TECHNICAL REPORT

TAMALA PARK DEVELOPMENT AREA

LEVEL 2 FLORA, VEGETATION AND GRACEFUL SUN MOTH SURVEY

MAY 2010

FOR
TAMALA PARK REGIONAL COUNCIL

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1.0 EXECUTIVE SUMMARY

Tamala Park Regional Council (TPRC) has initiated plans for the development of the northern part of Lot 9504 (historically referred to as Lot 17 Marmion Avenue, Clarkson) as part of the Tamala Park Development (TPD) area. In a previous targeted Declared Rare and Priority Flora Survey (Syrinx Environmental PL, 2009b) ten populations of *Fabronia hampeana* and one population of *Sarcozona bicarinata* were found within an area of significant vegetation.

A Level 2 Flora survey was requested by TPRC to gain a better understanding of the current status of the existing vegetation and flora on site prior to development, and to ensure all Department of Environment and Conservation (DEC) requirements are met prior to submission of the development plans.

No Declared Rare Flora Species or Threatened Ecological Communities were located within the survey area. The Priority Flora present on site were those identified previously: *Fabronia hampeana* (Priority 2) (10 populations) and *Sarcozona bicarinata* (Priority 3) (one population) (Syrinx Environmental PL, 2009b).

A total of 12 vegetation communities were identified on site, with 199 taxa, including 48 weed taxa recorded. The native species richness of 151 species reflects the good to excellent condition of portions of the site. The most diverse vegetation communities in the best condition are located adjacent to Marmion Avenue (west end of the site).

An assessment of the conservation significance of the flora and vegetation on site was made by assessing against criteria for regional significance (Government of Western Australia, 2000; Del Marco *et. al* 2004). The area is not identified as regionally significant in Bush Forever and is considered locally significant with attributes of regional significance when assessed against regional significance criteria.

In addition to the Flora and Vegetation survey, a Graceful Sun Moth survey of the entire development area was conducted as requested by the DEC. The survey area included the western cell development area (west of Marmion Avenue adjacent to the coast). The western cell was not included within the Level 2 Flora and Vegetation Survey area. Two (2) Graceful Sun Moths were captured in the western cell.

An 11.6ha area of vegetation assessed as having attributes of regional significance (area adjacent to the Marmion Avenue), called a Biodiversity Conservation Area (BCA), has been identified for retention. An Environmental Management Plan has been produced to ensure the appropriate management of the vegetation (Syrinx Environmental PL, 2009a). The Biodiversity Conservation Area will protect eight populations of *Fabronia hampeana* and the *Sarcozona bicarinata* population as well as

the majority of vegetation communities on site. In addition, POS areas planned within the site will protect patches of vegetation belonging to two other community types on site.

2.0 INTRODUCTION

Tamala Park Regional Council (TPRC) has initiated plans for the development of Lot 9504 Marmion Avenue, Clarkson as part of the Tamala Park Development (TPD) area. A Local Structure Planning (LSP) process for Lot 9504 Marmion Ave is currently underway.

A Level 2 Flora survey has been proposed by TPRC to gain a better understanding of the current status of the existing vegetation and flora of the site prior to development. The Department of Environment and Conservation (DEC) also recognised the possibility for the Level 2 survey to be used to identify potential habitat for the Graceful Sun Moth (J. Maguire *pers. comm.* September 2009).

Syrinx Environmental PL (Syrinx) was appointed by Tamala Park Regional Council (TPRC) to conduct a Level 2 Vegetation and Flora Survey of Lot 9504 Marmion Avenue, Clarkson as well as to identify the potential Graceful Sun Moth habitat.

2.1 SCOPE OF WORK

The scope of work covered in this assessment was to:

1. Undertake a Level 2 Flora and Vegetation Survey of the Tamala Park Development Site as per EPA Guidance Statement 51 (EPA, 2004) guidelines;
2. Re-assess the vegetation condition using Condition scale as per Perth's Bush Forever Vol. 2, from Keighery, (1994) and adjust previous mapping in the Environmental Management Plan (Syrinx Environmental PL, 2009a) if necessary;
3. Identify vegetation communities that provide habitat for the Graceful Sun Moth.

3.0 BACKGROUND

In the late 1990's the Western Australia Planning Commission (WAPC) initiated a major Metropolitan Region Scheme amendment (992/33 Clarkson Butler) in the north west corridor of the metropolitan region, including the Tamala Park Development (TPD) area. The EPA concluded the rezoning was environmentally acceptable provided certain ministerial conditions were met. The set of ministerial conditions relevant to the Tamala Park Development (TPD) site can be found in the Minister for the Environment Statement No. 629 (Minister for the Environment, 2003). The ministerial conditions included the requirement for a significant flora survey but not a Level 2 Vegetation and Flora Survey.

The land is currently controlled by Tamala Park Regional Council (TPRC), a corporate entity established in 2006 representing the interests of seven local governments in the urban development of 180 hectares of Lot 9504, Marmion Ave Clarkson.

In 2006 the TPRC initiated plans for future development of Lot 9504. To enable the development of the Local Structure Plan (LSP) process, various vegetation and flora surveys have been completed (Alan Tingay and Associates, 1999; Mattiske Consulting, 2000; Syrinx Environmental PL, 2009b), however a Level 2 Flora and Vegetation survey that would satisfy EPA Guidance Statement 51 (EPA, 2004) had not been conducted prior to this survey. As part of the LSP process an 11.6 ha area of high value vegetation on the western boundary (central cell) of the site has been selected for retention and termed as a Biodiversity Conservation Area (BCA) (Syrinx Environmental PL, 2009a).

Given the time since previous flora and vegetation surveys (Alan Tingay and Associates, 1999; Mattiske Consulting, 2000), TPRC City of Wanneroo and the Department of Environment and Conservation (DEC) considered it would be beneficial to conduct a Level 2 Flora and Vegetation survey of the central and eastern cells of the development (area zoned “urban deferred’) to provide current information on the flora and vegetation prior to development.

The western cell of the development (west of Marmion Avenue) which is zoned ‘urban’ was not included in the Flora and Vegetation survey as it was exempt from environmental assessments in accordance to the Negotiated Planning Solution (NPS) document (WAPC, 2006). Flora and Vegetation surveys have been conducted in the western cell development area by Alan Tingay and Associates (1999) and Mattiske Consulting (2000). Syrinx Environmental PL (2009d, 2009e) recently revised vegetation condition mapping and performed a DRF and Priority Flora search for the western cell and the area ceded to Bush Forever 322. No DRF were found on site however two *Fabronia hampeana* populations were found within the western cell with additional 12 *Fabronia hampeana* populations occurring in the area ceded to Bush Forever (Syrinx Environmental PL 2009d, 2009e).

3.1 SITE LOCATION AND OWNERSHIP

The 180ha Tamala Park Development (TPD) site is located 34km north of Perth. It is situated immediately south of Neerabup Road (a major east-west distributor) and north of the Mindarie Regional Council (MRC) landfill site (Figure 1).

The survey site is bounded by Marmion Avenue to the west and the Mitchell Freeway and railway line to the east. Connolly Drive intersects the site along the north south axis dividing the area into western and eastern sections. To the west of the site (west

of Marmion Avenue) is an area zoned 'Urban' which is a part of the same overall development area. This area is bounded by Bush Forever Site 322 which also forms a link with the "Urban deferred" area through the south west corner of the site. At the southern boundary, the site is connected to Bush Forever Site 323 which currently surrounds the Mindarie Regional Council (MRC) waste management facility. To the east and south eastern boundary is Bush Forever Site 383 which forms a part of the Neerabup National Park.

3.2 TENURE AND CURRENT USE

The land is owned by the Tamala Park Regional Council (TPRC), a local government body formed by seven municipal councils established for the specific purpose of creating the Tamala Park urban development. The TPRC includes the cities of Perth, Joondalup, Stirling, Wanneroo and the Towns of Cambridge, Victoria Park and Vincent.

Currently the land is vacant and unused with the exception of occasional four wheel driving and illegal refuse dumping, which is more prominent in the eastern portion of the site closer to the railway line. The site is frequented by a number of fauna species, including kangaroos which utilise both the cleared and vegetated areas of the site.

Figure 1 Tamala Park Development (TPD) Level 2 Flora survey area boundary

4.0 EXISTING ENVIRONMENT

4.1 GEOLOGY, LANDFORM AND SOILS

Tamala Park is located on the Swan Coastal Plain, dominated by ancient sedimentary dune systems deposited during the ice ages and interglacial periods (City of Wanneroo, 2005).

