospermum stoechadis</i> subsp. <i>stoechadis</i>	1	1.2	<i>Phlebocarya filifolia</i>	1	0.4
<i>Dasypogon bromeliifolius</i>	1	0.4	<i>Podotheca gnaphalioides</i>	1	0.05
<i>*Dysphania capitatum</i>	1	0.04	<i>Stirlingia latifolia</i>	2	1
<i>*Ehrharta calycina</i>	4	0.4	<i>*Ursinia anthemoides</i> subsp. <i>anthemoides</i>	1	0.05
<i>*Eragrostis curvula</i>	1	1	<i>Xanthorrhoea preissii</i>	1	1.5
<i>Haemodorum laxum</i>	1	0.4			

Cover Classes: n = one small individual or < 0.5% for annual herbs, Class 1 = <2%; Class 2 = 2%-10%; Class 3 = >10% -30%; Class 4 = >30%-70%; Class 5 = >70%. *Indicates naturalized alien taxa (weeds).



Location: Lot 102, Farrell Rd Stratton GPS: 31° 52.619'S; 116° 02.075'E	QUADRAT FAR-9
Sediments: Deep, white-pale grey, quartz colluvial sand	Area: 10m x 10m
Landform: Ridge Hill Shelf, well-drained dune, mid slope. Aspect: west	Litter Layer: 10-30% <5cm
Condition: Degraded. Although this site retains some of the uncommon signature species of the surrounding vegetation, biodiversity was depauperate & the vegetation structure highly altered. This site borders on areas known to have been highly disturbed in the past by vegetation clearing, vehicle tracks, sand dumping & probably fire associated with railway construction-in early 1960s. Weed cover high (25-30%) mainly * <i>E. calycina</i> .	Bare Ground: <2%
	Rocks : nil
	Total no. of taxa: 15 Weeds: 4
	Survey Date: 12/06/16
	Botanist: C.T.

Vegetation description: *Dasypogon bromeliifolius* mid-dense perennial herbs with open **Ehrharta calycina* grasses and low open *Eremaea pauciflora* var. *pauciflora* shrubs.

low open

Taxon	Cover Class	Max. Ht. (m)	Taxon	Cover Class	Max. Ht. (m)
<i>Conostephium pendulum</i>	1	0.4	<i>Jacksonia floribunda</i>	1	0.5
<i>Dasypogon bromeliifolius</i>	4	0.4	<i>Jacksonia restioides</i>	1	0.3
* <i>Ehrharta calycina</i>	3	0.4	<i>Lomandra caespitosa</i>	1	0.3
<i>Eremaea pauciflora</i> var. <i>pauciflora</i>	2	0.8	<i>Mesomelaena pseudostygia</i>	2	0.4
<i>Haemodorum laxum</i>	1	0.5	* <i>Monoculus monstrosus</i>	1	0.05
<i>Hibbertia hypericoides</i>	1	1	<i>Stirlingia latifolia</i>	2	1.5
* <i>Hypochaeris glabra</i>	n	0.01	* <i>Ursinia anthemoides</i> subsp. <i>anthemoides</i>	1	0.05
<i>Isopogon drummondii</i>	1	0.5			

Cover Classes: n = one small individual or < 0.5% for annual herbs, Class 1 = <2%; Class 2 = 2%-10%; Class 3 = >10% -30%; Class 4 = >30%-70%; Class 5 = >70%. *Indicates naturalized alien taxa (weeds).



Location: Lot 102, Farrell Rd Stratton GPS: 31° 52.573'S; 116° 02.073'E	QUADRAT FAR-10
Sediments: Deep, white-pale grey, quartz colluvial sand	Area: 10m x 10m
Landform: Ridge Hill Shelf, well-drained dune, mid-slope. Aspect: west	Litter Layer: 2-10% , <2cm
Condition: Good. High native species biodiversity in most layers. Heath structure comparable to good sites in Talbot Rd except weed grass cover. No recent soil disturbance or fire. Natural regeneration of native species from seed .	Bare Ground: 2-10%
Weed cover moderate (<15%) mainly * <i>E. calycina</i>). Naturally bare patches of soil not invaded by weeds	Rocks : nil
	Total no. of taxa: 36 Weeds: 7
	Survey Date: 29/05/16 & 12/06/16
	Botanist: C.T.

Vegetation description: *Eremaea pauciflora*- *Melaleuca trichophylla*- *Dasypogon obliquifolius* low open heath; over sparse *Mesomelaena pseudostygia* sedges; open **Ehrharta calycina* perennial grasses; and perennial and annual herbs and geophytes.

Taxon	Cover Class	Max. Ht. (m)	Taxon	Cover Class	Max. Ht. (m)
<i>Acacia sessilis</i>	1	0.4	* <i>Gladiolus caryophyllaceus</i>	n	0.3
<i>Adenanthos cygnorum</i> subsp. <i>cygnorum</i>	1	1	<i>Haemodorum spicatum</i>	1	0.4
<i>Anigozanthos humilis</i> subsp. <i>humilis</i>	n	0.2	<i>Hemiandra pungens</i>	1	0.3
<i>Bossiaea eriocarpa</i>	1	0.4	<i>Hibbertia huegelii</i>	1	0.2
<i>Chordifex sinuosus</i>	1	0.3	<i>Hibbertia hypericoides</i>	1	0.5
<i>Conostephium pendulum</i>	1	0.4	<i>Isopogon drummondii</i>	2	0.6
<i>Conostylis aculeata</i>	1	0.3	* <i>Hypochaeris glabra</i>	n	0.01
<i>Conostylis aurea</i>	1	0.2	<i>Jacksonia floribunda</i>	1	0.8
<i>Crassula colorata</i>	n	0.01	<i>Jacksonia restioides</i>	1	0.4
<i>Dasypogon obliquifolius</i>	2	0.4	<i>Lomandra caespitosa</i>	1	0.3
<i>Daviesia triflora</i>	1	0.5	<i>Mesomelaena pseudostygia</i>	2	0.5
<i>Drosera macrantha</i> subsp. <i>macrantha</i>	1	0.5	<i>Melaleuca trichophylla</i>	2	0.3
<i>Drosera menziesii</i> subsp. <i>penicillaris</i>	n	0.3	* <i>Monoculus monstrosus</i>	n	0.05
* <i>Ehrharta calycina</i>	3	0.5	* <i>Pelargonium capitatum</i>	n	0.2
<i>Eremaea pauciflora</i> var. <i>pauciflora</i>	3	0.8	<i>Podotheca gnaphalioides</i>	1	0.05
* <i>Erodium</i> sp.	n	0.05	<i>Pyrorchis nigricans</i>	n	0.01
<i>Gompholobium tomentosum</i>	1	0.5	<i>Scholtzia involucrata</i>	1	0.3
<i>Haemodorum laxum</i>	1	0.5	* <i>Ursinia anthemoides</i> subsp. <i>anthemoides</i>	1	0.05

Cover Classes: n = one small individual or < 0.5% for annual herbs, Class 1 = <2%; Class 2 = 2%-10%; Class 3 = >10% -30%; Class 4 = >30%-70%; Class 5 = >70%. *Indicates naturalized alien taxa (weeds).



Location: Lot 102, Farrall Rd Stratton GPS: 31° 52.533'S; 116° 02.071'E	QUADRAT FAR-11
Sediments: Deep, white-pale grey, quartz colluvial sand	Area: 10m x 10m
Landform: Ridge Hill Shelf, well-drained dune, mid slope. Aspect: west.	Litter Layer: leaf litter 2-10%, 3 cm; plus moderate wood litter
Condition: Good. Vegetation structure altered- canopy healthy due to regeneration but low cover of understorey species but representatives of all layers present. Natural regeneration of tree, shrub, perennial & annual herb species from the soil seed bank seed. No soil disturbance or signs of recent fire. Total native understorey cover about 15%. Weed cover moderate (<25%) mainly * <i>E. calycina</i> .	Bare Ground: 2-10%
	Rocks : nil
	Total no. of taxa: 21 Weeds: 4
	Survey Date: 12/06/16
	Botanist: C.T.

Vegetation description: *Banksia attenuata* low woodland; over *Adenanthos cygnorum*- *Allocasuarina humilis* low open shrubs; **Ehrharta calycina* open grasses and sparse perennial and annual herbs and geophytes.

