GARDEN STREET EXTENSION, SOUTHERN RIVER

TARGETED WETLAND VEGETATION ASSESSMENT

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pgv ENVIRONMENTAL

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1 INTRODUCTION

1.1 Background

The City of Gosnells proposes to extend Garden Street 0.8km from Harpenden Street to the intersection of Balfour and Holmes Streets (the site). The proposed construction will require the clearing of 4.35ha of native vegetation including both dryland and wetland vegetation types.

The proposed extension of the street was referred on 3 July 2016 under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (EPBC 2016/7735) and was determined to be a 'Controlled Action'. The Controlled Action level of assessment was determined on the basis that the proposed works could significantly impact on Department of the Environment and Energy (DotEE) eight matters listed under Section 18 and 18A of the Act including six plant species and two animal species.

The Preliminary Documentation for the proposal was advertised for public comment from ~~19~~ 17 January 2017 to 20 February 2017. Four of the 12 submissions raised the possibility that the 'Claypans of the Swan Coastal Plain' Threatened Ecological Community (TEC) may occur on the site. This vegetation type was not recorded in the original vegetation assessment undertaken on the site by Natural Area Consulting (2016) Wayne - 360's report?

The possibility that the Claypans of the Swan Coastal Plain TEC might occur on the site was based on a report titled *Reconnaissance level field survey and review of environmental impacts of the proposed Garden Street extension* by Tauss and Associates Biodiversity Consultants (2017) which was included as an appendix to the submission by the Urban Bushland Council.

Tauss and Associates considered that the area mapped by Natural Area Consulting (2016) as *Melaleuca systena* Closed Tall Scrub was in fact *Melaleuca viminea* Closed Tall Scrub. The Tauss and Associates report included an analysis of why they considered the vegetation containing *M. viminea* was the Claypans of the Swan Coastal Plain TEC. The assessment was based on Tauss and Associates' field work necessarily undertaken in February 2017 which was then compared to the criteria outlined in the Conservation Advice for the TEC. Tauss and Associates acknowledged that the timing and methodology of the survey was not ideal to survey for the Claypans TEC. Tauss and Associates assessment was also based on the assumption that geophytic and annual species were likely to be present in earlier flowering seasons especially from August to November.

PGV Environmental was commissioned by the City of Gosnells to determine whether the Claypans of the Swan Coastal Plain TEC occurs in the proposed road extension site. The work included:

- Sampling from 10m x 10m quadrats within vegetation containing *Melaleuca viminea* in late spring and early summer; within the Garden Street area or a different area?
- Undertaking computer analysis of the quadrat data; and
- Using the results of the field work and computer analysis to determine the Floristic Community Type of the *M. viminea* vegetation.

2 SITE DESCRIPTION

2.1 Vegetation

The vegetation on the site was surveyed between 12 and 16 October 2015 by Natural Area Consulting (NAC, 2016).

- *Banksia attenuata*, *Kunzea glabrescens*, *Melaleuca preissiana* Low Open Woodland;
- *Melaleuca preissiana* woodland over *Astartea affinis*;
- *Banksia attenuata* and *Eucalyptus todtiana* Low Open Woodland;
- *Melaleuca preissiana* Low Open Woodland and *Regelia* Shrubland;
- *Melaleuca viminea* Closed Tall Scrub;
- *Phlebocarya ciliata* and *Dasypogon bromeliifolius* Closed Sedgeland; and
- *Banksia*, *Allocasuarina fraseriana* Woodland.

The *Melaleuca viminea* Closed Tall Scrub was incorrectly described by NAC as *Melaleuca systena* Closed Tall Scrub. As pointed out by Tauss and Associates *M. systena* is a shrub that occurs on coastal dunes. *Melaleuca viminea* subsp. *viminea* occurs throughout the south-west of Western Australia in winter-wet depressions and along watercourses, consistent with the conditions in which it occurs on the Garden Street Extension site.

The wetland vegetation was determined by NAC to be consistent with Floristic Community Type 4 '*Melaleuca preissiana* damplands'. This determination was based on the presence of species considered to be typical of FCT 4 rather than being based on computer analysis of quadrat data. The NAC report did not contain any quadrat information in the area mapped as *M. viminea (M. systena)* Closed Tall Scrub. Confirm with Wayne

2.2 Soil Type

Three soil types are mapped in the Garden Street extension road reserve. The soil type in the core wetland area is mapped as:

- Pinjarra Sp1 Phase (213Pj_Sp1) which are Peaty Sand – grey to black, fine to medium-grained, moderately sorted quartz sand, slightly peaty, of lacustrine origin.

Douglas Partners installed a test bore in the wettest part of the wetland on the side of the north-south track on 5 December 2017. The bore log records show the following:

0 – 0.28m	Topsoil (Silty Sand) – brown, fine to medium grained silty sand with some organic matter and peat, moist
0.28 – 0.7m	Silty Sand – brown, fine to medium grained silty sand – becoming wet from 0.6m
0.7 – 1.8m	Sand – brown, fine to medium grained sand, wet – with a trace of clay from 1.0m.
1.8 – 2.5m	Clay – brown-grey, low plasticity clay.
2.5 – 3.0m	Silty Sand – brown, fine to medium grained silty sand.

2.3 Hydrology

The core wetland area on the site, which includes the vegetation containing *Melaleuca viminea*, regularly becomes inundated in winter/spring. Google Earth imagery shows extensive areas of water in the tracks and likely within the wetland vegetation in three of the last 5 years in winter/spring.

PGV Environmental observed the water depth in the wetland vegetation to be up to 0.2m deep in 2016 (Plate 1). In 2017 the above-ground water in the vegetated areas receded below ground in early December.

A track that runs north-south through the wetland is slightly deeper than the surrounding natural vegetation due to vehicle use and is inundated for longer periods and at greater depth (Plate 2).

Plate 1: Inundated vegetation (27 Sept 2016)

Plate 2 Inundated track (29 Sept 2017)

3 METHODOLOGY

3.1 Targeted Wetland Vegetation Survey

3.1.1 Site Survey

Prior to selecting sites for quadrat analysis, the boundary of the area containing the *Melaleuca viminea* Closed Tall Scrub was mapped using a hand-held GPS on 16 November 2017 (Figure 1). The *Melaleuca viminea* Closed Tall Scrub vegetation commonly contained the shrub species *Melaleuca viminea, Melaleuca teretifolia* and *Astartea affinis* 1-3m high and a ground cover of rushes and sedges, particularly *Leptocarpus decipiens* and *Leptocarpus roycei*. The vegetation was not completely uniform, however, and varied in the presence and abundance of the main species. *Melaleuca viminea*, for example, was not always present.

Surrounding the core area of *Melaleuca viminea* Closed Tall Scrub was a broad area of dense *Regelia ciliata* Closed Heath and dense stands of *Melaleuca preissiana* and *M. rhaphiophylla* Low Closed Forest. These vegetation types also intermixed with the *Melaleuca viminea* vegetation.

Four quadrats were sampled from within the mapped *Melaleuca viminea* Closed Tall Scrub vegetation and one quadrat was sampled as a comparison from the *Regelia ciliata* Closed Heath vegetation type.

The corners of each quadrat were pegged with fence droppers and the co-ordinates of the centre of the quadrat was taken using a hand-held GPS.

Plant species height and percentage cover were recorded from the quadrats on three occasions, 16 November 2017, 15 December 2017 and 23 January 2018. The late start to the first assessment in mid-November was due to the core wetland area being inundated from September through to early December in 2017.

3.1.2 Computer Analysis

The quadrat data were analysed using the multi-variate computer programme PRIMER by RPS Environmental Consultants (Appendix 3). The analysis used the original Gibson *et al.* (1994) dataset of 508 10m x 10m quadrats as well as the Supplementary dataset of Keighery *et al.* (2012) which included 590 quadrats.

4 CLAYPANS OF THE SWAN COASTAL PLAIN TEC

4.1 Location

The Claypans of the Swan Coastal Plain TEC occurs scattered throughout the Swan Coastal Plain bioregion as well as some occurrences of clay pans in the Jarrah Forest bioregion (Claypans of the Swan Coastal Plain Conservation Advice, 2012).

4.2 Geology, Landforms and Hydrology

The Conservation Advice states that the Claypans TEC occurs predominantly on the Pinjarra Plain but can also occur across the Bassendean dunes and the Ridge Hill Shelf.

The clay-based wetlands that include the Claypans TEC contain dense, compact and fairly impermeable layer of clay in the soil or subsoil. Water accumulates in the claypans directly from rainfall and small-scale local surface flow and are not considered to be connected to the local groundwater.

The claypans fill during winter rains and dry out completely over summer.

4.3 Vegetation

The Claypans of the Swan Coastal Plain TEC generally occurs as a shrubland and less commonly as a low, open woodland. The wetter parts of the TEC have a ground cover of geophytes, herbs and sedges. There are no dominant species that characterise the TEC.