The topography of the Tamala Park Development Area is undulating and variable across the site, generally reflecting the dunal system of the area. The western portion of the surveyed site in proximity to Marmion Avenue rises from approximately 35m AHD to a maximum height of 50m AHD, gently grading to 10m AHD in the east towards Connolly Drive and rises again to 20m AHD towards Neerabup National Park in the eastern portion of the site (Alan Tingay and Associates 1999, Douglas Partners 2009).

Both western and eastern parts of the surveyed site occur entirely on the Spearwood Dune System, including both the Cottesloe and Karrakatta major soil units. The Cottesloe unit comprises a series of ridges, hills and hollows that run in a north south direction. The soils are shallow brown or bright yellow sand-loam over limestone with limestone outcropping occurring in some areas. The elevated Cottesloe ridges have shallow soils with areas of limestone outcropping.

The Karrakatta unit consists of deep sand separated into 'yellow' and 'grey' phases. The yellow phase has a grey/ brown sandy surface underlain by bright yellow siliceous sand and limestone often within two metres. The grey phase sequence is characterised by grey sands at the surface, a very light grey sub-surface, followed by pale yellow sand and limestone at depth. The Karrakatta soil types typically occur on the eastern side of the Cottesloe ridge.

4.2 HYDROLOGY

4.2.1 Regional Setting

The Perth Basin is a deep geological deposit formed by the build-up of marine and continental sediments over millions of years (Barton *et. al*., 2009). The Tamala Park study site is located on the coastal margin of the Gnangara mound where superficial formations form a mainly unconfined groundwater system (Barton *et. al*., 2009).

4.2.2 Surface Water

As the majority of the site is characterised by deep well drained soils, the dominant water redistribution process on site is infiltration (Barton *et. al*., 2009). Therefore no

significant surface flows exist to or from the site (MWH, 2009). The surface water drainage system comprises of numerous small catchments mostly draining from west to east. The catchments of the ridge located to the west of the site are well defined with elevated catchment slopes, whereas the lower catchments are less defined. In general, the area is well drained and no pooling of water has been observed in the lower parts of the landscape.

4.2.3 Groundwater

The Tamala Park development area lies on the coastal margin of the Gnangara Mound where the saturated thickness of the superficial formations is around thirty metres and the depth to groundwater below ground surface varies from around fifteen to forty-five metres (CSIRO, 2009). Superficial groundwater within the Tamala Limestone drains in a westerly direction toward the coast. Subcrop formations at the base of the limestone include aquatards of the Osborne Formation and upper members of the underlying Leederville aquifer. Tamala Limestone is covered over by Safety Bay Sand along the coastal margin.

The Perth Groundwater Atlas (Department of Environment, 2004) indicates that the regional aquifer ranged from approximately 3m AHD in the east to less than 2m AHD at Marmion Avenue boundary in May 2003. The more recent monitoring by DoW during 2008 and 2009 indicated a very flat water table varying only by 0.2m across the site, which is consistent with the moderate to high permeability of the sands on site (MWH, 2009).

4.3 VEGETATION AND FLORA

4.3.1 Vegetation Complex

The study area is in the Swan Coastal Plain Biogeographic Region of the South-west Botanical Province (Thackway and Cresswell 1995, and Paczkowska and Chapman 2000). There are descriptions and/or maps of vegetation in the study area at various scales in Beard (1981), Heddle *et al.* (1980), Tingay and Associates (1999) and Mattiske (2000).

Beard (1981), described at scales of 1:250,000 and 1:1,000,000, the study area's vegetation as *Banksia* Low Woodland (bLi) on limestone and the Quindalup vegetation as Coastal Heath and Thicket ($a_{26}m_4Zc/a_{23,32}Sc$) dominated by *Acacia lasiocarpa, A. rostellifera, A. cyclops* and *Melaleuca systena*.

Heddle *et al*. (1980), produced a vegetation map at 1:250 000 scale, which defined vegetation complexes in relation to the landform-soil units determined by Churchward and McArthur (1980). This regional mapping work defines the study area as occurring within the Cottesloe Complex - Central and South and Karrakatta Complex - Central and South. Within each complex a range of structural formations are recognised.

• The Cottesloe Complex - Central and South supports heaths on limestone outcrops. The deeper sands support a mosaic of Tuart Woodland and an Open Forest of Tuart, Jarrah and Marri.

• The Karrakatta Complex - Central and South consists predominantly of an Open Tuart, Jarrah and Marri Forest, commonly supporting *Banksia attenuata*, *Banksia menziesii, Banksia grandis* and *Allocasuarina fraseriana*.

4.3.2 Floristic Community Types

The regional study of the floristic variation of the Swan Coastal Plain by Gibson *et al*. (1994) identified three floristic community types (FCT) in the Tamala Park Development Area (Syrinx's graphical representation of these communities is given in Figure 2). The vegetation communities identified previously within the proposed development area correspond most closely to the following community types:

- 26b Woodlands and Mallees on limestone (Reservation status: Well Reserved; Conservation status: Low Risk);
- 28 Spearwood *Banksia attenuata* or *Banksia attenuata – Eucalyptus* Woodlands; (Reservation status: Well Reserved; Conservation status: Low Risk);
- 29b *Acacia* shrublands on taller dunes (Reservation status: Poorly Reserved; Conservation status: Susceptible).

The shallow soils found on the limestone ridges adjacent to the Marmion Avenue are dominated by *Banksia sessilis* Heath which most closely corresponds to floristic community type 26b. *B. sessilis* is the dominant species of the Limestone Heath on site, which is not typical of FCT 26b. *Acacia rostellifera* low Shrublands are located in the same part of the site and on the ridge in proximity of Connolly Drive. This community can be classified as type 29b. Towards the east, Banksia/Tuart/Jarrah Woodlands comprise the transition into the Neerabup National Park (FCT 28).