Taxon	Cover Class	Max. Ht. (m)	Taxon	Cover Class	Max. Ht. (m)
<i>Adenanthos cygnorum</i> subsp. <i>cygnorum</i>	2	2	* <i>Hypochaeris glabra</i>	n	0.01
<i>Allocasuarina humilis</i>	2	1.3	<i>Jacksonia restioides</i>	1	0.4
<i>Anigozanthos humilis</i> subsp. <i>humilis</i>	n	0.2	<i>Leporella fimbriata</i>	n	0.01
<i>Banksia attenuata</i>	2	8	<i>Lomandra caespitosa</i>	1	0.3
<i>Bossiaea eriocarpa</i>	1	0.4	<i>Melaleuca trichophylla</i>	1	0.4
<i>Conostylis aculeata</i>	2	0.4	<i>Mesomelaena pseudostygia</i>	1	0.4
<i>Conostylis aurea</i>	n	0.3	* <i>Pelargonium capitatum</i>	1	0.4
* <i>Ehrharta calycina</i>	3	0.4	<i>Stirlingia latifolia</i>	1	1
<i>Eremaea pauciflora</i> var. <i>pauciflora</i>	1	0.8	<i>Thelymitra crinita</i>	n	0.1
<i>Gompholobium tomentosum</i>	1	0.4	* <i>Ursinia anthemoides</i> subsp. <i>anthemoides</i>	1	0.05
<i>Hibbertia hypericoides</i>	1	0.5			

Cover Classes: n = one small individual or < 0.5% for annual herbs, Class 1 = <2%; Class 2 = 2%-10%; Class 3 = >10% -30%; Class 4 = >30%-70%; Class 5= >70%. *Indicates naturalized alien taxa (weeds).



Location: Lot 102, Farrall Rd Stratton GPS: 31° 52.522'S; 116° 02.034'E	QUADRAT FAR-12
Sediments: Pale grey, humic, quartz colluvial sand over clay/silt.	Area: 10m x 10m
Landform: Ridge Hill Shelf/ Guildford Formation interface: lower dune slope with a seasonally high water table. Aspect: west.	Litter Layer: leaf litter 10-30%, 5 cm
Condition: Good. Vegetation structure intact, total native understorey cover about 35%. Canopy intact & healthy thus death of recent tree recruit, probably occurred as natural thinning during recent drought	Bare Ground: <2%
Species richness of understory moderate for this vegetation type but also secondary to weed invasion. No soil disturbance or signs of recent fire. Weed cover high (<30 %) mainly * <i>E. calycina</i> .	Rocks : nil
	Total no. of taxa: 19 Weeds: 2
	Survey Date: 12/06/16
	Botanist: C.T.

Vegetation description: *Banksia ilicifolia* woodland; over *Adenanthos cygnorum*- *Jacksonia furcellata* tall open shrubs; **Ehrharta calycina* open grasses and sparse perennial and annual herbs and geophytes.

Taxon	Cover Class	Max. Ht. (m)	Taxon	Cover Class	Max. Ht. (m)
<i>Acacia huegelii</i>	1	0.5	<i>Jacksonia furcellata</i>	1	0.4
<i>Adenanthos cygnorum</i> subsp. <i>cygnorum</i>	2	2	<i>Lomandra caespitosa</i>	1	0.3
<i>Banksia ilicifolia</i>	4	15	<i>Lomandra hermaphrodita</i>	1	0.3
<i>Conostylis aurea</i>	1	0.3	<i>Phlebocarya ciliata</i>	3	0.4
* <i>Ehrharta calycina</i>	3	0.4	<i>Stirlingia latifolia</i>	1	1
<i>Eremaea pauciflora</i> var. <i>pauciflora</i>	1	0.5	<i>Thelymitra crinita</i>	n	0.1
<i>Gompholobium tomentosum</i>	1	0.4	<i>Thysanotus manglesianus/patersonii</i>	1	0.6
<i>Haemodorum spicatum</i>	1	0.6	<i>Thysanotus sparteus</i>	n	0.3
<i>Hemiandra pungens</i>	1	0.3	<i>Xanthorrhoea brunonis</i>	1	0.8
* <i>Hypochaeris glabra</i>	n	0.01			

Adjacent: *Drosera zonaria*

Cover Classes: n = one small individual or < 0.5% for annual herbs, Class 1 = <2%; Class 2 = 2%-10%; Class 3 = >10% -30%; Class 4 = >30%-70%; Class 5= >70%. *Indicates naturalized alien taxa (weeds).

A large, white, serif capital letter 'D' is positioned in the top right corner of a light green rectangular header bar.

Multivariate Analysis

A large, solid light green rectangular area occupies the majority of the page below the header and title, serving as a background for the main content.

Table D1: The Aligned Test Dataset (including bushmo2 asp per Keighery et al., 2012; aligned with the nomenclature of the SCP Dataset)

Name aligned to Gibson et al.(1994) SCP Dataset	FAR-1	FAR-2	FAR-3	FAR-4	FAR-5	FAR-6	FAR-7	FAR-8	FAR-9	FAR-10	FAR-11	FAR-12	bushm02
<i>Acacia auronitens</i>	1												
<i>Acacia huegelii</i>			1		1							1	
<i>Acacia sessilis</i>				1		1		1		1			
<i>Acacia wilddenowiana</i>	1	1	1	1				1					
<i>Adenanthos cygnorum</i>	1	1		1	1	1	1			1	1	1	1
<i>Allocasuarina fraseriana</i>													1
<i>Allocasuarina humilis</i>	1	1		1		1		1			1		
<i>Amphipogon turbinatus</i>		1		1		1							
<i>Anigozanthos humilis</i>										1			1
<i>Anigozanthos manglesii</i>				1									
<i>Arnocrinum preissii</i>			1										
<i>Astroloma stomarrhena</i>													1
<i>Banksia attenuata</i>											1		1
<i>Banksia ilicifolia</i>												1	
<i>Banksia menziesii</i>		1	1	1	1	1							1
<i>Boronia ramosa</i>					1								
<i>Bossiaea eriocarpa</i>	1	1	1	1	1		1			1	1		
<i>Burchardia umbellata</i>	1	1	1	1	1	1		1					1
<i>Caladenia flava</i>		1											1
<i>Calandrinia corrigioloides</i>					1	1							
<i>Calectasia cyanea</i>			1	1									
<i>Calytrix angulata</i>		1	1	1		1		1					
<i>Caustis dioica</i>													1
<i>Chamaescilla corymbosa</i>		1	1	1	1	1	1						
<i>Conospermum stoechadis</i>			1					1					
<i>Conostephium pendulum</i>	1	1	1	1	1	1	1		1	1			
<i>Conostylis aculeata</i>	1		1		1	1				1	1	1	
<i>Conostylis aurea</i>		1		1						1	1		1
<i>Conostylis juncea</i>													1
<i>Conostylis setosa</i>													1
<i>Corynotheca micrantha</i>			1										
<i>Crassula colorata</i>	1	1	1	1	1	1				1			