The Conservation Advice states:

> *A distinctive feature of the particular clay pan wetlands that comprise the ecological community is the suite of geophytes and annual flora that germinates, grows and flowers sequentially as these areas dry over summer, producing a flora display for over three months* (DotEE, 2012).

The Claypans TEC comprises five ecological communities recognised by the Western Australian Department of Biodiversity Conservation and Attractions (DBCA) and described in the Listing Advice as follows:

- **Herb rich saline shrublands in clay pans (Community Type 7 (SCP07))**

This vegetation community type occurs on heavy clay soils that are generally inundated from winter to mid-summer. In early spring many of the sites in this vegetation community are covered by free water up to 30 cm deep. Aquatic species are common in this vegetation community early in the growing season. *Cotula coronopifolia* (water buttons) can form yellow floating mats in some pools while others are dominated by *Ornduffia submersa*. As the wetland dries a succession of species such as *Centrolepis* spp. and annual *Stylidium* spp. (trigger plants) successively germinate, grow and flower, resulting in an extended flowering period of over three months.

Structurally this vegetation community type is quite variable ranging from woodlands to herblands, the most common overstorey taxa being *Melaleuca viminea, M. uncinata* (broom bush)*, M. cuticularis*

(saltwater paperbark) or *Casuarina obesa* (swamp sheoak). The species saltwater paperbark and swamp sheoak may indicate some saline influence for at least some part of the year.

Typical species in the understorey include the common herbs *Brachyscome bellidioides*, *Centrolepis polygyna* (wiry centrolepis), *Pogonolepis stricta* and water buttons. In addition, species such as *Angianthus* aff. *drummondii*, *Eryngium pinnatifidum* subsp. *palustre* ms, and *Blennospora drummondii* occur in low frequency (<50%) and are absent from the other four vegetation community types (SCP08, SCP09, SCP10a and 117).

- **Herb rich shrublands in clay pans (Community Type 8 (SCP08))**

This vegetation community type occurs in low lying flats with a clay impeding layer allowing seasonal inundation. While aquatic annuals are common, the pools are probably not inundated to the same depth or for the same length of time as in ecological community type 7.

This vegetation community type is dominated by one or more of the shrubs: *Viminaria juncea*, *Melaleuca viminea*, *M. lateritia* (robin redbreast bush), broom bush*, Kunzea micrantha* or *K. recurva* with occasional emergents of *Eucalyptus wandoo* (wandoo). Species such as *Hypocalymma angustifolium* (white myrtle), *Acacia lasiocarpa* var. *bracteolata* long peduncle variant (G. J. Keighery 5026) and *Verticordia huegelii* (variegated featherflower) occur at moderate frequencies. This vegetation community type has a high percentage of weeds and appears to be the clay pan vegetation community type that has the greatest disturbance.

- **Dense shrublands on clay flats (Community Type 9 (SCP09))**

This vegetation community type is shrublands or low open woodlands on clay flats that are inundated for long periods because it usually occurs very low in the landscape. Sedges are more apparent in this ecological community and include *Chorizandra enodis* (black bristlerush), *Cyathochaeta avenacea*, *Lepidosperma longitudinale* (pithy sword-sedge) and *Meeboldina coangustata*. Shrubs include *Hakea varia* (variable-leaved hakea) and *Melaleuca viminea* and occasionally *Xanthorrhoea preissii, Xanthorrhoea drummondii* (grass trees) and *Kingia australis*.

This vegetation community type has a lower species richness and weed frequency than in the other clay pan community types, presumably because of the longer inundation times.

- **Shrublands on dry clay flats (Community Type 10a (SCP10a))**

This is the most rapidly drying of the clay flats vegetation community types. The microtopography is generally shallower and they have thin skeletal soils. This vegetation community type has a high species richness and includes the aquatic annuals and geophytes typical of other clay pan and clay flat vegetation community types (e.g. *Schoenus natans* (floating bog-rush), *Crassula natans*, *Eryngium pinnatifidum* subsp. *palustre* ms, *Wurmbea dioica* subsp. *alba* (early nancy) and *Amphibromus nervosus*). There are many species of herbs in this vegetation community type in spring. The shrub layer is dominated by species of *Hakea* (*H. varia* and *H. sulcata*) which, along with *Pericalymma ellipticum* (swamp teatree)*,* is indicative of a short inundation period.

- **Clay pans with shrubs over herbs (Community Type 117)**

These clay pans are predominantly deeper basin clay pans usually dominated by a shrubland of robin redbreast bush with a thick understorey of herbs. This vegetation community type occurs on the Swan

Coastal Plain with disjunct occurrences in the Jarrah Forest bioregion (including the adjacent Darling plateau at Drummond Nature Reserve).

These clay pans are characterised by aquatic taxa (*Hydrocotyle lemnoides* (aquatic pennywort)) and amphibious taxa (e.g. *Glossostigma diandrum*, *Liparophyllum capitatum*, and *Eleocharis keigheryi*). Species richness is still high but is lower than in SCP07 and SCP08.

4.4 Condition Classes and Hydrological Regime

According to the Listing Advice the area of vegetation must have a functioning hydrological regime and meet a minimum Good condition using the Bush Forever condition rating scale (Government of Western Australia, 2000).

A functioning hydrological regime is described as one that will provide the natural seasonal hydrological pattern (winter and spring clay pan submersion, followed by drying of the clay pan during the summer and autumn) necessary to support the flora and fauna of the ecological community.

4.5 Patch Size

A patch is defined as a discrete and continuous area that comprises the ecological community. The smallest Claypans of the Swan Coastal Plain TEC mapped by DBCA is 0.013ha with 16% smaller than 0.5ha. No minimum patch size was recommended in the Listing Advice on the basis that the Claypans TEC can be very small and are able to resist weed invasion due to the density of vegetation, seasonal inundation and dry, impenetrable clay-based soils in summer (Government of Western Australia, 2000).

5 RESULTS

5.1 Quadrat Data

Species richness in the four quadrats sampled from the *Melaleuca viminea* vegetation type ranged from 12 – 22 per 10m x 10m plot (Appendix 1). Quadrat GS5 had a higher density of shrub cover which would have reduced the number of species on the site. The species richness of the quadrat sampled from the *Regelia ciliata* Closed Heath was higher, at 28, presumably due to the drier conditions of the site which are more tolerable to a greater range of species.

Species that were most commonly recorded in the *Melaleuca viminea* quadrats were *Melaleuca viminea, Astartea affinis, Pericalymma ellipticum, Acacia pulchella* var. *glaberrima, Leptocarpus decipiens, Melaleuca lateritia, Melaleuca teretifolia, Euchilopsis linearis* and *Lepidosperma longitudinale*.

Quadrat GS4 was transitional between the *Melaleuca viminea* Tall Open Scrub and *Regelia ciliata* Closed Heath vegetation types and did not have any *M. viminea* or any *Leptocarpus* species as were common in GS1, 2 and 3.

The condition of the vegetation in all quadrats was Excellent with very few introduced species recorded.

The soil type in the four quadrats sampled in the *Melaleuca viminea* vegetation was all a black-brown peaty sand which was waterlogged to shallowly inundated on 16 November 2017. The soil type of the quadrat sampled in the *Regelia ciliata* Closed Heath was grey-black sand that was not waterlogged.

A total of 57 species was recorded from the five quadrats including 51 native and 6 introduced species (Appendix 2). Most of the species recorded in the quadrats were recorded in the first November survey. Very few additional species were recorded in subsequent assessments on 15 December 2017 and 23 January 2018. Table 1 shows the additional species recorded on 15 December 2017. The percentage cover of the newly recorded species was in all instances less than 1%.

Overall, there were very few geophytes and annual flora recorded in the quadrats or in the wetland area in general. Ephemeral species recorded in quadrats included *Anthotium junciforme, Aphelia brizula, Lobelia tenuior, Microtis media, Ornduffia albiflora* and *Prasophyllum drummondii.*

Outside of the quadrats *Anthotium junciforme* and *Lobelia anceps* were common near quadrat GS2 in December and *Anthotium junciforme* was scattered through the site in January 2018.

Anthotium junciforme and *Goodenia pulchella* subsp. Swan Coastal Plain (M. Hislop 634) were common on the side of the main north-south track in December and January (Plate 3) as well as on some slightly raised mounds next to the track.

Table 1: Additional species recorded on 15 December 2017 and 23 January 2018

Species	GS1	GS2	GS3	GS4	GS5
Anthotium junciforme		+	+		
Aphelia brizula					+
Centella asiatica	+				
**Sonchus oleraceus*					+
Stylidium repens					+
Thysanotus multiflorus	+	+			

Plate3: *Anthotium junciforme* on the side of the main track

5.2 Computer Analysis

The results of the computer analysis are provided in Appendix 3.

RPS Environmental Consultants considered that the floristic data from the five Garden Street quadrats was compatible with the Southern Swan Coastal Plain dataset due to consistencies in quadrat size, nomenclature, species richness and vegetation condition.