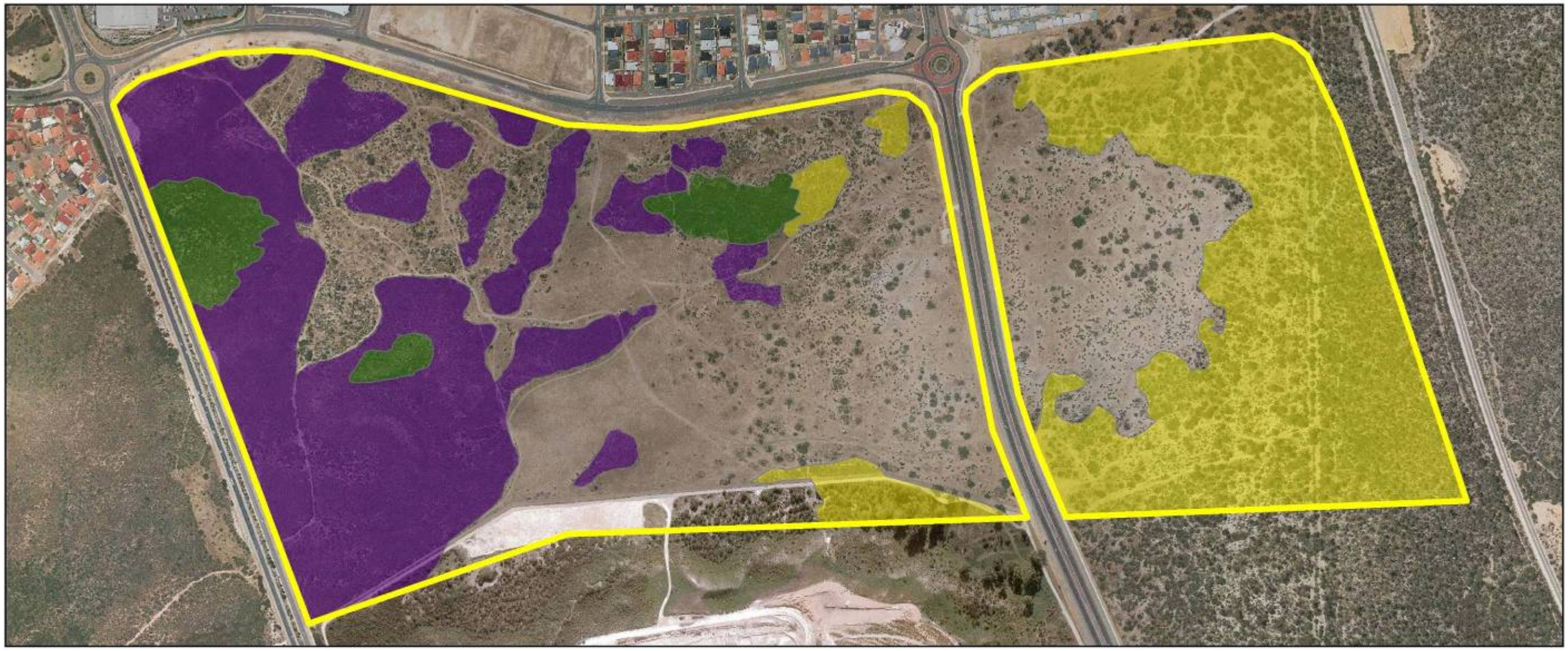


Figure 2 Floristic Community Types

4.3.3 Previous Flora and Vegetation Surveys within the Study Area

Several flora and vegetation surveys have been undertaken in the Tamala Park Development area and the nearby Neerabup National Park. Tingay and Associates (1999) prepared a detailed environmental review of the area in 1999 and Mattiske (2000) assessed the vegetation condition and summarised previous surveys to assess the vegetation in a local and regional context. Most recently, Syrinx reviewed the vegetation condition and undertook a Declared Rare and Priority flora survey to satisfy one of the conditions stated in the Ministerial Statement 629 (Syrinx Environmental PL, 2009b). In addition, a significant tree survey was completed (Syrinx Environmental PL, 2009c) to address requirements of the City of Wanneroo.

Ten vegetation communities were identified by Tingay and Associates (1999) (Table 1). During the 2009 survey, Syrinx identified the same number of communities during the DRF and Level 1 Flora Survey (Syrinx Environmental Pl 2009b), with minor amendments to the Tingay and Associates (1999) vegetation communities description.

Some of the vegetation communities identified during the Level 1 Flora survey (Syrinx Environmental PL, 2009b) were recognised as potentially providing habitat suitable for the Graceful Sun Moth. The selection of the Graceful Sun Moth habitat was based on the presence of the key plant species *Lomandra hermaphrodita* and *L. maritima*, which have been identified previously as being important for Graceful Sun Moth breeding and feeding patterns.

The flora and vegetation surveys described above were used in the Environmental Management Plan for the Tamala Park Development area (Syrinx Environmental PL, 2009a).

Table 1 Vegetation communities for Tamala Park Development area described by Tingay and Associates (1999)

Tingay and Associates (1999) Vegetation Communities	
1	*Banksia attenuata, B. menziesii and Allocasuarina fraseriana* Low Open Woodland with scattered emergent Jarrah (*Eucalyptus marginata*) and Tuart (*E. gomphocephala*) over *Hibbertia hypericoides* and *Mesomelaena pseudostygia*.
2	Jarrah and Tuart Woodland with *B. attenuata, B. menziesii* and *Allocasuarina fraseriana* Low Woodland over Balga (Xanthorrhoea preissii), *Stirlingia latifolia, Hibbertia hypericoides, Leucopogon propinquus* and *Conostylis aculeata.*
3	*Banksia Woodland* over *Hakea lissocarpha*, *Acacia rostellifera*, *Dryandra sessilis* and *X. preissii.*
4	Jarrah, Tuart and *Coastal* Blackbutt (*E. todtiana*) with occasional *Banksia* over parkland cleared.
5	*Banksia attenuata* and *B. menziesii* Low Open Woodland with occasional Coastal Blackbutt and *E. decipiens* over *Allocasuarina humilis*, Balga and *Calothamnus quadrifidus*.
6	Limestone Heath of Parrot Bush (*Dryandra sessilis*) interspersed by Balga and occasional strands of *E. decipiens* and *Banksia*.
7	Parrot bush Open Heath with occasional *B. menziesii* over Low Open Heath to Closed Heath of *Hibbertia hypericoides, Hakea prostrata, Melaleuca acerosa and Hakea lissocarpha* over *Mesomelaena pseudostygia, X. reflexa, Loxocarya flexuosa* and *Conostylis aculeata.*
8	*Acacia rostellifera* Low Shrubland.
9	*Hakea lissocarpha* Low Shrubland with *Hibbertia hypericoides* and occasional Balga.
10	Parkland cleared with occasional strands of *Banksia menziesii*, *B. attenuata* and Tuart

4.3.4 Threatened and Priority Ecological Communities

No Threatened or Priority Ecological Communities were identified on site in the previous floristic studies of the area (Alan Tingay and Associates, 1999, Mattiske, 2000 and Syrinx Environmental PL, 2009b).

4.3.5 Known Declared Rare and Priority Flora onsite

Populations of two priority species *Fabronia hampeana* (Priority 2) and *Sarcozona bicarinata* (Priority 3) previously identified within the Tamala Park Development (TPD) area have been mapped and described in Syrinx Environmental PL, (2009b). The species and locations identified in this report are provided in Table 2 and are briefly described below.

4.3.5.1 Fabronia hampeana

Ten populations of *Fabronia hampeana, a* Priority 2 species, were found within the Tamala Park Development (TPD) area. For the purpose of this survey a single *Macrozamia riedlei* trunk with *Fabronia hampeana* was considered a population. All of these populations were associated with large stands of *Macrozamia riedlei* and all were found within the western portion of the site and within the proposed Biodiversity Conservation area (Syrinx Environmental PL 2009).

Very little is known about this moss species due to the fact that it has not been extensively surveyed in the past. Only four collected specimens existed at the WA Herbarium prior to the Tamala Park survey.

4.3.5.2 Sarcozona bicarinata

Sarcozona bicarinata a prostrate growing herb, is a Priority 3 species (DEC, 2009) and belongs to the family Aizoaceae. This species occurs sporadically on limestone outcrops and often in association with *Banksia sessilis* (Mattiske 2000). *Sarcozona bicarinata* has been found previously in the Burns Beach area, Yanchep and Seabird (Mattiske 2000) as well as Alkimos (Syrinx Environmental, 2005).

Only one population was found within the TPD in the north west corner of the site on a limestone outcrop (Syrinx Environmental PL, 2009b).

Table 2 Locations of *Fabronia hampeana* and *Sarcozona bicarinata* (Syrinx Environmental PL, 2009b)

Species and Population Number	GPS Location (GDA 94)
Fabronia hampeana Pop no.1	0378462, 6492570
Fabronia hampeana Pop no.2	0378486, 6492551
Fabronia hampeana Pop no.3	0378572, 6492562
Fabronia hampeana Pop no.4	0378557, 6492528
Fabronia hampeana Pop no.5	0378657, 6492191
Fabronia hampeana Pop no.6	0378664, 6492127
Fabronia hampeana Pop no.7	0378955, 6492149
Fabronia hampeana Pop no.8	0378831, 6492152
Fabronia hampeana Pop no.9	0378786, 6492026
Fabronia hampeana Pop no.10	0378792, 6492072
Sarcozona bicarinata Pop no. 1	0378441, 6492692

4.3.6 Conservation Status of Vegetation Communities

As described in Section 4.3.1, the vegetation on site forms a part of the Cottesloe Central and South vegetation complex (Heddle *et al*. 1980). Across the Swan Coastal Plain 41% of the original extent this Complex remains with 9% in protected tenure (EPA 2006). Within the City of Wanneroo, of the original extent of 13, 302ha, 26% is in protected tenure (EPA 2006).

From the previous floristic studies in the area, (Mattiske 2000 and Syrinx Environmental PL 2009b) at a regional level the vegetation communities present on site are considered significant as they maintain a linkage between coastal bushland and Neerabup National Park. This linkage was also identified, as a part of the greater Tamala Park area between Burns Beach and Neerabup National Park, as a potential Greenway within the Strategic Plan for Perth's Greenways (Alan Tingay and Associates, 1998).

At a local level plant communities that are poorly reserved and have susceptible conservation status (e.g. Community type 29b *Acacia* shrublands on taller dunes, (Gibson *et. al.* 1994, Mattiske 2000) are also considered significant.

5.0 METHODS

5.1 APPROACH

The approach taken for this survey was as follows:

- Desktop review of the existing literature from previous reports and Department of Environment and Conservation records of declared rare and priority flora, and threatened ecological community locations;
- Spring field survey undertaken over 4 days between September 8th and 15th 2009;
- Autumn survey was conducted in March 2010 to revisit the plots and capture late Summer flowering annuals;
- Analysis and presentation of data (tables, map productions and photographs).