<i>Dampiera linearis</i>		1	1		1	1							
<i>Dasypogon bromeliifolius</i>		1	1	1	1	1	1	1	1				1
<i>Dasypogon obliquifolius</i>	1									1			1
<i>Daviesia triflora</i>	1	1	1	1	1					1			
<i>Drosera macrantha</i>			1		1	1							
<i>Drosera menziesii</i> subsp. <i>penicillaris</i>	1	1	1	1	1	1				1			
<i>Drosera pallida</i>		1	1							1			
<i>Drosera stolonifera</i>													1
<i>Drosera zonaria</i>	1	1				1							
<i>Dryandra nivea</i>	1				1			1					
<i>Eremaea pauciflora</i> subsp. <i>pauciflora</i>	1	1					1		1	1	1	1	
<i>Eriostemon spicatus</i>					1								
<i>Gompholobium tomentosum</i>	1	1	1	1	1	1				1	1	1	
<i>Haemodorum laxum</i>	1		1	1	1		1	1	1	1			
<i>Haemodorum spicatum</i>	1	1	1	1	1		1	1		1		1	
<i>Hemiantra pungens</i>	1	1								1		1	
<i>Hibbertia huegelii</i>		1								1			1
<i>Hibbertia hypericoides</i>	1		1	1	1		1		1	1	1		
<i>Hibbertia racemosa</i>		1		1									
<i>Hovea trisperma</i> var. <i>trisperma</i>			1	1									
<i>Hypolaena exsulca</i>			1	1			1						
<i>Isopogon drummondii</i>		1				1		1	1	1			
<i>Isotropis cuneifolia</i>			1	1	1	1							
<i>Jacksonia floribunda</i>	1								1	1			
<i>Jacksonia furcellata</i>				1								1	
<i>Jacksonia restioides</i>	1	1	1	1	1	1	1	1	1	1	1		1
<i>Johnsonia pubescens</i>													1
<i>Lepidosperma eastern terete</i> (BJK&NG 232)													1
<i>Leporella fimbriata</i>		1			1	1					1		
<i>Leptospermum erubescens</i>		1				1							
<i>Leucopogon conostephioides</i>					1								
<i>Lomandra caespitosa</i>			1			1		1	1	1	1	1	
<i>Lomandra hermaphrodita</i>	1	1	1	1								1	1
<i>Lomandra preissii</i>	1												
<i>Lomandra spartea</i>	1	1											
<i>Loxocarya fasciculata</i>		1	1	1		1							
<i>Lyginia barbata</i>		1	1	1	1	1		1					

<i>Lyginia barbata</i>	1	1	1	1	1	1		1					1
<i>Lyperanthus nigricans</i>	1	1		1	1	1				1			
<i>Macrozamia riedlei</i>		1	1	1									
<i>Melaleuca seriata</i>		1											
<i>Melaleuca trichophylla</i>	1	1	1	1	1		1	1		1	1		
<i>Mesomelaena pseudostygia</i>	1	1		1	1		1		1	1	1		1
<i>Neurachne alopecuroidea</i>													1
<i>Nuytsia floribunda</i>				1									
<i>Patersonia occidentalis</i>	1			1				1					1
<i>Petrophile linearis</i>	1	1	1	1	1		1						
<i>Phlebocarya ciliata</i>												1	
<i>Phlebocarya filifolia</i>			1	1	1			1					
<i>Podotheca gnaphalioides</i>	1	1		1	1	1	1	1		1			
<i>Pronaya fraseri</i>			1										
<i>Pterostylis recurva</i>													1
<i>Restio sinus</i>			1					1		1			
<i>Scaevola repens</i> var. <i>repens</i>					1								
<i>Schoenus caespitius</i>		1	1	1									
<i>Schoenus efoliatus</i>													1
<i>Scholtzia involucrata</i>		1	1	1		1				1			
<i>Stirlingia latifolia</i>		1	1	1	1	1		1	1		1	1	
<i>Thelymitra crinita</i>					1						1	1	
<i>Thysanotus sparteus</i>			1	1								1	1
<i>Thysanotus thyrsoideus</i>													1
<i>Trachymene pilosa</i>	1	1		1	1	1							1
<i>Tricoryne elatior</i>													1
<i>Verticordia densiflora</i>					1								
<i>Xanthorrhoea brunonis</i>				1								1	
<i>Xanthorrhoea preissii</i>								1					

Tables D2- D15: Nearest Neighbour Analysis**Table D2:** Bray Curtis dissimilarity for FAR1 (33 species)

Plot	FCT	Total Species	Common Species	Bray-Curtis Dissimilarity
talb7	20c	47	17	0.57
talb11	20c	48	17	0.58
talb10	20c	78	21	0.62
talb3	20c	64	18	0.63
talb6	20c	44	14	0.64
WHITE-1	23a	53	15	0.65
NEER-21	28	41	13	0.65
GOLF-1	20a	55	15	0.66
talb9	20c	66	17	0.66
MELA-6	23b	44	13	0.66

Table D3: Bray Curtis dissimilarity for FAR2 (45 species)

Plot	FCT	Total Species	Common Species	Bray-Curtis Dissimilarity
talb3	20c	64	23	0.58
talb10	20c	78	25	0.59
WHITE-1	23a	53	20	0.59
talb9	20c	66	22	0.6
YULE-2	23a	50	19	0.6
dard02	21b	73	23	0.61
talb11	20c	48	18	0.61
talb7	20c	47	18	0.61
BULL-3	23a	64	21	0.61
WARB-3	23a	71	22	0.62

Table D4: Bray Curtis dissimilarity for FAR3 (43 species)

Plot	FCT	Total Species	Common Species	Bray-Curtis Dissimilarity
talb3	20c	64	23	0.57
talb7	20c	47	19	0.58
M53	20a	64	22	0.59
talb11	20c	48	18	0.6
talb10	20c	78	24	0.6
talb5	20c	56	20	0.6
card7	21a	38	16	0.6
BULL-3	23a	64	21	0.61
DEJONG-c	21c	37	15	0.62
card9	20b	51	18	0.62

Table D5: Bray Curtis dissimilarity for FAR4 (47 species)

Plot	FCT	Total Species	Common Species	Bray-Curtis Dissimilarity
talb7	20c	47	23	0.51
talb9	20c	66	27	0.52
talb3	20c	64	26	0.53
talb5	20c	56	24	0.53
M53	20a	64	25	0.55
talb11	20c	48	21	0.56
talb10	20c	78	27	0.57
DEJONG-c	21c	37	17	0.6
BULL-3	23a	64	22	0.6
KOON-2	20a	62	22	0.6

Table D6: Bray Curtis dissimilarity for FAR5 (39 species)

Plot	FCT	Total Species	Common Species	Bray-Curtis Dissimilarity
talb11	20c	48	19	0.56
talb10	20c	78	25	0.57
BULL-3	23a	64	22	0.57
talb9	20c	66	22	0.58
talb3	20c	64	21	0.59
talb7	20c	47	17	0.6
DEJONG-c	21c	37	15	0.61
hurst04	23a	49	17	0.61
WHITE-1	23a	53	18	0.61
talb5	20c	56	18	0.62

Table D7: Bray Curtis dissimilarity for FAR6 (32 species)

Plot	FCT	Total Species	Common Species	Bray-Curtis Dissimilarity
talb7	20c	47	16	0.59
DEJONG-c	21c	37	14	0.59
WHITE-1	23a	53	16	0.62
card7	21a	38	12	0.66
YULE-2	23a	50	14	0.66
talb3	20c	64	16	0.67
low01	21c	35	11	0.67
card11	6	17	8	0.67
HARRY-4	23a	35	11	0.67
dard02	21b	73	17	0.68

Table D8: Bray Curtis dissimilarity for FAR7 (15 species)

Plot	FCT	Total Species	Common Species	Bray-Curtis Dissimilarity
PLINE-3	21a	32	6	0.74
talb5	20c	56	9	0.75
M53	20a	64	10	0.75
talb3	20c	64	9	0.77
talb7	20c	47	7	0.77
kelly02	21b	56	8	0.77
BULL-3	23a	64	9	0.77
talb11	20c	48	7	0.78
BURNRD01	20b	68	9	0.78
RUAB-1	21b	48	7	0.78

Table D9: Bray Curtis dissimilarity for FAR8 (22 species)

Plot	FCT	Total Species	Common Species	Bray-Curtis Dissimilarity
talb7	20c	47	13	0.62
talb11	20c	48	12	0.66
talb5	20c	56	13	0.67
YULE-3	21c	47	10	0.71
talb10	20c	78	14	0.72
M53	20a	64	12	0.72
talb6	20c	44	9	0.73
talb9	20c	66	12	0.73
card7	21a	38	8	0.73
card11	6	17	5	0.74

Table D10: Bray Curtis dissimilarity for FAR9 (11 species)

Plot	FCT	Total Species	Common Species	Bray-Curtis Dissimilarity
card11	6	17	4	0.71
TRIG-4	28	34	5	0.78
talb7	20c	47	6	0.79
M53	20a	64	8	0.79
PLINE-3	21a	32	4	0.81
KING-2	28	41	5	0.81
NEER-23	28	21	3	0.81
talb10	20c	78	8	0.82
LAND-1	20a	69	7	0.82
DEPOT-1	28	33	4	0.82

Table D11: Bray Curtis dissimilarity for FAR10 (29 species)