The results of the analysis were inconclusive as is often the case with multivariate analysis of quadrat data. The results show that the four quadrats sampled in the area generally mapped as *Melaleuca viminea* Closed Tall Scrub vegetation community had the greatest affinity with the following Gibson *et al.* Floristic Community Types:

- 12 '*Melaleuca teretifolia* and/or *Astartea* aff. *fascicularis* shrublands' (*Astartea* aff. *fascicularis* is now known as *Astartea affinis* in the Perth Metropolitan Region);
- FCT 13 'Deeper wetlands on heavy soils; and
- FCTS03 'Wet sedgelands on sandy clays'

The quadrat sampled from outside the *Melaleuca viminea* Closed Tall Scrub vegetation community and contained the *Regelia ciliata* vegetation type (GS4) had a strong affinity with FCT 4 '*Melaleuca*

preissiana damplands' and FCT 21c 'Low lying *Banksia attenuata* woodlands or shrublands'. Given the site is a wetland, FCT 4 is considered the most likely match for GS4.

None of the quadrats had a similarity with any of the Claypans of the Swan Coastal Plain FCTs (7, 8, 9, 10a and 117).

5.3 Assessment Against Claypans of the Swan Coastal Plain TEC Criteria

The following assessment of the vegetation in the core wetland area on the Garden Street extension area has been made using the description of the Claypans of the Swan Coastal Plain TEC contained in the Listing Advice and Conservation Advice.

Location

The Garden Street site is located in the Swan Coastal Plain bioregion where most of the Claypan TECs occur.

Geology

The mapped soil type in the core wetland area is:

- Pinjarra Sp1 Phase (213Pj_Sp1) which are Peaty Sand – grey to black, fine to medium-grained, moderately sorted quartz sand, slightly peaty, of lacustrine origin.

The soil type in the core wetland quadrats matches this description. The soil type meets the definition on which most of the Claypan TEC sites are located.

The test hole dug for the ASS sampling in December 2017 in the middle of the core wetland area contained a 0.7m thick lens of clay at a depth of 1.8-2.5m below ground level. The presence of clay meets the definition of the Claypan TEC having dense, compact clay in the soil or subsoil. The presence of clay in a wetland, however, is not restricted to FCTs that make up the Claypan TEC. Wetland FCTs 12 and S03, which are not part of the Claypan TEC, also contain clay soils.

Hydrology

The core wetland area has contained above-ground water in winter/spring in most of the recent years. It is not known whether the water is groundwater or perched above the subsoil clay layer. The water is more likely to be perched and filled by rainfall rather than being connected to the local groundwater.

The wetland areas always appear to dry out in summer.

The hydrological features of the core Garden Street wetland meet the definition of the Claypans TEC.

Vegetation

The vegetation in the core *Melaleuca viminea* Closed Tall Scrub vegetation on the site does not meet the definition of the Claypan TEC for the following reasons:

1. The vegetation does not exhibit a suite of geophytes and annual flora that germinate after the site dries out as is stated in the Conservation Advice as being the distinctive feature of the TEC. Very few annuals and geophytes were recorded on the site and most occurred at low

density. The abundance of *Anthotium junciforme* and *Goodenia pulchella* subsp. Swan Coastal Plain (M. Hislop 634) predominantly on the edge of the main track that runs through the wetland as well as on raised mounds suggests their presence is more due to a preference for open, disturbed sites rather than being a feature of a claypan wetland.

2. Computer analysis of the quadrat data did not show any alliance of the quadrats to any of the four ecological communities in the Perth Metropolitan Region that comprise the Claypans TEC.

3. The Claypan TEC has a very high species richness, made up mostly of the ephemeral ground layer of plants rather than the perennial shrub species. The quadrats sampled on the Garden Street site had a low species richness comprising mostly of perennial shrub species; and

4. The Claypans TEC vegetation structure is typically a Shrubland with a low density of shrubs 1-2m tall. The low density allows the open ground cover to display the geophytes and herbs that distinguishes the TEC from other wetland FCTs. The wetland vegetation on the Garden Street site is very dense, almost 100% cover of mid - to tall shrubs and dense rushes which does not allow a dense cover of geophytes and annuals to grow.

6 CONCLUSION

Field studies followed by computer analysis of quadrat data show that the core wetland vegetation in the Garden Street road reserve that contains *Melaleuca viminea* vegetation is not one of the Floristic Community Types that characterise the Claypans of the Swan Coastal Plain TEC. The Garden Street wetland contains very few geophytes and annuals in the understorey that characterise the Claypans of the Swan Coastal Plain TEC.

7 REFERENCES

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FIGURES

APPENDIX 1

Quadrat data

QUADRAT GS1

50 401565 E 6449009 N

Vegetation: *Melaleuca viminea* Tall Open Scrub over *Astartea affinis* Shrubland over *Leptocarpus decipiens* Sedgeland

Condition: Excellent

Soil Type: Dark brown – black peaty sand, 1cm deep water in western half

Landform: Flat

QUADRAT (10 x 10m)

SPECIES	HEIGHT (m)	COVER (%)
Melaleuca viminea	2.5-3	25
Acacia saligna	3	2
Hakea varia	2	5
Astartea affinis	1.6	10
Melaleuca teretifolia	1.3	<1
Leptocarpus decipiens	1.2	50
Acacia pulchella var. *glaberrima*	1.2	<1
Melaleuca lateritia	1.1	<1
Kunzea glabrescens	1	2
Regelia ciliata	1	1
Euchilopsis linearis	0.8	2
Prasophyllum drummondii	0.8	<1
Pericalymma ellipticum	0.6	5
Lepidosperma longitudinale	0.4	2
Thysanotus multiflorus	0.4	<1
Thelymitra sp	0.4	<1
Microtis media	0.4	<1

SPECIES	HEIGHT (m)	COVER (%)
Ornduffia albiflora	0.3	<1
Centella asiatica	0.2	<1
Cassytha racemosa forma *racemosa*	climber	<1
Cassytha glabella forma *dispar*	climber	<1

* introduced species

QUADRAT GS2

50 401580 E 6448982 N

Vegetation: *Melaleuca viminea/Hakea varia* Tall Shrubland over *Astartea affinis* Shrubland over *Leptocarpus decipiens/Leptocarpus roycei/Lepidosperma longitudinale* Sedgeland

Condition: Excellent

Soil Type: Blackish brown peaty sand, waterlogged (not inundated)

Landform: Flat

QUADRAT (10 x 10m)

SPECIES	HEIGHT (m)	COVER (%)
Hakea varia	2.8	5
Melaleuca viminea	2.2	20
Melaleuca teretifolia	2	1
Astartea affinis	1.9	10
Pericalymma ellipticum	1.7	2
**Acacia longifolia*	1.7	2
Melaleuca lateritia	1.6	15
Leptocarpus decipiens	1.2	20
Leptocarpus roycei	1	15
Patersonia occidentalis	1	1
Lepidosperma longitudinale	0.9	30
Acacia pulchella var. *glaberrima*	0.8	<1
Euchilopsis linearis	0.6	1
Calothamnus lateralis	0.6	<1
Lobelia anceps	0.5	<1

SPECIES	HEIGHT (m)	COVER (%)
Anthotium junciforme	0.5	<1
Dampiera linearis	0.4	15
Microtis media	0.3	<1
Thysanotus multiflorus	0.3	<1
Cassytha racemosa forma *racemosa*	climber	1

* introduced species

QUADRAT GS3

50 401537 E 6449032 N

Vegetation: *Melaleuca viminea/Hakea varia* Tall Shrubland over *Astartea affinis* Open Heath over *Leptocarpus decipiens* Sedgeland

Condition: Excellent

Soil Type: Blackish brown peaty sand, waterlogged (not inundated)

Landform: Flat

Quadrat (10 x 10m)

SPECIES	HEIGHT (m)	COVER (%)
Hakea varia	3	15
Melaleuca viminea	2	10
Acacia pulchella var. *glaberrima*	1.7	1
Calothamnus lateralis	1.5	2
Leptocarpus decipiens	1.4	10
Melaleuca rhaphiophylla	1.3	1
Astartea affinis	1.2	50
Melaleuca lateritia	1	5
Pericalymma ellipticum	1	2
Melaleuca teretifolia	1	2
Euchilopsis linearis	0.8	5
Lepidosperma longitudinale	0.8	2
Prasophyllum drummondii	0.7	<1
Schoenus pedicellatus	0.4	<1
Dampiera linearis	0.3	<1
Anthotium junciforme	0.3	<1
Phlebocarya ciliata	0.3	<1
Cassytha racemosa forma *racemosa*	climber	<1

* introduced species

QUADRAT GS4

50 401576 E 6449044 N

Vegetation: *Regelia ciliata* Closed Heath
Condition: Excellent
Soil Type: Greyish black sand, damp (not waterlogged)
Landform: Flat

QUADRAT (10 x 10m)