5.1.1 Desktop Review

The desktop review examined the following reference material:

- Alan Tingay and Associates (1999). Proposal 2 – Lot 17 Mindarie/Tamala Park Environmental Review – Metropolitan region scheme amendment 992/33 Clarkson Buttler. Report for Western Australian Planning Commission.
- Gibson, N. Keighery, B., Burbidge, A. and Lyons, M. (1994). A floristic survey of the Southern Swan Coastal Plain. Unpublished Report for the Australian Heritage Commission. Department of Conservation and Land Management and Conservation Council of Western Australia.
- Mattiske Consulting Pty. Ltd. (2000). Flora and Vegetation Assessment of Lot 17, Marmion Avenue, Clarkson. Report for the Planning Group Pty Ltd.
- Minister for the Environment (2003). Metropolitan Region Scheme Amendment No. 992/33 Clarkson-Butler (Assessment No. 1139). Government of Western Australia.
- Syrinx Environmental PL (2009b) Tamala Park Declared Rare and Priority Flora Survey, Level 1 Fauna Survey and Vegetation Condition Mapping. A Technical Report for TPRC. Perth Western Australia.
- Syrinx Environmental PL (2009c) Tamala Park Significant Tree Survey Report. A Technical Report for TPRC. Perth Western Australia.

5.1.2 Significant Flora and Ecological Communities

5.1.2.1 Declared Rare and Priority Flora

Prior to the field survey, a database search was carried out using the DEC Declared Rare and Priority Flora records and the Threatened and Priority Ecological communities (see Table 3 and text below). The DEC database search included the surveyed area and a 5 km buffer (refer to Appendix 1 for an explanation of the classification levels for Western Australian Threatened and Priority Ecological Communities and Declared Rare Flora (DRF)). During the field survey, targeted searches were made in areas of potential habitat for DRF and Priority species.

Table 3 List of DRF and Priority Flora potentially present on site based on DEC database search September 2009

Species Name	Priority	Potential Habitat
Eucalyptus argutifolia	R	✓
Marianthus paralius	R	×
Melaleuca sp. Wanneroo (G.J. Keighery 16705)	1	✓
Leucopogon sp. Perth coastal (AS George 17305)	1	✓
Acacia benthamii	2	✓
Lecania turicensis var. *turicensis*	2	✓
Fabronia hampeana	2	✓
Jacksonia sericea	3	✓
Hibbertia spicata subsp. *leptotheca*	3	✓
Sarcozona bicarinata	3	✓
Leucopogon sp. Yanchep (M. Hislop 1986)	3	✓
Grevillea thelemanniana	4	×

5.1.2.2 Potential Threatened and Priority Ecological Communities

The search of DEC Threatened Ecological Communities (TECs) and Priority Ecological Communities (PECs) database showed that there are no known occurrences of TECs or PECs recorded within the boundary of the site. A specific search was conducted for the following TECs and PECs which occur in the 5km radius of the site:

Threatened Ecological Communities

- *Banksia attenuata* Woodland over species rich dense shrublands (SCP20a – Endangered);
- *Melaleuca huegelii - Melaleuca systena* Shrublands on limestone ridges (SCP26a– Endangered);

Priority Ecological Communities

- Coastal Shrublands on shallow sands (SCP 29a – Priority 3); and
- Northern Spearwood shrublands and woodlands (SCP 24 – Priority 3).

5.2 VEGETATION AND FLORA SURVEY

5.2.1 Level of Assessment

The Tamala Park Development area lies within the Bioregion Group 1 (EPA 2004). The scale and nature of impact of the proposal is considered high as the clearing will be >10ha, therefore this survey is classified as a Level 2 under Guidance Statement No. 51 (EPA, 2004).

The guidance statement was used to inform suitability of the team to the survey, survey sampling design and presentation of survey data and reporting.

5.2.2 Fieldwork

5.2.2.1 Spring 2009 Survey

Spring fieldwork was undertaken over four days between September 8th and 15th 2009. The vegetation and flora survey work was undertaken by Sandra Santich, Senior Botanist (Licence No: SL008400); Anita Cole, Conservation Biologist (Licence No: SL008397); Rada Tomanovic, Environmental Scientist (Licence No: SL008398); and Jacqui Purvis, Conservation Biologist (Licence No: SL008395).

Survey plots of 10m x 10m were located in all vegetation types. Structural descriptions and species presence was recorded as per methods described in Keighery (1994). At least one plot was located in each vegetation community type. Areas of vegetation community larger than 1 ha had two plots located. Relevees were also undertaken in areas of vegetation where plots weren't located.

Foot traverses were made of all vegetation types with particular attention paid towards the identification any of the DRF or Priority Flora listed in Table 3. Opportunistic collections were made of uncommon species to ensure any potential Declared Rare or Priority Flora was collected.

The location of plots (north-west corner of each plot) and populations of any significant flora were recorded using GPS (GDA94 MGA50).

5.2.2.2 Autumn 2010 Survey

Autumn fieldwork was undertaken over 2 days on March 4th and 9th 2010. All survey plots were revisited. Opportunistic collections were also made at this time.

5.2.2.3 Specimen Identification

Upon collection, specimens were identified using a field herbarium created from specimens recently collected and identified in the area (verified at the WA Herbarium, Perth) and by comparing them with specimens at the WA Herbarium. Most specimens were identified to species level, with ambiguous specimens identified to the genus level.

Confirmation of all species was made by Dr. Arthur Weston at the Western Australian Herbarium. Flora voucher specimens of all species collected will be submitted to the Western Australian Herbarium. Russel Barrett provided determinations for the *Lepidosperma* spp and Allan Lowrie provided determination for the *Stylidium* spp.

5.2.2.4 Vegetation Condition Assessment

Vegetation condition was assessed concurrently with the flora survey search using the vegetation condition scale described in Bush Forever (Government of Western Australia, 2000) (Table 4). This scale was developed primarily for bushland areas within the Perth metropolitan region.

Table 4 Vegetation Condition Ranking (Government of Western Australia, 2000)

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

5.2.3 Limitations of Methods

As this report is based on two survey efforts (Spring 2009 and Autumn 2010), Summer and Winter flowering annuals would have not been collected. However, it is estimated that more than 80% of species were collected in the two surveys conducted. Low Summer rainfall may have resulted in less annual species being collected in Autumn 2010.

6.0 RESULTS

6.1 VEGETATION

A total of 12 vegetation types were identified within the Tamala Park Development (TPD) area. Of these, 4 vegetation types are within the Biodiversity Conservation Area (BCA) and are to be retained, whilst 8 are within the future development area. It is important to note that another two vegetation types (Vegetation Type 7 and 10), will be retained as a small pockets of bushland within Public Open Space (POS) areas and two other vegetation types (Vegetation Types 11 and 12) are those of completely degraded vegetation communities where significant trees will be retained where possible.