Plot	FCT	Total Species	Common Species	Bray-Curtis Dissimilarity
talb7	20c	47	15	0.61
MELA-6	23b	44	11	0.7
WHITE-1	23a	53	12	0.71
NEER-20	28	41	10	0.71
talb3	20c	64	13	0.72
talb10	20c	78	15	0.72
WARI-1	28	52	11	0.73
MELA-8	23b	59	12	0.73
talb5	20c	56	11	0.74
BULL-3	23a	64	12	0.74

Table D12: Bray Curtis dissimilarity for FAR11 (16 species)

Plot	FCT	Total Species	Common Species	Bray-Curtis Dissimilarity
talb7	20c	47	10	0.68
talb11	20c	48	9	0.72
TRIG-4	28	34	7	0.72
talb6	20c	44	8	0.73
low01	21c	35	7	0.73
talb10	20c	78	12	0.74
buffer01	21b	52	9	0.74
DEJONG-c	21c	37	7	0.74
FL-5	21c	38	7	0.74
M53	20a	64	10	0.75

Table D13: Bray Curtis dissimilarity for FAR12 (16 species)

Plot	FCT	Total Species	Common Species	Bray-Curtis Dissimilarity
FL-5	21c	38	8	0.7
DEJONG-c	21c	37	7	0.74
FL-6	21c	31	6	0.74
talb7	20c	47	8	0.75
RIVD-2	21a	48	8	0.75
WAND-1	23a	56	9	0.75
YAN-17	22	27	5	0.77
YAN-22	22	28	5	0.77
C71-2	21a	64	9	0.78
AUSTRA-1	21a	48	7	0.78

Table D14: Bray Curtis dissimilarity for bushm02 (29 species)

Plot	FCT	Total Species	Common Species	Bray-Curtis Dissimilarity
card7	21a	38	12	0.64
M53	20a	65	16	0.66
low06a	21c	42	12	0.66
YULE-2	23a	53	13	0.68
TWIN-8	21c	39	11	0.68
low04	21a	45	12	0.68
hurst 03	23a	59	14	0.68
ELDO-1	23b	56	13	0.69
MPK3	23b	49	12	0.69
MILT-6	21a	36	10	0.69

Table D15: Summary of Near Neighbour Analysis

Quadrat	Species Richness	Gibson plot	FCT	Bray-Curtis
FAR-1	33	talb7	20c	0.57
FAR-2	45	talb3	20c	0.58
FAR-3	43	talb3	20c	0.57
FAR-4	47	talb7	20c	0.51
FAR-5	39	talb11	20c	0.56
FAR-6	32	talb7	20c	0.59
FAR-7	15	PLINE-3	21a	0.74
FAR-8	22	talb7	20c	0.62
FAR-9	11	card11	6	0.71
FAR-10	29	talb7	20c	0.61
FAR-11	16	talb7	20c	0.68
FAR-12	16	FL-5	21c	0.70
bushm02	29	card-7	21a	0.64

Figures D1-D22: Cluster Analyses Dendrograms (FAR-1 to FAR-12 sites of Lot 102 Farrall Rd vs. Gibson *et al.* (1994) SCP Dataset. [Please view at 200% if sites not clearly visible].

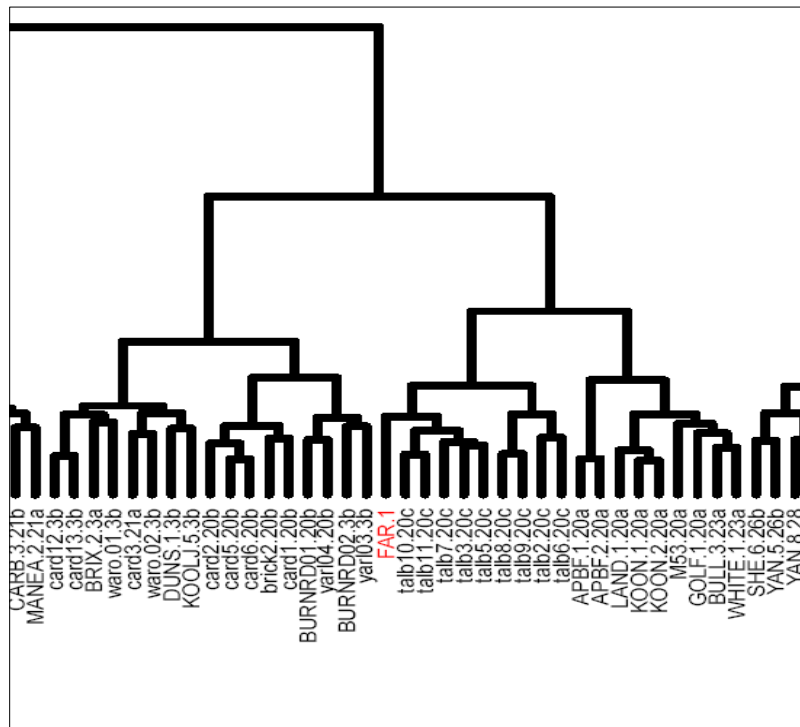


Figure D1: Bray Ward Clustering. Single Site Insertion of **FAR-1** into Gibson *et al.* (1994) SCP dataset. **FAR-1** (a site in good condition in Lot 102) clusters with FCT 20c.

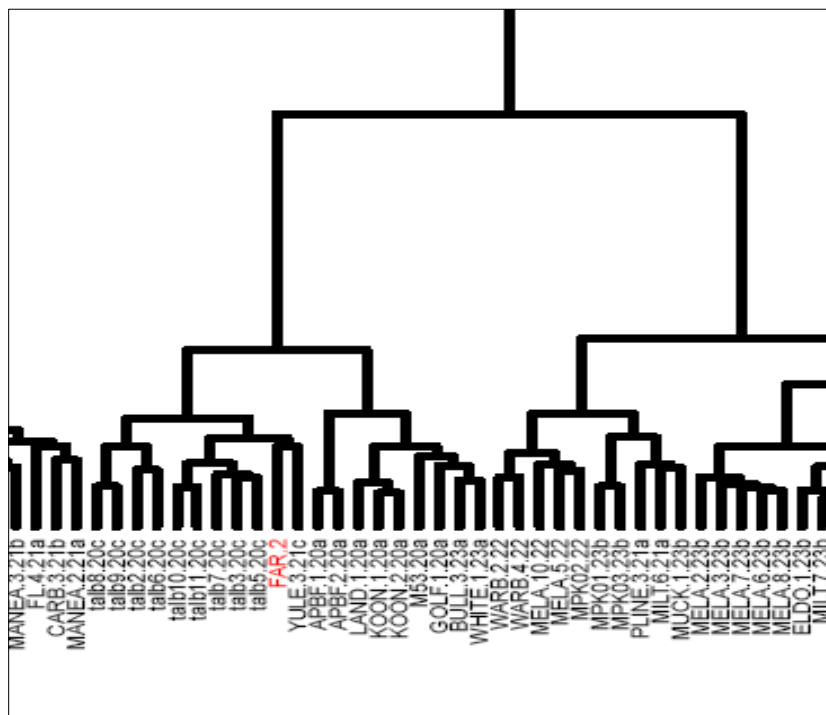


Figure D2: Bray Ward Clustering. Single Site Insertion of **FAR-2** into Gibson *et al.* (1994) SCP dataset: **FAR-2** (a site in very good condition in Lot 102) clusters with FCT 20c but also drags a Gibson FCT 21c site into the resultant FCT 20c cluster.