SPECIES	HEIGHT (m)	COVER (%)
Kunzea glabrescens	3	2
Regelia ciliata	1	90
Xanthorrhoea preissii	1.1	<1
Xanthorrhoea brunonis	1	1
Acacia pulchella var. *glaberrima*	0.9	1
Euchilopsis linearis	0.6	1
Schoenus efoliatus	0.6	<1
**Gladiolus caryophyllaceus*	0.5	<1
Beaufortia squarrosa	0.5	<1
Phlebocarya ciliata	0.4	2
Burchardia congesta	0.4	<1
Austrostipa compressa	0.4	<1
**Ursinia anthemoides*	0.4	<1
Hypolaena exsulca	0.4	<1
Tricoryne tenella	0.4	<1
Lomandra sericea	0.4	<1
Gompholobium tomentosum	0.4	<1

SPECIES	HEIGHT (m)	COVER (%)
Lyginia barbata	0.4	<1
Dasypogon bromeliifolius	0.3	5
Lomandra hermaphrodita	0.3	<1
Thysanotus thyrsoideus	0.3	<1
**Briza maxima*	0.3	<1
Lobelia tenuior	0.2	<1
Chamaescilla corymbosa	0.2	<1
Laxmannia squarrosa	0.2	<1
Trachymene pilosa	0.1	<1
**Hypochaeris radicata*	flat	<1

* introduced species

QUADRAT GS5

50 401540 E 6448592 N

Vegetation: *Kunzea glabrescens* Tall Shrubland over *Regelia ciliata/Astartea affinis* Closed Heath
Condition: Excellent
Soil Type: Black-brown peaty sand, waterlogged
Landform: Flat

QUADRAT (10 x 10m)

SPECIES	HEIGHT (m)	COVER (%)
Kunzea glabrescens	3	10
Regelia ciliata	1.7	70
Astartea affinis	1.5	30
Pericalymma ellipticum	1	1
Calothamnus lateralis	0.6	<1
Schoenus pedicellatus	0.4	<1
Hypolaena exsulca	0.4	<1
Euchilopsis linearis	0.3	<1
**Sonchus oleraceus*	0.3	<1
Drosera stolonifera	0.2	<1
Stylidium repens	0.1	<1
Aphelia brizula	<0.1	<1

* introduced species

APPENDIX 2

Quadrat Species List

Garden Street Wetland Quadrats

Species	Quadrat				
	GS1	GS2	GS3	GS4	GS5
**Acacia longifolia*		✓			
Acacia pulchella var. *glaberrima*	✓	✓	✓	✓	
Acacia saligna	✓				
Anthotium junciforme		✓	✓		
Aphelia brizula					✓
Astartea affinis	✓	✓	✓		✓
Austrostipa compressa				✓	
Beaufortia squarrosa				✓	
**Briza maxima*				✓	
Burchardia congesta				✓	
Calothamnus lateralis		✓	✓		✓
Cassytha glabella forma *dispar*	✓				
Cassytha racemosa forma *racemosa*	✓	✓	✓		
Centella asiatica	✓				
Chamaescilla corymbosa				✓	
Dampiera linearis		✓	✓		
Dasypogon bromeliifolius				✓	
Drosera stolonifera					✓
Euchilopsis linearis	✓	✓	✓	✓	✓
**Gladiolus caryophyllaceus*				✓	
Gompholobium tomentosum				✓	
Hakea varia	✓	✓	✓		
**Hypochaeris radicata*				✓	
Hypolaena exsulca				✓	✓
Kunzea glabrescens	✓			✓	✓
Laxmannia squarrosa				✓	
Lepidosperma longitudinale	✓	✓	✓		
Leptocarpus decipiens	✓	✓	✓		
Leptocarpus roycei		✓			
Lobelia anceps		✓			
Lobelia tenuior				✓	
Lomandra hermaphrodita				✓	
Lomandra sericea				✓	
Lyginia barbata				✓	
Melaleuca lateritia	✓		✓		
Melaleuca rhaphiophylla			✓		
Melaleuca teretifolia	✓	✓	✓		
Melaleuca viminea	✓	✓	✓		
Microtis media	✓	✓			
Ornduffia albiflora	✓				
Patersonia occidentalis		✓			
Pericalymma ellipticum	✓	✓	✓		✓
Phlebocarya ciliata			✓	✓	
Prasophyllum drummondii	✓		✓		
Regelia ciliata	✓			✓	✓
Schoenus efoliatus				✓	

Species	Quadrat				
	GS1	GS2	GS3	GS4	GS5
**Sonchus oleraceus*					✓
Schoenus pedicellatus			✓		✓
Stylidium repens					✓
Thelymitra sp	✓				
Thysanotus multiflorus	✓	✓			
Thysanotus thyrsoideus				✓	
Trachymene pilosa				✓	
Tricoryne tenella				✓	
**Ursinia anthemoides*				✓	
Xanthorrhoea brunonis				✓	
Xanthorrhoea preissii				✓	

* indicates introduced species

APPENDIX 3

Computer Analysis (RPS)

REPORT

Garden Street Wetlands

Floristic Analysis Report

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No:	EEL18012.001		
Version:	Draft		
Date:	22/01/2018		

RPS

Document Status

Version	Purpose of Document	Author	Reviewed by	Review Date
Draft	Client Review	C Gill	J Halleen	

Approval for Issue of Final Report

Name	Signature	Date

RPS

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(contained within report text)

1 Introduction

1.1 Project Background

RPS Australia West (RPS) was engaged by PGV Environmental (PGV) to undertake a multivariate analysis of floristic survey data from five sites located in wetland vegetation at a site in Garden Street, Huntingdale.

1.2 Scope and Objectives

Floristic quadrat data (presence / absence) was analysed using multivariate techniques (via PRIMER v6 software) in order to classify the vegetation types within the survey area. The survey data was analysed against the combined southern Swan Coastal Plain dataset (Gibson *et al*. 1994; Keighery *et al.* 2012) in an effort to determine the Floristic Community Types present within the site.

1.3 SCP and Supplementary Datasets

Floristic Community Types (FCTs) are based on an original survey of the vegetation of the Swan Coastal Plain from Seabird to Dunsborough, completed by Gibson *et al.* (1994). The purpose of the survey was to determine the number and type of vegetation communities present across the southern Swan Coastal Plain and to then assess how much of each remained and whether they are adequately represented and protected within reserves. The Gibson *et al*. (1994) survey involved the sampling of 508 10 m x 10 m floristic plots.

The Supplementary dataset (Keighery *et al*. 2012) is derived from the results of several additional floristic studies completed between 1990 and 1996. These supplementary studies involved the sampling of an additional 590 floristic quadrats. The studies are summarised in Table 1. The combined 1098 site SCP and Supplementary dataset is now known as the “Southern Swan Coastal Plain (SCP) dataset”. The FCTs allocated to the Southern SCP quadrats differ to a degree from those in Gibson *et al.* (1994); this is because the original SCP quadrats were reanalysed in conjunction with the Supplementary survey quadrats, and the combined analysis resulted in a reassignment of some sites’ FCTs.

Table 1: Floristic studies used in the preparation of the SCP and Supplementary datasets

Study	Reference	Coverage	No. of Sampling Sites	Years of Survey
SCP	Gibson *et al*. (1994)	Southern Swan Coastal Plain	508	1990-1993
SYS6ENV	DEP (1996) – 1994 data	Southern Swan Coastal Plain	590	1993-1994
SYS6ENV2	DEP (1996) – 1994 data	Southern Swan Coastal Plain		1995-1996
GRIFFIN	Griffin (1993, 1994), Weston *et al*. (1993)	Swan Coastal Plain north of Perth		1993
GJKENV	Keighery (1996)	Tuart (*Eucalyptus gomphocephala*) woodlands on the Swan Coastal Plain		1990-1994

2 Methods

2.1 Multivariate Analysis of Floristic Data

All multivariate data analyses followed the procedures outlined in Clarke and Gorley (2006), and were carried out using the appropriate modules of the Primer statistical software package (Plymouth Marine Laboratory- Version 6) (PrimerV6) including Classification, Similarity Profile Analysis (SIMPROF), and Similarity of Percentages (SIMPER) (Clarke and Gorley 2006). The analyses aimed to compare the floristic composition of the sites sampled for Garden Street survey to the floristic composition of FCTs defined by Keighery *et al*. (2012).

The complete Southern SCP dataset (incorporating the original SCP dataset and Supplementary dataset) was used in these analyses because it was thought it was likely to improve the clarity and accuracy of the results because:

1. the 1098 site Southern SCP dataset constitutes a more comprehensive representation of the range of vegetation types present on the Swan Coastal Plain than the original 508 site SCP dataset; and
2. the Southern SCP analysis (Keighery *et al*. 2012) defined an additional eleven seasonal wetland FCTs many of which are in closer proximity to the Garden Street study area than any of the original SCP sites.