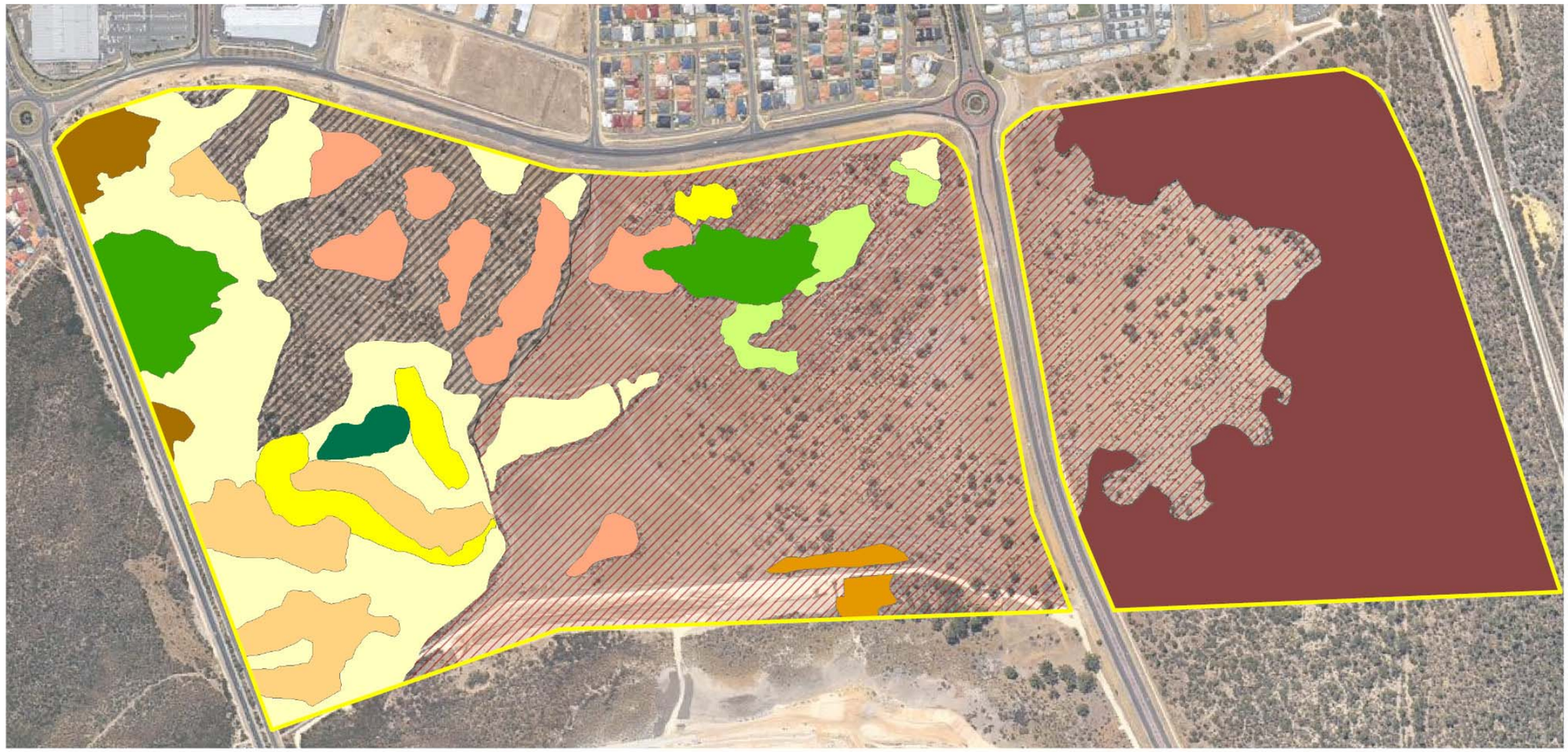
The vegetation survey identified three broad landform units during the survey. These are as follows:

- Dune Swale (5 vegetation types);
- Dune Crest and Slope (4 vegetation types);
- Limestone Outcrop (3 vegetation types).

These landform units are common regionally on the Swan Coastal Plain. However, due to clearing for urban expansion, it is not common for these landform units to be vegetated, particularly close to the coast.

The vegetation types present were closely related to the landform types. The distribution of the vegetation types and vegetation condition are shown in Figure 2 and Figure 3 and described in the sections that follow.

None of the vegetation types described are Threatened or Priority Ecological Communities (TECs or PECs).



LIMESTONE OUTCROP VEGETATION TYPES

Vegetation Type 1 : *Banksia sessilis, Melaleuca huegelii* and *Acacia cyclops* Closed Heath over *Melaleuca systena, Conostephium pendulum, Grevillea preissii* subsp. *preissii* Very Open Shrubland over **Ehrharta brevifolia Grassland / *Hypochaeris glabra Herbland / Desmocladus flexuosus* Very Open Sedgeland

Vegetation Type 4 : *Acacia rostellifera* Closed Heath over mixed Open Grassland */Lepidosperma sp.* Coastal Dunes and *Desmocladus* flexuosus Open Sedgeland

Vegetation Type 8 : *Melaleuca systena Hakea lissocarpha* and *Acacia pulchella* Closed Heath over *Banksia dallanneyi* var *dallanneyi* Very Open Shrubland over mixed Open Grassland / **Carpobrotus edulis* Very Open Herbland / *Desmocladus flexuosus* Sedgeland

N

0 100 500

METERS

DUNE CREST AND SLOPE VEGETATION TYPES

Vegetation Type 2 : *Banksia sessilis* Tall Shrubland over *Acacia pulchella, Xanthorrhoea preissii* and*Hibbertia hypericoides* Open Heath over mixed Grassland and Herbland

Vegetation Type 5 : *Xanthorrhoea preissii / X. brunonis, Hakea lissocarpha* and *Melaleuca systena* Open Heath over **Ehrharta calycina* Open Grassland / mixed Open Herbland / *Desmocladus flexuosus* / Open Sedgeland

Vegetation Type 6 : *Acacia rostellifera* Tall Open Scrub over *Hibbertia hypericoides* Open Heath over mixed Very Open Grassland and mixed Very Open Herbland

Vegetation Type 10 : Mixed shrubland with scattered *Nuytsia floribunda* and *Bankisa attenuata* over mixed Grassland / mixed Herbland and *Mesomelaena pseudostygia Desmocladus flexuosus* Sedgeland

DUNE SWALE VEGETATION TYPES

Vegetation Type 3 : *Banksia attenuata* and *B. menziesii* Low Woodland over *Macrozamia riedlei, Hakea lissocarpha* Open Heath, over *Hibbertia hypericoides, Phyllanthus calycinus* Low Shrubland over **Ehrharta brevifolia* Grassland / **Ursinia anthemoides* and **Hypochaeris glabra* Herbland / *Mesomelaena pseudostygia* Sedgeland

Vegetation Type 7 : *Eucalyptus gomphocephala* and *Eucalyptus marginata* Woodland over *Banksia attenuata* Low Open Woodland over *Xanthorrhoea preissii / X. brunonis, Hakea lissocarpha* Shrubland over *Hibbertia hypericoides, Gompholobium tomentosum* Low Shrubland over mixed Very Open Grassland / mixed Very Open Herbland / *Mesomelaena pseudostygia* Open Sedgeland

Vegetation Type 9 : *Banksia menziesii / B. attenuata Low Woodland* over *Allocasuarina humilis Hakea lissocarpha* Open Heath over *Daviesia triflora*

Vegetation Type 11 : Scattered *Banksia attenuata / B. menziesii* over parkland cleared