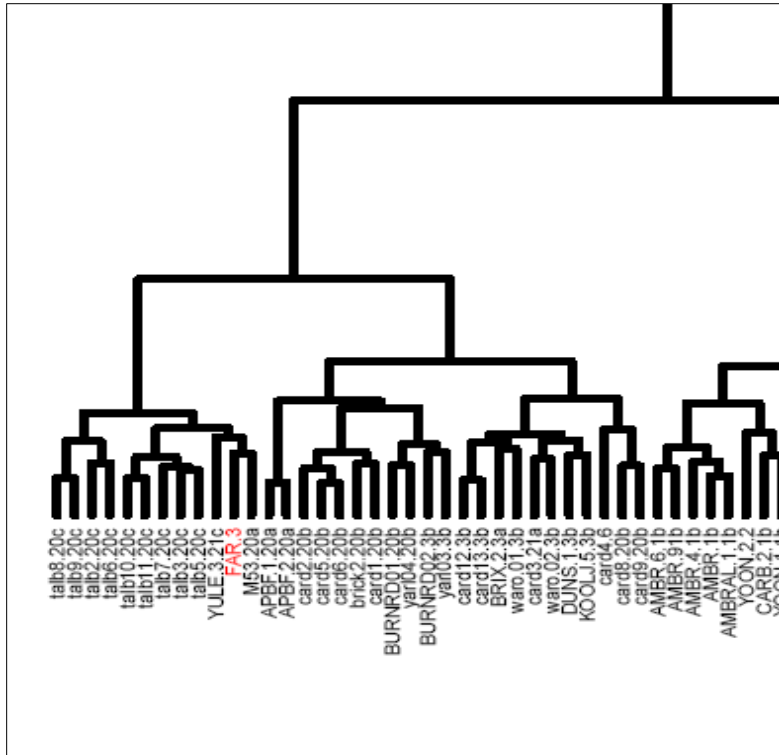


Figure D3: Bray Ward Clustering. Single Site Insertion of **FAR-3** into Gibson *et al.* (1994) SCP dataset: **FAR-3** (a site in good condition in Lot 102) clusters with FCT 20c but also drags a Gibson FCT 21c site and a Gibson FCT 20a site into the resultant FCT 20c cluster.

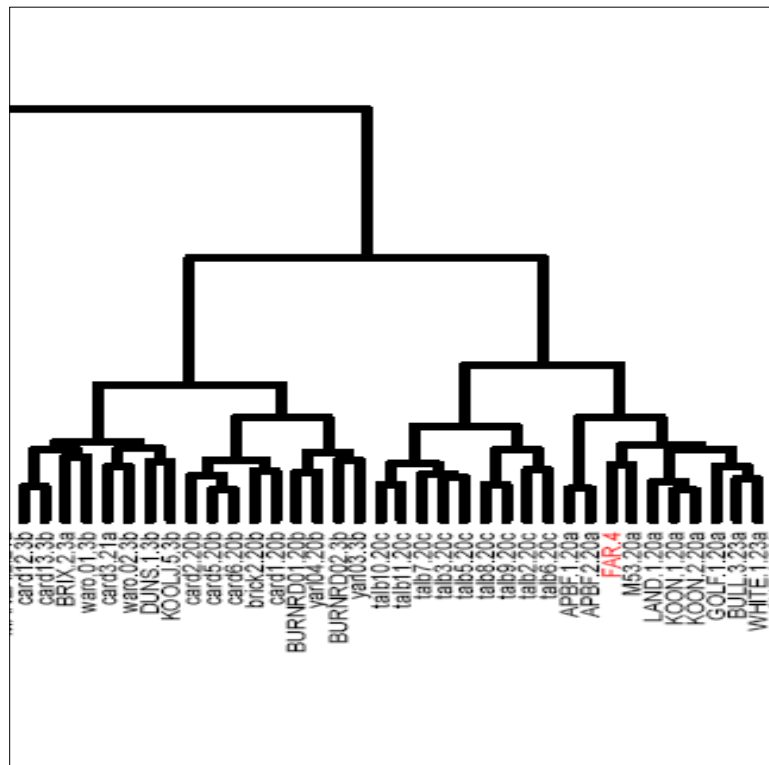


Figure D4: Bray Ward Clustering. Single Site Insertion of **FAR-4** into Gibson *et al.* (1994) SCP dataset: **FAR-4** (a site in excellent condition in Lot 102) clusters with FCT 20a (a closely related 'sister group' of FCT 20c). However FAR-4 also drags some Gibson FCT 23a sites into the resultant FCT 20a cluster.

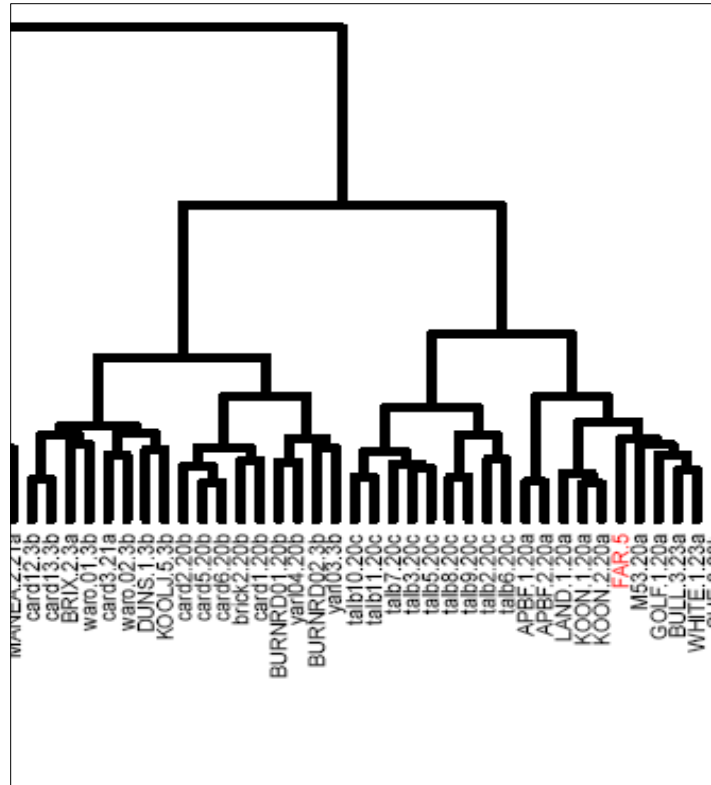


Figure D5: Bray Ward Clustering. Single Site Insertion of **FAR-5** into Gibson *et al.* (1994) SCP dataset: **FAR-5** (a site in very good condition in Lot 102) clusters with FCT 20a (a closely related 'sister group' of FCT 20c). However FAR-5 also drags some Gibson FCT 23a sites into the resultant FCT 20a cluster.

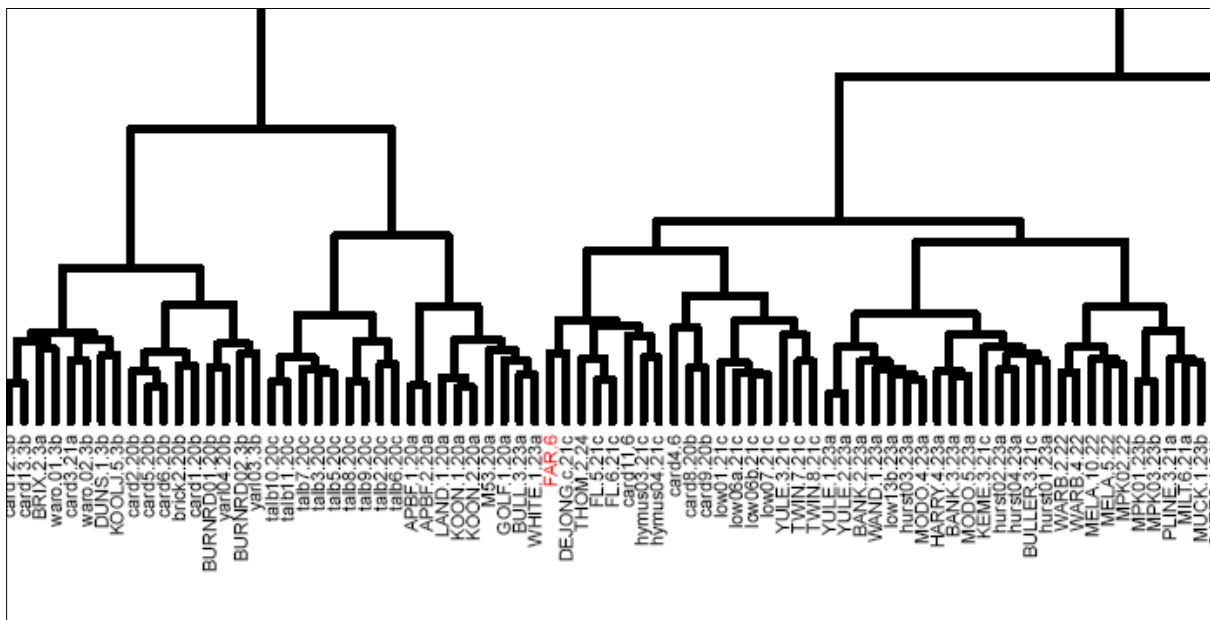


Figure D6: Bray Ward Clustering. Single Site Insertion of **FAR-6** into Gibson *et al.* (1994) SCP dataset: **FAR-6** (a vegetation structure altered site of Lot 102 in but still in overall good condition) breaks out of the FCT 20c and FT 20a sister group cluster of Gibson and clusters with FCT 21c Gibson sites and a couple of weedy FCT 6 sites of the eastern SCP. This is interesting because FAR-6 was located immediately adjacent to FAR-2 in Lot 102. FAR-2 clustered strongly in SSI with FCT20c but was far more species rich than FAR-6.