2.1.1 Data Preparation

The Garden Street survey data was reconciled with the Southern SCP dataset by standardising the names of taxa with those used in the earlier studies (current as at June 2005 when Bronwyn and Greg Keighery revised the taxonomy). This was necessary due to changes in nomenclature in the intervening period. Taxa that were only identified to genus level were excluded while some infraspecies that have been identified since these studies were reduced to species level. Taxonomic changes made to the Garden Street dataset for the purpose of these analyses are listed in Table 2. Once the taxonomy had been reconciled the data from the five Garden Street quadrats was combined with the 1098 site Southern SCP dataset in PrimerV6.

Table 2: Taxonomic reconciliation undertaken for the current analysis

Current Taxonomy	Keighery *et al*. (2012) aligned taxonomy
Acacia longifolia	excluded from analysis (no equivalent)
Cassytha glabella forma *dispar*	*Cassytha glabella*
Burchardia congesta	*Burchardia umbellata*
Cassytha racemosa forma *racemosa*	*Cassytha racemosa*
Hypochaeris radicata	*Hypochaeris glabra*
Kunzea glabrescens	*Kunzea ericifolia*
Leptocarpus decipiens	excluded from analysis (no equivalent)
Leptocarpus roycei	*Meeboldina roycei*
Lobelia anceps	*Lobelia alata*
Ornduffia albiflora	*Villarsia albiflora*
Schoenus efoliatus	*Schoenus rodwayanus*
Thelymitra sp.	excluded from analysis

2.1.2 Classification & Similarity Profile Analysis (SIMPROF)

The purpose of classification is to produce a dendrogram that allows patterns (clusters) in the data to be visualised. Dendrograms illustrate the “relatedness” of groups of samples; in this case, based on floristics. A Bray-Curtis similarity matrix was subjected to hierarchical (group average linkage) assessment to produce each dendrogram. Further, a “similarity profile” SIMPROF permutation test was carried out at each node of each dendrogram to look for statistically significant evidence of genuine clusters in the set of samples (indicated by the black lines on the dendrograms).

2.1.3 SIMPER Analysis

As part of the multivariate analysis a SIMPER Analysis was run on the floristic data from the five Garden Street sites to determine which species contribute most to the dissimilarity between statistically significant clusters, and which species contribute most consistently to the floristic cohesiveness (similarity) of each significant cluster.

2.2 Limitations of the floristic analysis

It is generally accepted that the addition of new sites to the regional dataset to produce a combined classification, may disrupt the original classification of sites (Griffin and Trudgen 2004), the more data that is added, the higher the level of disruption. Analysing each test site separately with the regional dataset is considered a more reliable means of deriving accurate FCT groups because the addition of a single test site (sample) causes minimal disruption to the dataset.

The use of different statistical analysis software (PRIMERV6 rather than PATN, which was used in the original analysis) is recognised to cause differences in the hierarchical clustering of the data. This is because the two software programs use a different default beta value in the group-average linkage (UPGMA) clustering routine. Neil Gibson confirmed that it was likely that we would not be able to recreate the original analysis results exactly because PRIMER does not allow you to change the beta value in the UPGMA algorithm. The version of PATN used 20 years ago used a value of -0.1 as a default, this parameter is not accessible in PRIMER which uses a default of 0.0 (N. Gibson 2016, pers. comm. 21 November 2016).

Finally, the success of the PrimerV6 analysis to assign an FCT to survey quadrats can be limited to the extent that the type of vegetation in the study areas was sampled in the SCP survey and Supplementary site surveys.

3 Results

3.1.1 Multivariate Analysis of Floristic Data

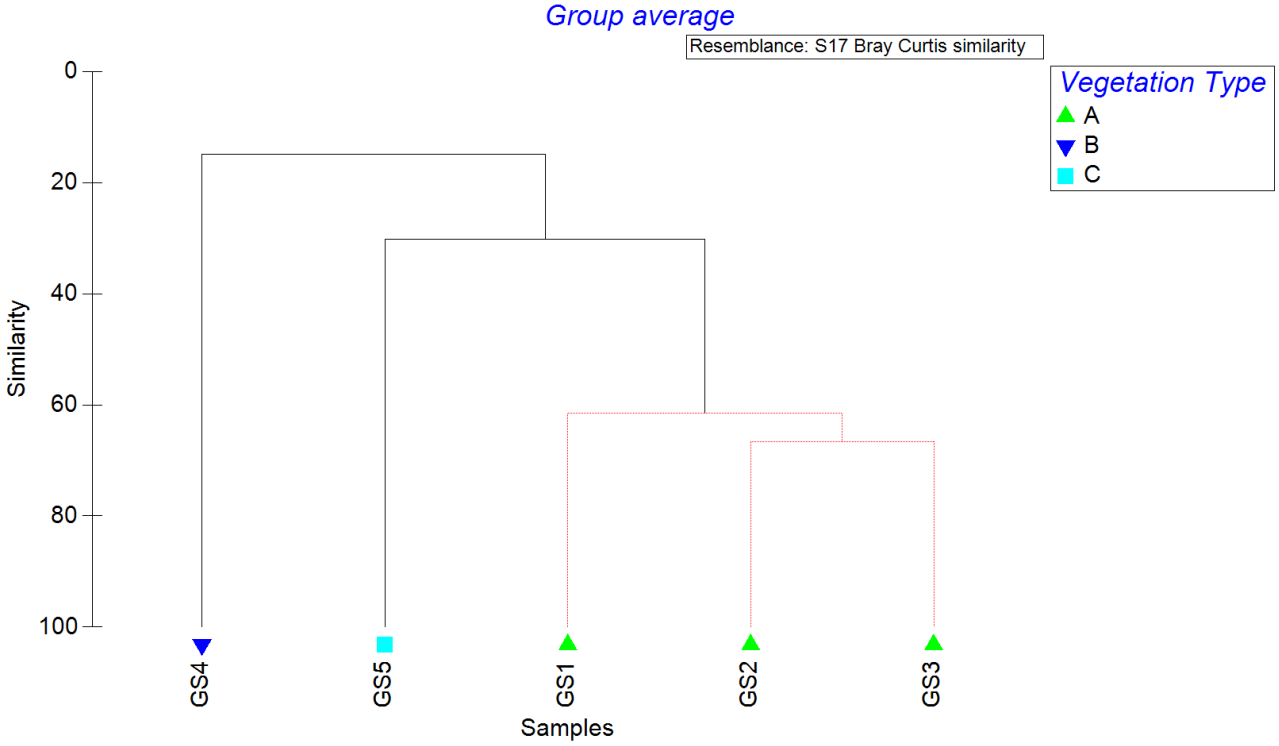
3.1.1.1 Data Compatibility

Floristic data from the five Garden Street quadrats were considered compatible with the Southern SCP dataset due to consistencies in quadrat size (10 m × 10 m), nomenclature, species-richness (indicative of sampling effort) and vegetation condition between the test sites and the regional dataset.

3.1.1.2 Hierarchical Cluster Analysis and FCTs

Garden Street Survey Quadrats (Test Sites)

An analysis was run on the five Garden Street test sites (quadrats) to determine existing groupings based on floristic similarities. Graph 1 shows the five sites forming three statistically significant clusters (denoted by the black lines). The SIMPER analysis determined which species are contributing most to the within-group floristic similarity, and the between-group dissimilarity seen in the classification dendrogram. Group A (GS1, GS2 and GS3) and Group B (GS4) showed the highest dissimilarity floristically (with an average dissimilarity of 87%). The eight species highlighted in red in Table 3 are characteristic of (consistently represented in) the wetter Group A sites, but are absent from the Group B site. Group A and Group C have an average dissimilarity of 69.8 % and were also differentiated on many of the same wetland species (Table 4). Group B and Group C had an average dissimilarity of 79.49% and were differentiated by the species listed in Table 5. The 20 species highlighted in red in Table 5 are characteristic of the dryer Group B site (GS4).



Graph 1: Classification Dendrogram Showing the Relationship between the Garden Street survey Quadrats

Table 3: SIMPER results showing the species contributions to the floristic difference between Group A (GS1, GS2 and GS3) and Group B (GS4)

Species	Group A Av.Abund	Group B Av.Abund	Contrib%	Cum.%
Astartea affinis	1.00	0.00	2.50	2.50
Austrostipa compressa	0.00	1.00	2.50	5.00
Beaufortia squarrosa	0.00	1.00	2.50	7.51
Briza maxima	0.00	1.00	2.50	10.01
Burchardia congesta	0.00	1.00	2.50	12.51
Cassytha racemosa forma *racemosa*	1.00	0.00	2.50	15.01