Vegetation Type 12 : Scattered mixed trees over parkland cleared

Figure 3 Vegetation Types

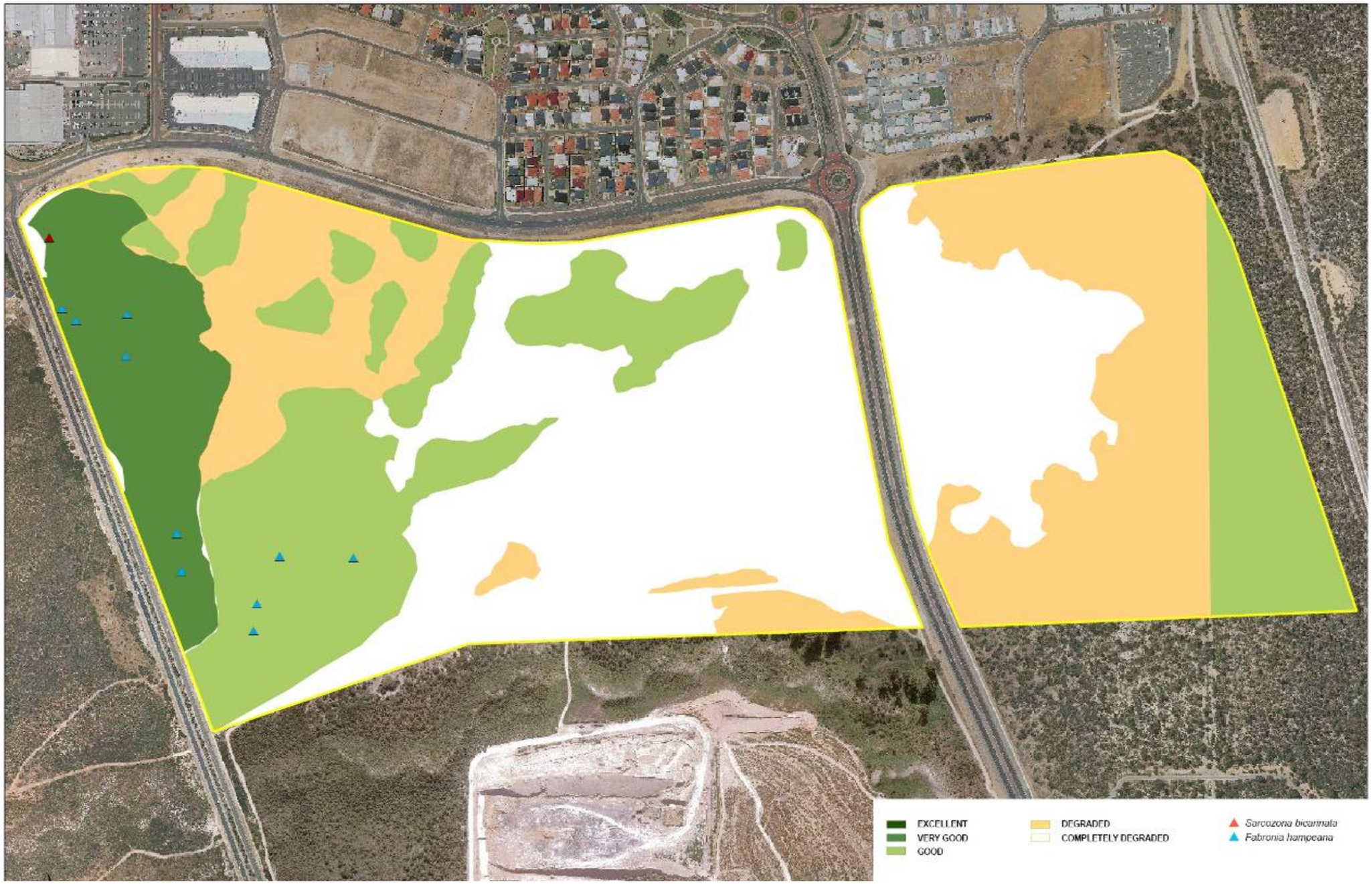


Figure 4 Vegetation Condition and Location of Priority Flora

6.1.1 Limestone Outcrop Vegetation Types

6.1.1.1 **Vegetation Type 1:** *Banksia sessilis, Melaleuca huegelii* and *Acacia cyclops* Closed Heath over *Melaleuca systena, Conostephium pendulum, Grevillea preissii* subsp. *preissii* Very Open Shrubland over **Ehrharta brevifolia* Grassland / **Hypochaeris glabra* Herbland / *Desmocladus flexuosus* Very open Sedgeland

Tingay and Associates (1999): Limestone Heath of Parrot Bush (*Dryandra sessilis*) interspersed by Balga and occasional strands of *Eucalyptus decipiens* and *Banksia*.

Vegetation Condition: Very Good

This vegetation type occurs on top of the limestone ridges adjacent to Marmion Avenue where approximately 40% of the surface is exposed limestone rock. Soils are loamy sands dark brown in colour and litter covers less than 30% of the surface. All vegetation is stunted in growth, reflecting the shallow soil layer on the limestone, and tallest shrubs are about 1.5 m (Figure 5). Evidence of native species seedling recruitment was present, as well as the evidence of some fire damage which occurred in the past. Vegetation condition was very good though patches of excellent condition vegetation were present as well.

Figure 5 Vegetation Type 1 *Banksia sessilis*, *Melaleuca huegelii* and *Acacia cyclops* Closed Heath

6.1.1.2 **Vegetation Type 4:** *Acacia rostellifera* Closed Heath over mixed Open Grassland / *Lepidosperma sp.* Coastal Dunes and *Desmocladus flexuosus* Open Sedgeland

Tingay and Associates (1999): *Acacia rostellifera* Low Shrubland

Vegetation Condition: Good

This vegetation type grows in the same soil type as Vegetation Type 1 with the same limestone outcrop cover of 40%. However, it occurs on a more sloping terrain to the south of the site (Figure 6). The total observed weed cover was very low in this area, reflecting the high cover of limestone. The good condition of the vegetation reflects the proximity of this vegetation type from the parkland cleared areas.

Figure 6 Vegetation Type 4 *Acacia rostellifera* Closed Heath

6.1.1.3 **Vegetation Type 8:** *Melaleuca systena / Hakea lissocarpha* and *Acacia pulchella* Closed Heath over *Banksia dallanneyi var. dallanneyi* Very Open Shrubland over mixed Open Grassland / **Carpobrotus edulis* Very Open Herbland / *Desmocladus flexuosus* Sedgeland

Tingay and Associates (1999): Limestone Heath of Parrot Bush (*Dryandra sessilis*) interspersed by Balga and occasional strands of *E. decipiens* and Banksia.

Vegetation Condition: Good

Although this vegetation type occurs on similar terrain as Vegetation Type 1, it differs in species composition with most shrubs being lower in height (Figure 7). The soils of this area were deeper, with approximately 20% of limestone outcropping. Most of this vegetation community was in good condition however there are localised areas which have been invaded by introduced species, mainly grasses and herbs such as **Carpobrotus edulis.*

Figure 7 Vegetation Type 8 *Melaleuca systena* / *Hakea lissocarpha* and *Acacia pulchella* Closed Heath

6.1.2 Dune Crest and Slope Vegetation Types

6.1.2.1 **Vegetation Type 2:** *Banksia sessilis* Tall Shrubland over *Acacia pulchella*, *Xanthorrhoea preissii* and *Hibbertia hypericoides* Open Heath over Mixed Grassland and Herbland.

Tingay and Associates (1999): Limestone Heath of Parrot Bush (*Dryandra sessilis*) interspersed by Balga and occasional strands of *E. decipiens* and *Banksia*.

Vegetation Condition: Very Good

This vegetation type was most common of all vegetation communities on site and occupied a range of landforms however the most typical is on the lower slopes of the dunes (Figure 8). There was variability in the dominance of species from north to south, with *Banksia sessilis* being the species that had localised areas of dominance. For the majority of the extent of this community the vegetation was in very good to good condition reflecting its resilience against weed species increased by the dense forming growth habit.

Figure 8 Vegetation Type 2 *Banksia sessilis* Tall Shrubland

6.1.2.2 **Vegetation Type 5:** *Xanthorrhoea preissii* / *X. brunonis, Hakea lissocarpha* and *Melaleuca systena* Open Heath over **Ehrharta brevifolia* Open Grassland / Mixed Open Herbland / *Desmocladus flexuosus* / Open Sedgeland.

Tingay and Associates (1999): Limestone Heath of Parrot Bush (*Dryandra sessilis*) interspersed by Balga and occasional strands of *E. decipiens* and *Banksia*.

Vegetation Condition: Good

This community is structurally similar to Vegetation Type 2 however the species composition and the underlying substrate is slightly different (Figure 9). Limestone covers approximately 30% of the ground surface. This community is found scattered in the parkland cleared areas and has been subject to disturbance for extended period of time. Therefore, weeds were common and the condition of most patches of vegetation was good with degraded edges.

Figure 9 Vegetation Type 5 *Xanthorrhoea preissii* / *X. brunonis*, *Hakea lissocarpha* and *Melaleuca systena* Open Heath

6.1.2.3 **Vegetation Type 6:** *Acacia rostellifera* Tall Open Scrub over *Hibbertia hypericoides* Open Heath over Mixed Very Open Grassland and Mixed Very Open Herbland.

Tingay and Associates (1999): *Acacia rostellifera* Low Shrubland.

Vegetation Condition: Good

Similarly to Vegetation Type 4, this vegetation community is dominated by *Acacia rostellifera*, however the understorey is significantly different in species composition (Figure 10). This community occurs on the slope and in the swale, with the swale area having a greater diversity of species. This is particularly so for the area in the north west of the site previously identified as Open Banksia Woodland (Tingay and Associates, 1999), which is now dominated by *A. rostellifera* with the diverse understorey containing species such as *Hypocalymma angustifolium* which indicate a higher water retention in the area. The sands in this particular area are deep (>1m) whereas the part of the community located at the eastern portion of the site has more limestone outcropping and shallower soils.

Figure 10 Vegetation Type 6 *Acacia rostellifera* Tall Open Scrub

6.1.2.4 **Vegetation Type 10:** Mixed Shrubland with scattered *Nuytsia floribunda* and *Banksia attenuata* over Mixed Grassland / Mixed Herbland and *Mesomelaena pseudostygia* / *Desmocladus flexuosus* Sedgeland

Tingay and Associates (1999): Limestone Heath of Parrot Bush (*Dryandra sessilis*) interspersed by Balga and occasional strands of *E. decipiens* and Banksia; and *Hakea lissocarpha* Low Shrubland with *Hibbertia hypericoides* and occasional Balga.