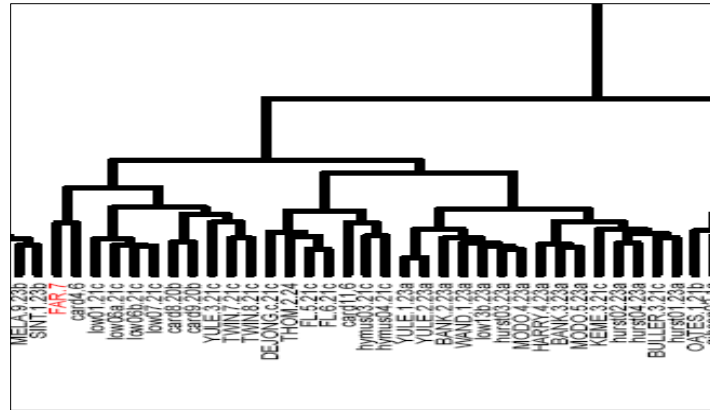


Figure D7: Bray Ward Clustering. Single Site Insertion of **FAR-7** into Gibson *et al.* (1994) SCP dataset: **FAR-7** (a species -depauperate site of Lot 102 in degraded condition) clusters with Gibson sites of FCT 21c, a weedy FCT 6 site of the eastern SCP and some FCT 20b sites of the eastern SCP.

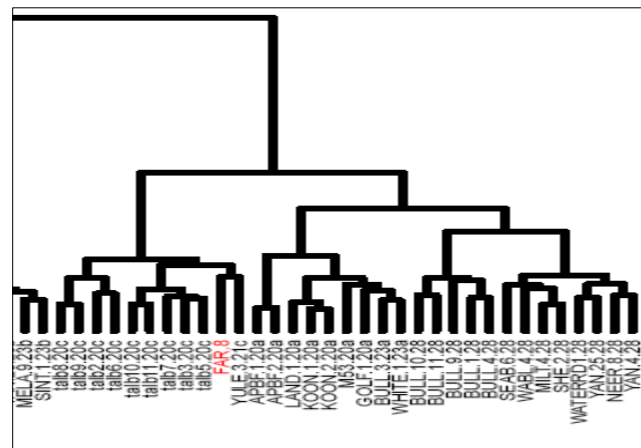


Figure D8: Bray Ward Clustering. Single Site Insertion of **FAR-8** into Gibson *et al.* (1994) SCP dataset: **FAR-8** (a somewhat species-depauperate site of Lot 102 in good condition) clusters with Gibson sites of FCT 20c and one Gibson FCT 21c site from eastern SCP.

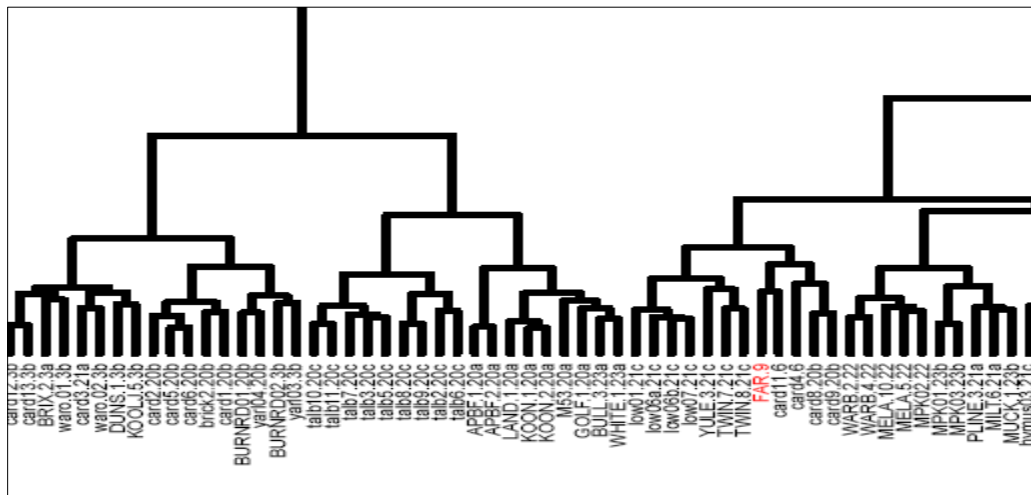


Figure D9: Bray Ward Clustering. Single Site Insertion of **FAR-9** into Gibson *et al.* (1994) SCP dataset: **FAR-9** (a very species-poor site of Lot 102 in degraded condition) clusters with Gibson sites of FCT21c, weedy FCT 6, and FCT 20b: all the latter three FCT sites were from the eastern SCP.

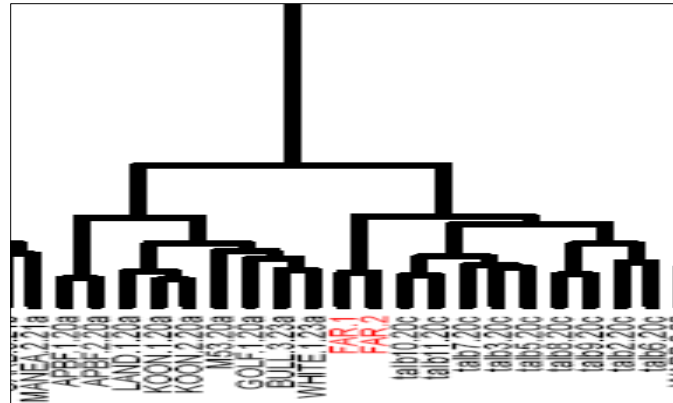


Figure D13: Bray Ward Clustering. Two Site Insertion of **FAR-1** & **FAR-2** (both shown to cluster with FCT20c in previous SSI analyses) into Gibson *et al.* (1994) SCP dataset: The inserted sites cluster with the Gibson **FCT 20c** sites.

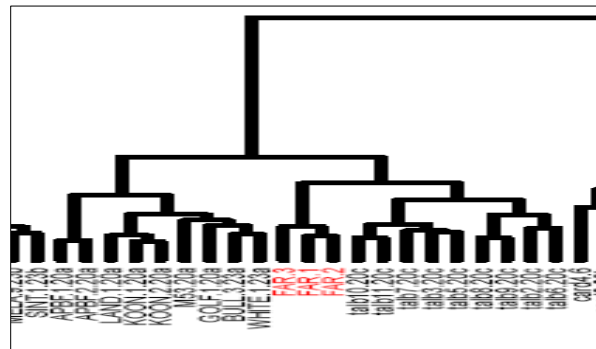


Figure D14: Bray Ward Clustering. Three Site Insertion of **FAR-1**, **FAR-2** & **FAR-3** (all shown to be FCT 20c in previous SSI analyses) into Gibson *et al.* (1994) SCP dataset: The inserted sites cluster with the Gibson **FCT 20c** sites.