Species	Group A Av.Abund	Group B Av.Abund	Contrib%	Cum.%
Chamaescilla corymbosa	0.00	1.00	2.50	17.51
Dasypogon bromeliifolius	0.00	1.00	2.50	20.02
Gladiolus caryophyllaceus	0.00	1.00	2.50	22.52
Gompholobium tomentosum	0.00	1.00	2.50	25.02
Hakea varia	1.00	0.00	2.50	27.52
Hypochaeris radicata	0.00	1.00	2.50	30.02
Hypolaena exsulca	0.00	1.00	2.50	32.52
Laxmannia squarrosa	0.00	1.00	2.50	35.03
Lepidosperma longitudinale	1.00	0.00	2.50	37.53
Leptocarpus decipiens	1.00	0.00	2.50	40.03
Lobelia tenuior	0.00	1.00	2.50	42.53
Lomandra hermaphrodita	0.00	1.00	2.50	45.03
Lomandra sericea	0.00	1.00	2.50	47.54
Lyginia barbata	0.00	1.00	2.50	50.04
Melaleuca teretifolia	1.00	0.00	2.50	52.54
Melaleuca viminea	1.00	0.00	2.50	55.04
Pericalymma ellipticum	1.00	0.00	2.50	57.54
Schoenus efoliatus	0.00	1.00	2.50	60.05
Thysanotus thyrsoideus	0.00	1.00	2.50	62.55
Trachymene pilosa	0.00	1.00	2.50	65.05
Tricoryne tenella	0.00	1.00	2.50	67.55
Ursinia anthemoides	0.00	1.00	2.50	70.05
Xanthorrhoea brunonis	0.00	1.00	2.50	72.55
Xanthorrhoea preissii	0.00	1.00	2.50	75.06

Table 4: SIMPER results showing the species contributions to the floristic difference between Group A (GS1, GS2 and GS3) and Group C (GS5)

Species	Group A Av.Abund	Group C Av.Abund	Contrib%	Cum.%
Acacia pulchella var. glaberrima	1.00	0.00	4.63	4.63
Aphelia brizula	0.00	1.00	4.63	9.27
Cassytha racemosa forma racemosa	1.00	0.00	4.63	13.90
Drosera stolonifera	0.00	1.00	4.63	18.54

Species	Group A Av.Abund	Group C Av.Abund	Contrib%	Cum.%
Hakea varia	1.00	0.00	4.63	23.17
Hypolaena exsulca	0.00	1.00	4.63	27.81
Lepidosperma longitudinale	1.00	0.00	4.63	32.44
Leptocarpus decipiens	1.00	0.00	4.63	37.07
Melaleuca teretifolia	1.00	0.00	4.63	41.71
Melaleuca viminea	1.00	0.00	4.63	46.34
Sonchus oleraceus	0.00	1.00	4.63	50.98
Stylidium repens	0.00	1.00	4.63	55.61

Table 5: SIMPER results showing the species contributions to the floristic difference between Group B (GS4) and Group C (GS5)

Species	Group B Av.Abund	Group C Av.Abund	Contrib%	Cum.%
Acacia pulchella var. *glaberrima*	1.00	0.00	3.23	3.23
Aphelia brizula	0.00	1.00	3.23	6.45
Astartea affinis	0.00	1.00	3.23	9.68
Austrostipa compressa	1.00	0.00	3.23	12.90
Beaufortia squarrosa	1.00	0.00	3.23	16.13
Briza maxima	1.00	0.00	3.23	19.35
Burchardia congesta	1.00	0.00	3.23	22.58
Calothamnus lateralis	0.00	1.00	3.23	25.81
Chamaescilla corymbosa	1.00	0.00	3.23	29.03
Dasypogon bromeliifolius	1.00	0.00	3.23	32.26
Drosera stolonifera	0.00	1.00	3.23	35.48
Gladiolus caryophyllaceus	1.00	0.00	3.23	38.71
Gompholobium tomentosum	1.00	0.00	3.23	41.94
Hypochaeris radicata	1.00	0.00	3.23	45.16
Laxmannia squarrosa	1.00	0.00	3.23	48.39
Lobelia tenuior	1.00	0.00	3.23	51.61
Lomandra hermaphrodita	1.00	0.00	3.23	54.84
Lomandra sericea	1.00	0.00	3.23	58.06
Lyginia barbata	1.00	0.00	3.23	61.29
Pericalymma ellipticum	0.00	1.00	3.23	64.52

Species	Group B Av.Abund	Group C Av.Abund	Contrib%	Cum.%
Phlebocarya ciliata	1.00	0.00	3.23	67.74
Schoenus efoliatus	1.00	0.00	3.23	70.97
Sonchus oleraceus	0.00	1.00	3.23	74.19
Schoenus pedicellatus	0.00	1.00	3.23	77.42
Stylidium repens	0.00	1.00	3.23	80.65
Thysanotus thyrsoideus	1.00	0.00	3.23	83.87
Trachymene pilosa	1.00	0.00	3.23	87.10
Tricoryne tenella	1.00	0.00	3.23	90.32

Southern SCP Dataset (Keighery et al. 2012)

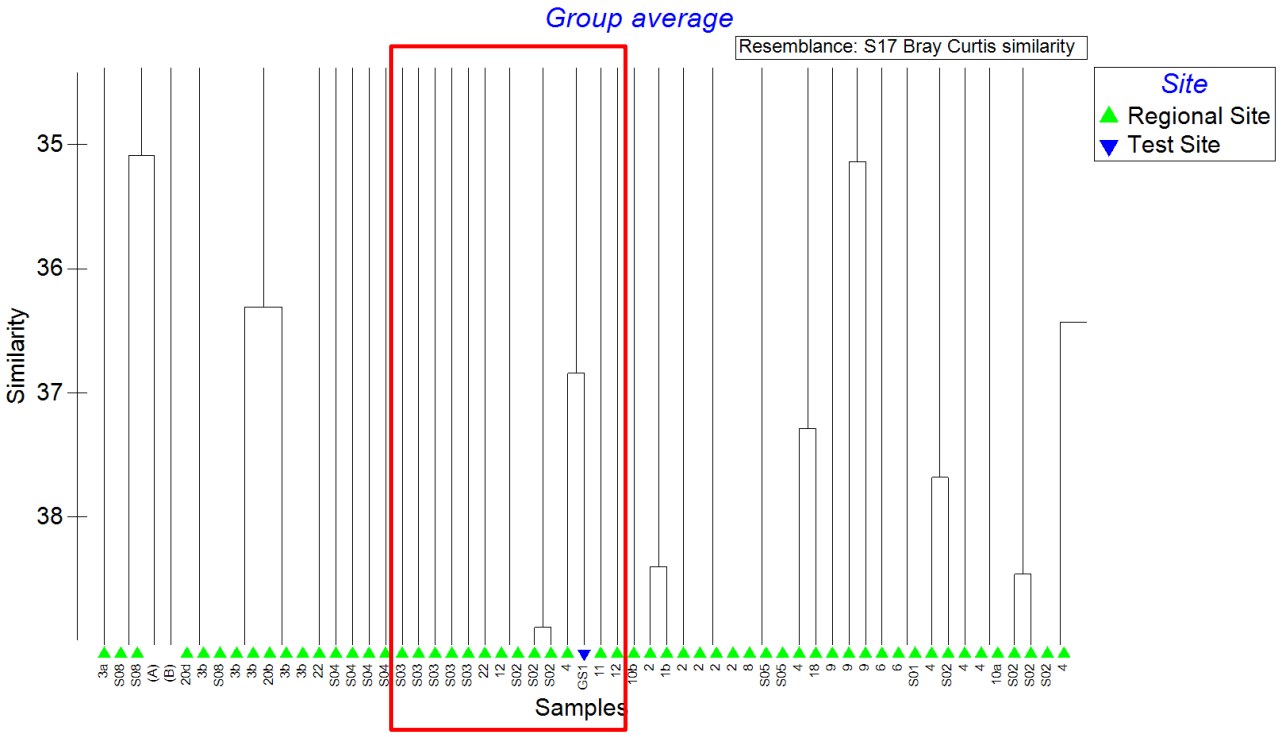
A Hierarchical Cluster Analysis was run on the combined 1098 site Southern SCP dataset to see if the output showed similar groupings based on FCTs. Keighery *et al*. (2012) made the following proviso regarding the updated dataset: “It is important to know that the data in this dataset are not ideal for floristic community type analysis due to inconsistencies in the grouping and splitting of some species compared to that used in the Gibson *et al.* (1994) analysis. This dataset is not the exact dataset used to analyse FCTs for Bush Forever (Western Australian Planning Commission)”.

The dendrogram for the Southern SCP dataset shows differences in clustering of sites to the original Gibson analysis, however, the majority of the sites still group according to their FCTs.