Vegetation Condition: Good

This vegetation type is typified by a combination of transitional vegetation communities from an Open Banksia Woodland to Open Heath (Figure 11). This vegetation type contains the greatest number of *Nuytsia floribunda* on site. Due to frequent grazing by native animals, rubbish dumping and similar, this vegetation community structure is significantly altered, however localised areas of good condition vegetation remain with a high potential for regeneration.

Figure 11 Vegetation Type 10 Mixed Shrubland with scattered *Nuytsia floribunda* and *Banksia attenuata*

6.1.3 Dune Swale Vegetation Types

6.1.3.1 **Vegetation Type 3:** *Banksia attenuata* and *B. menziesii* Low Woodland over *Macrozamia riedlei*, *Hakea lissocarpha* Open Heath, over *Hibbertia hypericoides*, *Phyllanthus calycinus* Low Shrubland over **Ehrharta brevifolia* Grassland / **Ursinia anthemoides* and **Hypochaeris glabra* Herbland / *Mesomelaena pseudostygia* Sedgeland.

Tingay and Associates (1999): 5. *Banksia attenuata* and *B. menziesii* Low Open Woodland with occasional Coastal Blackbutt and *E. decipiens* over *Allocasuarina humilis*, Balga and *Calothamnus quadrifidus*.

Vegetation Condition: Very Good - Good

The Banksia Woodland communities on site have been impacted by fire, rubbish dumping and weed invasion however, they recorded a high species diversity and condition ranged from very good to good (Figure 12).

This community has the greatest number of native annuals including at least four different orchid species and a Priority 2 moss species (*Fabronia hampeana*) found on the trunk of large *Macrozamia riedlei*.

Figure 12 Vegetation Type 3 *Banksia attenuata* and *B. menziesii* Low Woodland

6.1.3.2 **Vegetation Type 7:** *Eucalyptus gomphocephala* and *E. marginata* Woodland over *Banksia attenuata* Low Open Woodland over *Xanthorrhoea preissii* / *X. brunonis*, *Hakea lissocarpha* Shrubland over *Hibbertia hypericoides*, *Gompholobium tomentosum* Low Shrubland over Mixed Very Open Grassland / Mixed Very Open Herbland / *Mesomelaena pseudostygia* Open Sedgeland.

Tingay and Associates (1999): Banksia Woodland over *Hakea lissocarpha*, *Acacia rosteliffera*, *Dryandra sessilis* and *X. preissii*; and Jarrah, Tuart and Coastal Blackbutt (*E. todtiana*) with occasional Banksia over parkland cleared.

Vegetation Condition: Good - Degraded

This vegetation type is typified by tall remnant trees predominantly Tuart and Jarrah interspersed with *Banksia* and *Allocasuarina* species. This vegetation type is patchy with localised areas of *Banksia* or *Eucalyptus* dominance, however the patches are too small to warrant the delineation of two different vegetation communities. This community is outlined as a large area on the eastern edge of Lot 9504 Marmion Ave (Figure 13) with both Degraded and Good condition vegetation. The area of bushland adjacent to the railway line is the best example of this vegetation community on site and is in good condition.

Figure 13 Vegetation Type 7 *Eucalyptus gomphocephala* and *E. marginata* Woodland

6.1.3.3 **Vegetation Type 9:** *Banksia menziesii* / *B. attenuata* Low Woodland over *Allocasuarina humilis Hakea lissocarpha* Open Heath over *Daviesia triflora Hibbertia hypericoides* Open Low Heath over Mixed Grassland and *Mesomelaena pseudostygia* Sedgeland

Tingay and Associates (1999): 5. *Banksia attenuata* and *B. menziesii* Low Open Woodland with occasional Coastal Blackbutt (*Eucalyptus todtiana*) and *E. decipiens* over *Allocasuarina humilis,* Balga and *Calothamnus quadrifidus.*

Vegetation Condition: Good – Degraded

This Banksia community is typified by deeper soils and difference in species composition including shrub species such as *Daviesia triflora* and *Calothamnus sanguineus*. The dominant *Banksia* species is *B. menziesii.* The condition of this community has deteriorated due to edge effects and the nearby landfill activities, with a large number of weed species present.

Figure 14 Vegetation Type 9 *Banksia menziesii* / *B. attenuata* Low Woodland

6.1.3.4 **Vegetation Type 11:** Scattered *Banksia attenuata* / *B. menziesii* over Parkland cleared

Tingay and Associates (1999): Parkland cleared with occasional stands of *Banksia menziesii*, *B. attenuata* and *Eucalyptus gomphocephala*.

Vegetation Condition: Degraded

This vegetation type is a remnant of the Open Banksia Woodland which once existed on site (Figure 15). Typical scattered understorey species include *Xanthorrhoea preissii*, *Hakea prostrata and Hibbertia hypericoides.*

Figure 15 Vegetation Type 11 Scattered *Banksia attenuata* / *B. menziesii* over Parkland cleared

6.1.3.5 Vegetation Type 12: Scattered mixed trees over parkland cleared

Tingay and Associates (1999): Parkland cleared with occasional strands of *Banksia menziesii*, *B. attenuata* and Tuart.

Vegetation Condition: Degraded

This vegetation type differs from the Vegetation Type 11 due to the presence of Tuart and Coastal Blackbutt (*Eucalyptus todtiana*) as the dominant species (Figure 16). This area is not as species rich as the Vegetation Type 11, however a few species of sedges such as *Lyginia barbata* and shrubs such as *Eremaea pauciflora* have been found in isolated patches.

Figure 16 Vegetation Type 12 Scattered mixed trees over parkland cleared

6.2 FLORA

During the Spring survey a total of 199 taxa were recorded within the Tamala Park Development (TPD) area of which 48 were exotic species (Appendix 2). The most common families represented on site were: Papilionaceae, Poaceae and Proteaceae, typifying the heathland vegetation types dominant in the study area.

Similar to the finding of Mattiske (2000), a number of aggressive weed species were recorded including Annual and Perennial Veldt grass (**Ehrharta brevifolia* and **Ehrharta calycina)* Bearded oats (**Avena barbata*), Wild gladiolus (**Gladiolus caryophyllaceus*), One-leaf cape tulip (**Moraea flaccida*), Mediterranean turnip (*Brassica tournefortii*), Narrow leaf lupin (**Lupinus angustifolius*), West Australian blue lupin (**Lupinus cosentinii*), Rose pelargonium (**Pelargonium capitatum*), Geraldton carnation (**Euphorbia terracina*), Castor oil (**Ricinus communis*), Blackberry nightshade (**Solanum nigrum*) and Capeweed (**Arctotheca calendula*).

6.2.1 Significant Flora

No Declared Rare Flora (DRF) were found on site.

No additional Priority Flora to the two species identified previously in the Level 1 Flora Survey (Syrinx Environmental PL, 2009b) *Fabronia hampeana* or *Sarcozona bicarinata* were found in Level 2 Survey.

7.0 GRACEFUL SUN MOTH

The Department of Environment (DEC) requested that the Tamala Park Regional Council undertake a Graceful Sun Moth (GSM) survey throughout the entire Tamala Park Development (TPD) area, (including the part of the development area west of Marmion Avenue which was exempt from the Level 2 Flora survey) to determine if GSM are present on site.

The GSM is listed as Endangered under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) and is declared as specially protected fauna under the WA Wildlife Conservation Act 1950, as it is rare or likely to become extinct. This is partly due to the GSM having a restricted distribution only known in nine populations on the Swan Coastal Plain between Quinns Rock in the north to Mandurah in the south (Bishop, *et. al.* 2009).

The GSM biology also renders it vulnerable as the males establish small territories called leks in open spaces during the breeding season that are only 20m^2 in size. These leks are almost always along tracks and fire breaks and close to *Lomandra* food plants (Bishop et al. 2009).

The Department of the Environment, Water, Heritage and the Arts (n.d) identifies the following as ongoing threats to the GSM survival:

- track use and maintenance;
- inappropriate fire regimes; and
- damage to habitat from the recreational use of four-wheel drive vehicles.

The species is likely to have poor dispersal capabilities, and therefore it is unlikely to re-establish in a previously occupied sites should a subpopulation become extinct.