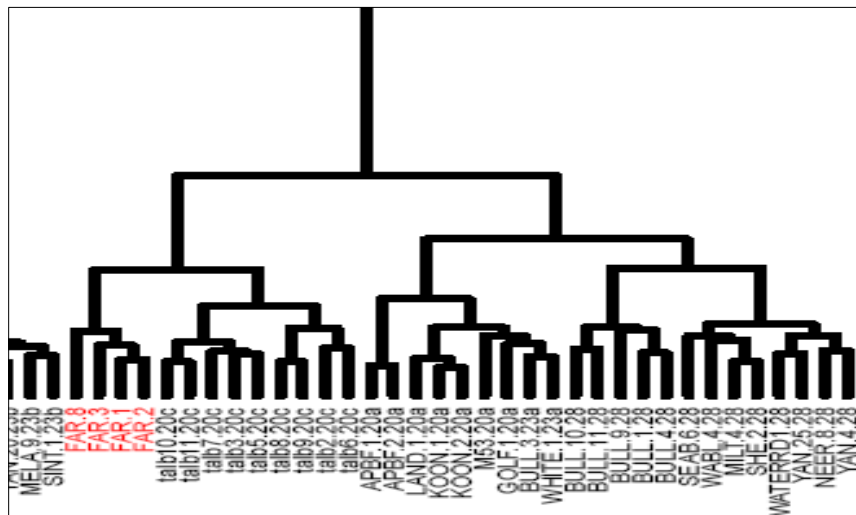


Figure D15: Bray Ward Clustering. Four Site Insertion of **FAR-1**, **FAR-2**, **FAR-3** & **FAR-8** (all shown to be FCT 20c in previous SSI analyses) into Gibson *et al.* (1994) SCP dataset: The inserted sites cluster together with the Gibson **FCT 20c** sites as a sister group. Interestingly the FCT 20a sites of Gibson are moved out of the resultant FCT 20c cluster into a higher order group to cluster with some Gibson FCT 23a sites and a FCT 28 sister group

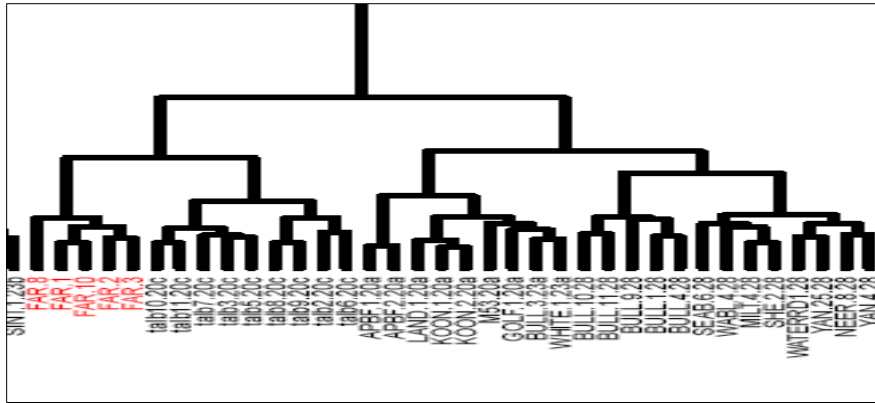


Figure D16: Bray Ward Clustering. Five Site Insertion of **FAR-1, FAR-2, FAR-3, FAR-8 & FAR-10** (all shown to be FCT 20c in previous SSI analyses) into Gibson *et al.* (1994) SCP dataset: The inserted sites cluster with the Gibson FCT 20c sites.

[Interestingly the FCT 20a sites of Gibson are moved out of the resultant FCT 20c cluster into a higher order group to cluster with 23a sites with a sister group of mainly FCT 28 of Gibson.]

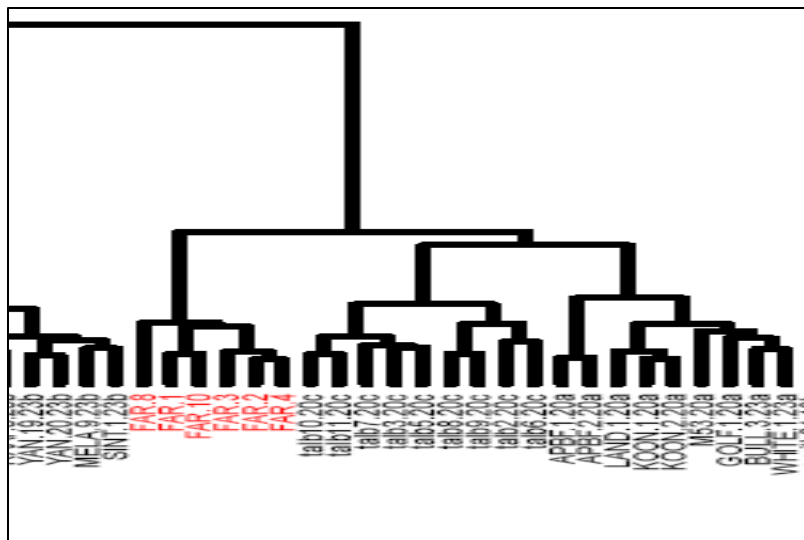


Figure D17: Bray Ward Clustering. Six Site Insertion of **FAR-1, 2, 3, 4, 8 & 10** into Gibson *et al.* (1994) SCP dataset. (FAR-4 was previously shown to group in SSI with FCT 20a). These six sites inserted from Lot 102 form a sister group to the Gibson cluster of [FCT20c plus FCT 20a and some FCT 23a].

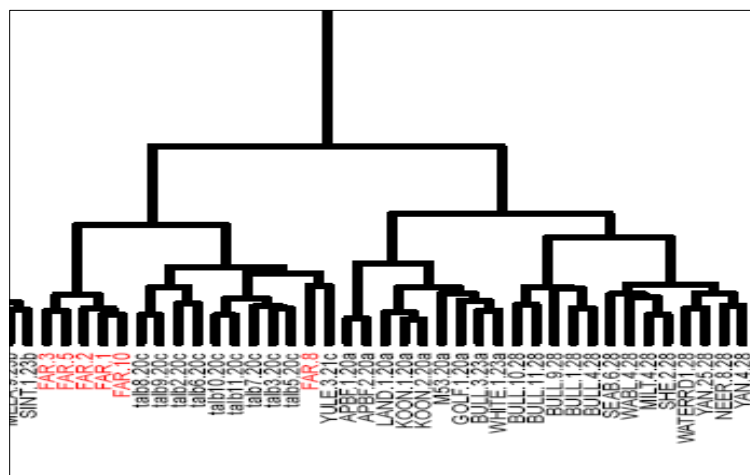


Figure D18: Bray Ward Clustering. Six Site Insertion of **FAR-1, 2, 3, 5, 8 & 10** into Gibson *et al.* (1994) SCP dataset. (FAR-5 was previously shown to group in SSI with FCT 20a). Five of these sites inserted from Lot 102 form a sister group to the Gibson cluster of [FCT20c plus FAR-8 and an FCT21c site of the eastern SCP].

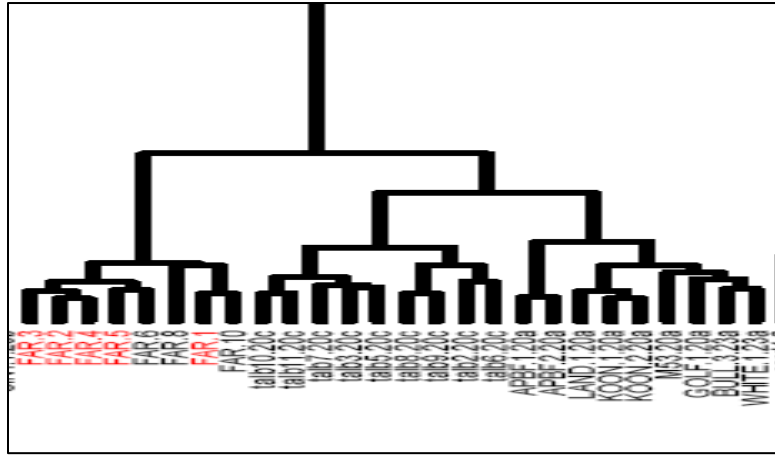


Figure D19: Bray Ward Clustering. Eight Site Insertion of **FAR-1, FAR-2, FAR-3, FAR-4, FAR-5, FAR-6, FAR-8 & FAR-10** into Gibson *et al.* (1994) SCP dataset. (The inserted sites all cluster with FCT 20c in SSI, except FAR-4 and FAR-5 that clustered with FCT 20a). The sites inserted from Lot 102 in this eight site insertion formed a sister group to the Gibson cluster [FCT20c plus FCT 20a with two FCT 23a sites].