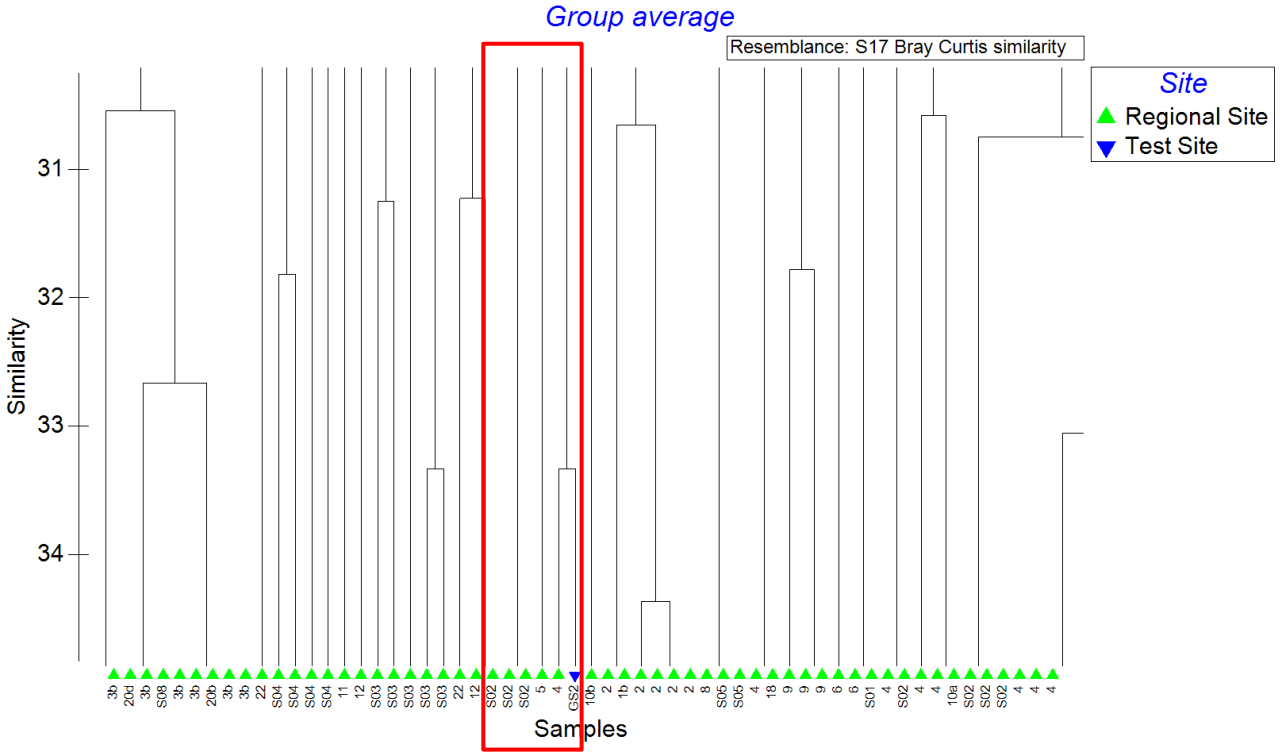
Garden Street Survey Sites plus the Southern SCP Dataset

All of the five test sites were added to the Southern SCP dataset together and a Hierarchical Cluster Analysis run. The dendrogram output from the analysis is too large to display in this report however it showed that GS1, GS2 and GS3 grouped together (>66% similarity) and had the next strongest affinity (33% similarity) to one FCT04 site (KOOLJ-1). These three Garden Street sites were next most similar to seasonal wetlands sites belonging to FCTS03 and FCT13. GS4 showed the greatest floristic affinity to numerous FCT04 sites and a weaker affinity to one FCT21a and one FCT21c site. GS5 was most strongly affiliated (32% similarity) with an FCT22 site and weaker affinities to sites from FCTS02, FCTS03 and FCT12 (Table 6).

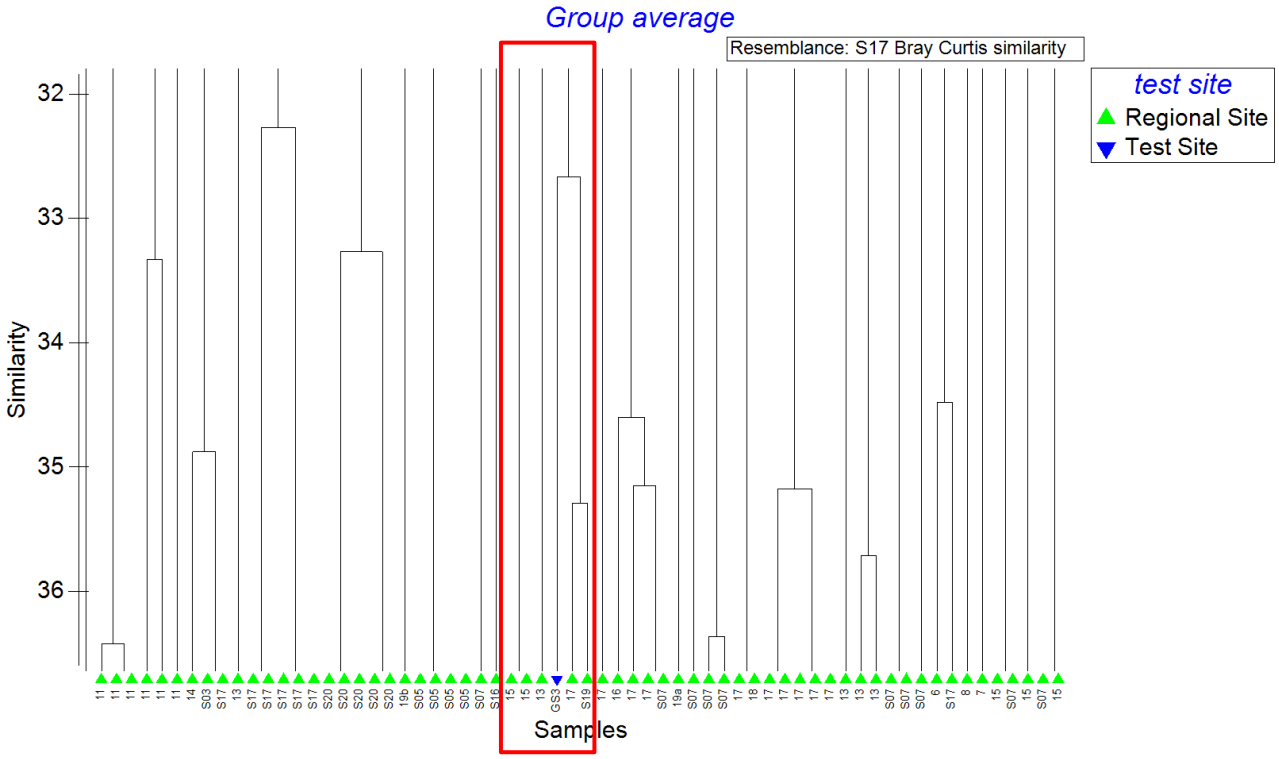
Each of the test sites was then added separately to the Southern SCP dataset in an effort to minimise disruption to the original groupings and to clarify mixed FCT affinities. This analysis resolved some but not all of these mixed affinities. GS1 grouped with one FCT04 site (Graph 2), GS2 showed the greatest affinity to the same FCT04 site and a weaker affinity to an FCT05 site (Graph 3). GS3 showed the strongest affinity to one FCT17 site and one FCTS19 site (Graph 4). GS4 showed the strongest affinity to several FCT04 sites and one FCT21a site (Graph 5). GS5 showed the strongest affinity to one FCT04 site (Graph 6).



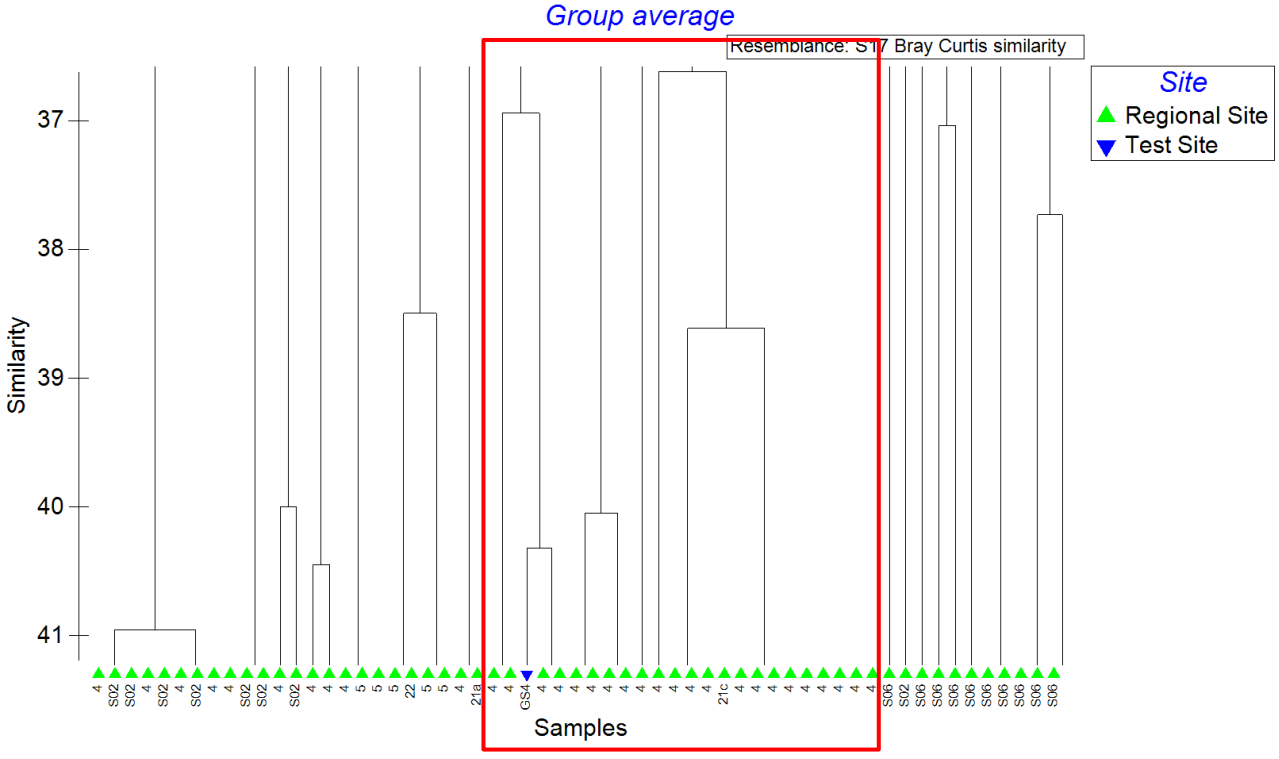
Graph 2: Relevant Portion of Classification Dendrogram Showing Relationship between GS1 and Southern SCP Dataset (Keighery *et al.* 2012) FCTs



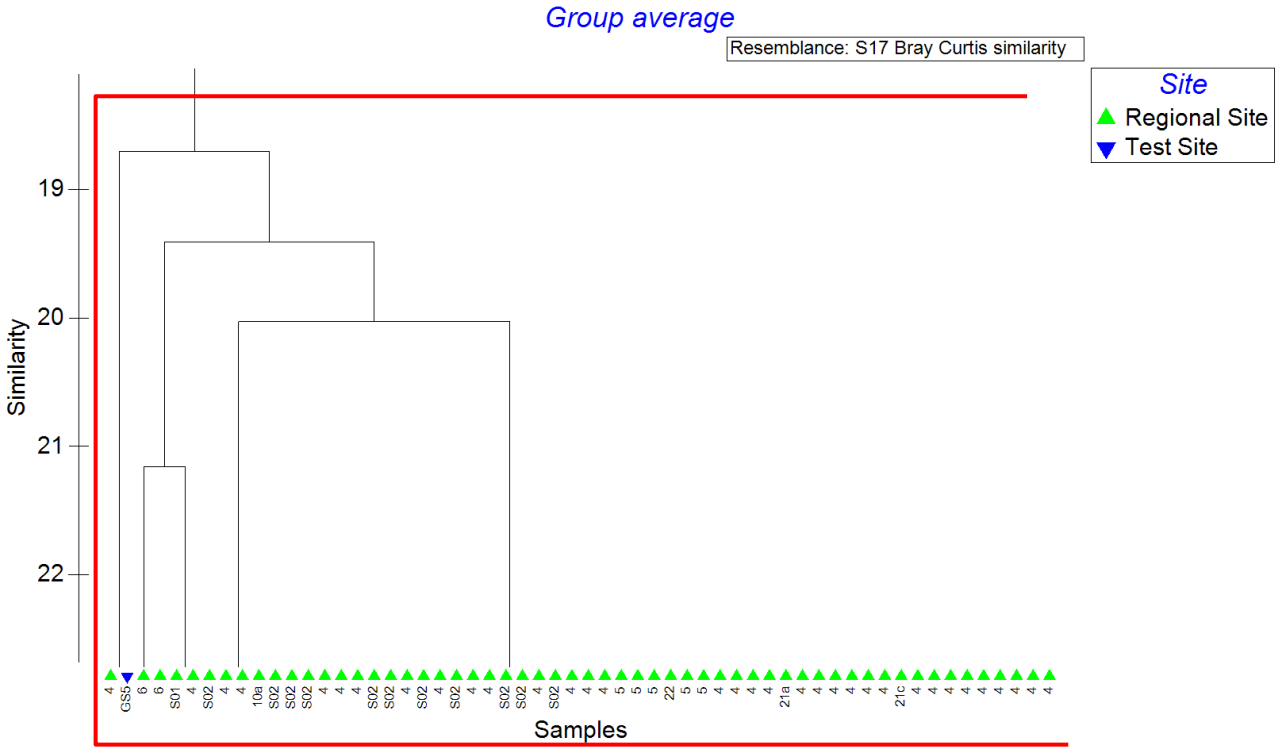
Graph 3: Relevant Portion of Classification Dendrogram Showing Relationship between GS2 and Southern SCP Dataset (Keighery *et al.* 2012) FCTs



Graph 4: Relevant Portion of Classification Dendrogram Showing Relationship between GS3 and Southern SCP Dataset (Keighery *et al.* 2012) FCTs



Graph 5: Relevant Portion of Classification Dendrogram Showing Relationship between GS4 and Southern SCP Dataset (Keighery *et al.* 2012) FCTs



Graph 6: Relevant Portion of Classification Dendrogram Showing Relationship between GS5 and Southern SCP Dataset (Keighery *et al.* 2012) FCTs

3.1.1.3 Landform, Species Occurrence and Geographic Distribution as an Indicator of FCT

Giving consideration to landform, vegetation structure and species occurrence as well as known geographic distribution of FCTs when assessing floristic sites with mixed FCT affinities, can sometimes assist in resolving ambiguities resulting from statistical analysis of the data, and can help to make a more reliable FCT determination.

For the current assessment the presence in particular of *Melaleuca viminea, M. teretifolia, M. rhaphiophylla* and *M. lateritia* in GS1, GS2 and GS3 confounds the analysis results because these species are not characteristic of FCT04, in fact they are typically absent from this community type. Like-wise, species considered most constant to FCT04; *Melaleuca preissiana, Hypolaena exsulca, Hypocalymma angustifolium* and *Dasypogon bromeliifolius* (Gibson *et al*. 1994) are conspicuously absent from the Garden Street sites. Species recorded at these three sites (including *Melaleuca viminea, M. teretifolia, M. rhaphiophylla* and *M. lateritia*) are more typical of FCT12 and FCT13 as well as other seasonal wetland community types not alluded to in the analysis. Some species present at these three sites (e.g. *Hakea varia*) are typical of FCT13 while others (e.g. *Lepidosperma longitudinale*) are typical of FCT12 and do not typically occur in FCT13.

There are numerous Southern SCP seasonal wetland sites representing community types FCT04, FCT05, FCTS03 and FCT21c that occur between 5 km and 10 km of the Garden Street study area. Proximity of these records to the study area means that classification results implicating these FCTs are credible in terms of their geographic distribution.

The Single Site Insertion classification of GS3 floristic data showed greatest affinity to one FCT17 site and, however this community type is restricted to the Quindalup, Vasse and Spearwood systems close to the coast. Based on the geographic distribution of this FCTs GS3 could not be representative of it.

The hierarchical cluster analyses of GS1, GS2, GS3 and GS5 data suggests that these sites are likely to represent the same FCT. Consideration of floristic composition, landform, and FCT distribution, in addition to the analysis results for these sites suggest they are most likely to belong to FCT12, FCT13 or FCTS03 (Table 6).

The hierarchical cluster analysis of GS4 data shows that this site differs from the other four sites floristically. Consideration of the analysis results, floristic composition, landform, and FCT distribution suggest GS4 is most likely to belong to either FCT04 or FCT21c (Table 6).

Table 6: FCTs Estimated from PRIMERv6 Analyses of the Test Data and Swan Coastal Plain and Supplementary Dataset

Garden Street Sites	FCT - Southern SCP and Test Data (All sites)	FCT - Southern SCP and Test Data (Single Site Insertion)	Determination
GS1	**FCT04** / FCTS03 / FCT13	FCT04	**? FCT12 / FCT13 / FCTS03**
GS2	**FCT04** / FCTS03 / FCT13	FCT04 / FCT05	**? FCT12 / FCT13 / FCTS03**
GS3	**FCT04** / FCTS03 / FCT13	FCT17 / FCTS19	**? FCT12 / FCT13 / FCTS03**
GS4	**FCT04** / FCT21c / FCT21a	FCT04 / FCT21a	**?FCT21c / FCT04**
GS5	**FCT22** / FCTS03 / FCT12 / FCTS02	FCT04	**? FCT12 / FCT13 / FCTS03**

4 Conclusions

Results of the PrimerV6 analysis were inconclusive in so far as no one FCT could clearly be assigned to any of the five Garden Street sites. The study sites had the greatest affinity (based on their floristic composition) to the Southern SCP sites assigned to FCT12, FCT13, FCTS03, FCT04 and FCT21c (Table 7).

Table 7: FCTs Potentially Represented within the Garden Street Study Area

FCT	Description	Garden Street Sites
FCT12	*Melaleuca teretifolia* and/or *Astartea* aff. *fascicularis* shrublands	GS1, GS2, GS3, GS5
FCT13	Deeper wetlands on heavy soils	
FCTS03	Wet sedgelands on sandy clays	
FCT04	*Melaleuca preissiana* damplands	GS4
FCT21c	Low lying *Banksia attenuata* woodlands or shrublands	

5 References

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