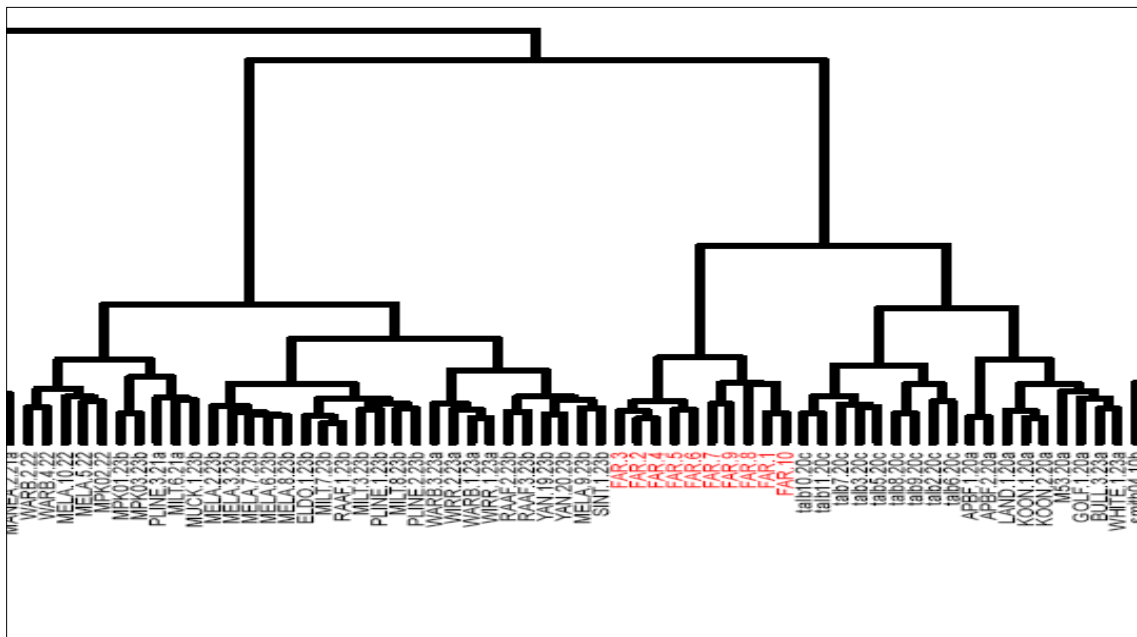


Figure D20: Bray Ward Clustering. Ten Site Insertion of Lot 102 quadrats into Gibson *et al.* (1994) SCP dataset: The Lot 102 sites cluster strongly with each other and so form a sister group to the Gibson FCT20c and FCT 20a cluster. This relationship illustrates the strong similarities of the FAR sites to each other and that they are as a group also closely related to FCT 20c & FCT 20a sites of Gibson. The FAR-6, FAR-7 and FAR-9 sites that show the most signs of disturbance and the FAR-4 and FAR-5 that tend to cluster with FCT 20a in SSI, move the sites FAR-1, FAR-2, FAR-3, FAR-8, FAR-10 and FAR-5 that cluster most strongly with FCT 20c out of the FCT 20c/ FCT 20a cluster of Gibson.

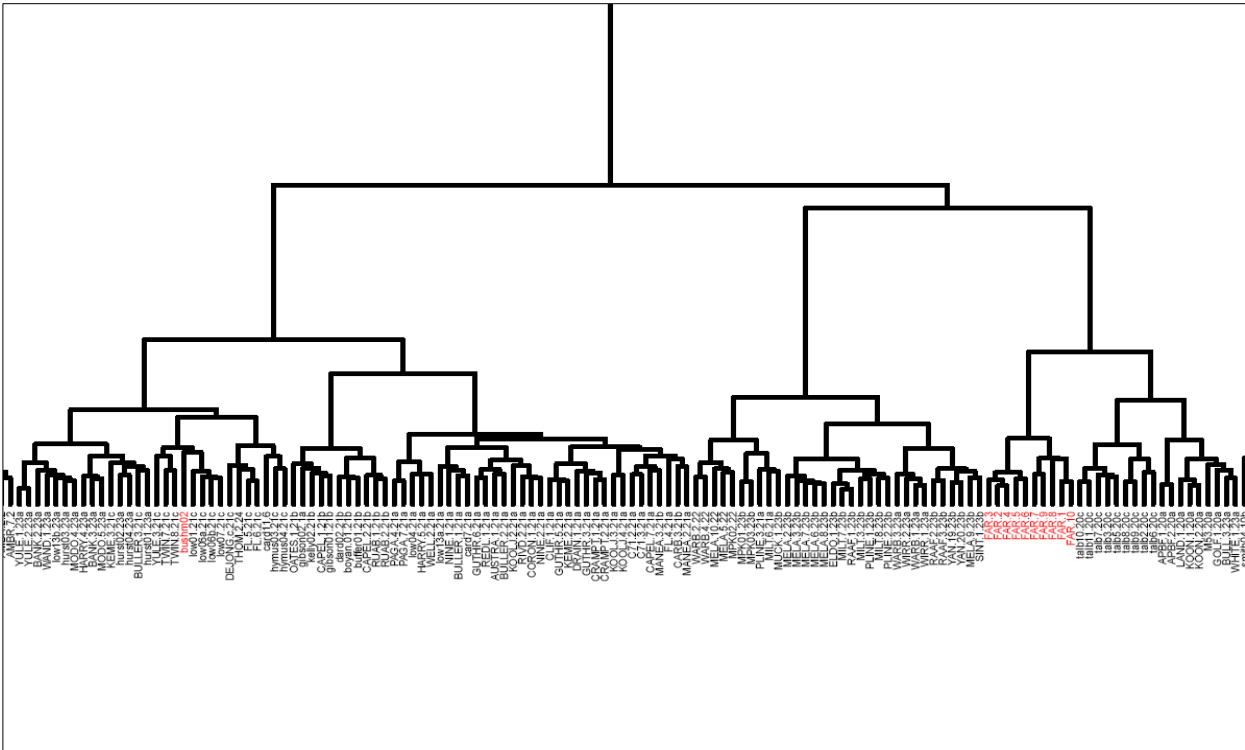


Figure D21 : (View at 200%) Bray Ward Clustering for Bushmead (**bushmo2**) site added to **Ten Site Insertion of Lot 102** quadrats into Gibson *et al.* (1994) SCP dataset: The bushmo1 site clusters with FCT 21c of the SCP Dataset.

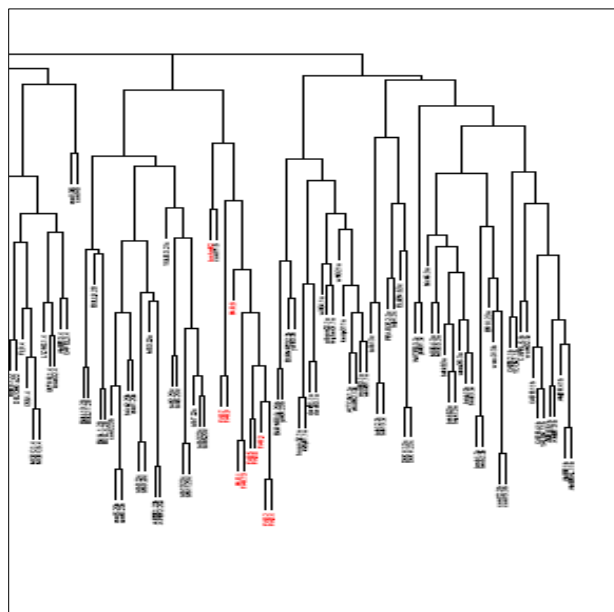


Figure D22: Complete Linkage Clustering for Bushmead (**bushmo2**) site **with ten sites of Lot 102 quadrats** into Gibson *et al.* (1994) SCP dataset. The bushmo1 site clusters with Card-11 (FCT 6) a weedy site of the Ridge Hill Shelf and the FAR1-10 sites. The sister group of (FAR1-10 , bushmo2 & card-11) comprises all of the talb FCT20c sites , the three eastern SCP FCT 20a sites (APBF-1 , APBF-2 and M53), two FCT23a sites (BULL-3 and WHITE-1), YULE-3 FCT21c, and some card FCT 20b sites and a BRICK FCT 20b site of the Ridge Hill Shelf. The Bushmead site is thus interpreted as a weedy FCT 20c site, unambiguously allied with the Ridge Hill Shelf.