7.1 METHODOLOGY

Prior to conducting GSM surveys Syrinx staff were required to attend a DEC workshop on how to undertake a GSM survey. This was attended in November 2009 by Jacqui Purvis (Conservation Biologist) and Rada Tomanovic (Environmental Scientist).

A *Lomandra* density survey and GSM survey were conducted as per the methodologies on pages 6 to 11 of the Information Kit with Survey Methods (Appendix 3).

7.2 FIELDWORK

7.2.1 Lomandra Density Survey

The Lomandra Density Survey was undertaken over four days between the 22nd and 25th February 2010. Data was collected on locations and densities of *Lomandra hermaphrodita* and *Lomandra maritima*, known to be GSM food plants. This data was then utilised to determine the locations of transects for the focused Graceful Sun Moth (GSM) survey (Figure 18). The raw data obtained from this survey has been forwarded to DEC as required.

7.2.2 Graceful Sun Moth Survey

The GSM survey was completed one day a week over a four week period in March 2010. Wind, cloud and temperature are important factors for observing the GSM, therefore the day chosen each week was determined by the required climatic conditions.

Prior to commencing the fieldwork, transects were determined from the results of the *Lomandra* Density Survey (refer Section 7.2.1). The transects shown in Figure 18 were foot traversed on each field day. The western, eastern and central cells of the site were surveyed at different times of each field day to ensure a good coverage of temperature and wind conditions. For example the western cell was surveyed early morning one day and late afternoon on another day.

Any GSM sighted were trapped for identification purposes. A GPS location and vegetation type was recorded; and a photo taken of each specimen. The raw data collected during this survey has been forwarded to DEC.

7.3 RESULTS

Two Graceful Sun Moths (GSM) were found within the western cell of the development and one outside the development boundary in the adjacent Bush Forever Site 322 (Figure 18). No GSM were observed in areas of potential habitat within the central or eastern cells. Table 5 details the GPS locations of the specimens as captured on each sampling day. The capture locations as well as the transects traversed on site are shown in Figure 18.

Table 5 Graceful Sun Moth (GSM) Survey Results

Survey Date	No. GSM Found	Easting	Northing	Vegetation Type
05/03/10	0	-	-	-
10/03/10	1	377775	6491796	*Melaleuca systena* Open Heath over *Lomandra maritima* Closed Herbland **(outside development boundary)**
19/03/10	0	-	-	-
26/03/10	1	377850	6429113	*Acacia rostellifera* Open Low Shrubland *Melaleuca systena* Open Heath over *Lomandra maritima* Closed Herbland
	1	377935	6492096	

Figure 17 Graceful Sun-Moth (*Synemon gratiosa*)

Figure 18 Graceful Sun Moth Transects and Capture Locations

8.0 DISCUSSION

8.1 VEGETATION CONSERVATION VALUES

None of the vegetation units, floristic community types or species of significant flora recorded in the study area are protected under the Commonwealth's Environment Protection and Biodiversity Conservation Act 1999. No Declared Rare Flora species as listed under subsection (2) of Section 23F of the Western Australian Wildlife Consevation Act 1950 by the Department of Environment and Conservation (Atkins, 2008) were located in the survey area. In addition, No Threatened Ecological Communities (TECs) were recorded on site.

No additional species or populations of Priority Flora were found in this survey in addition to the two Priority Flora species (*Fabronia hampeana* and *Sarcozona bicarinata*) that were recorded in the Level 1 survey of the area (Syrinx Environmental PL, 2009b).

The 11.5ha of intact vegetation at the western boundary of the site (adjacent to Marmion Avenue) of highest conservation value has been identified for retention on the basis of criteria described in Bush Forever (Government of Western Australia, 2000) and Del Marco (2004). This area has been named Biodiversity Conservation Area (BCA) in the Local Structure Plan and an Environmental Management Plan (Syrinx Environmental PL, 2009a) has been prepared to protect its values.

The BCA is locally significant as it is one of the few remaining areas in the north western corridor of very good condition and contains both species of Priority Flora found on site. This area also includes a mosaic of vegetation types in good to excellent condition from the exposed limestone *Banksia sessilis* Closed Heath (Vegetation Types 1 and 2) to the Banksia Woodland (Vegetation Type 3) and *Acacia rostellifera* Tall Open Scrub (Vegetation Type 6). The mosaic of vegetation types is part of a larger area of vegetation which includes Bush Forever Site 322 to the south west and Bush Forever Site 323 which currently surrounds the Mindarie Regional Council (MRC) waste management facility. To the east and south eastern boundary is Bush Forever Site 383 which forms part of the Neerabup National Park. Therefore the Biodiversity Conservation Area is an important part of an east-west linkage between the coast and Neerabup National Park.

Finally, the vegetation community 29b *Acacia* shrublands on taller dunes within the BCA is considered poorly reserved and has a susceptible conservation status because there is evidence that these communities can be modified or destroyed by human activities (Gibson *et. al,* 1994).

8.2 VEGETATION CONDITION

The condition of the bushland has deteriorated since the Mattiske (2000) surveys and the fire of 2001 has changed the vegetation structure from *Banksia* Woodland to *Acacia rostellifera* Shrubland in an area along the western boundary of Lot 9504 Marmion Avenue. The increased frequency in fires is continuing to simplify the vegetation types, as observed by Mattiske (2000). Therefore fire management strategies for the Biodiversity Conservation Area will be important to ensure current bushland condition and biodiversity values are sustained or improved.

8.3 GRACEFUL SUN MOTH

This survey has determined that Graceful Sun Moth (GSM) do inhabit the coastal areas of the western cell, in areas from the third dune where *Lomandra maritima* forms a dense Herbland.

DEC will be collating data collected from GSM surveys over the next three years in order to clarify habitat requirements and distribution of the Graceful Sun-Moth within the Swan Coastal Plain (Bishop *et al*, 2009). At this stage the GSM will retain its endangered status in the short term and any proposal likely to impact the GSM requires referral to the Department of the Environment, Water, Heritage and the Arts (DEWHA) under the Environment Protection and Biodiversity Conservation Act, 1999 (the EPBC Act).

9.0 RECOMMENDATIONS

Majority of recommendations pertaining to conservation of floristic diversity and habitat for endangered fauna such as Graceful Sun Moth are outlined in the Tamala Park Environmental Management Plan (Syrinx Environmental PL, 2009a) particularly in the Key Management Actions table. The main recommendations from this report are congruent with those of the aforementioned EMP and are listed below:

- Choose areas of GSM habitat most suitable for retention and protection of GSM in collaboration with DEC and the City of Wanneroo;
- Use flora identified as feeding, breeding or roosting habitat for endangered fauna (i.e. Graceful Sun Moth and Carnaby's Black Cockatoo) in revegetation and landscaping works around and within the development;
- Collect seed of native plants from the development area in Summer 2011 and propagate seedlings for revegetation and landscaping works within the development area;
- Transplant some of the existing *Lomandra maritima* (late Autumn is best) to areas suitable for Graceful Sun Moth habitat within and outside development boundary (e.g within the Coastal Conservation Reserve or Bush Forever site 322).

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APPENDICES

APPENDIX 1 DEC Threatened Ecological Communities Category of Threat (English and Blyth, 1997) and Declared Rare and Priority Flora – Conservation Codes (Atkins 2008)

DEFINITIONS AND CRITERIA FOR PRESUMED TOTALLY DESTROYED, CRITICALLY ENDANGERED, ENDANGERED AND VULNERABLE ECOLOGICAL COMMUNITIES

Presumed Totally Destroyed (PD)

An ecological community that has been adequately searched for but for which no representative occurrences have been located. The community has been found to be totally destroyed or so extensively modified throughout its range that no occurrence of it is likely to recover its species composition and/or structure in the foreseeable future.

An ecological community will be listed as presumed totally destroyed if there are no recent records of the community being extant **and either** of the following applies (A or B):

A) Records within the last 50 years have not been confirmed despite thorough searches of known or likely habitats **or**

B) All occurrences recorded within the last 50 years have since been destroyed

Critically Endangered (CR)

An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or that was originally of limited distribution and is facing severe modification or destruction throughout its range in the immediate future, or is already severely degraded throughout its range but capable of being substantially restored or rehabilitated.

An ecological community will be listed as **Critically Endangered** when it has been adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future. This will be determined on the basis of the best available information, by it meeting **any one or more of** the following criteria (A, B or C):

A) The estimated geographic range, and/or total area occupied, and/or number of discrete occurrences since European settlement have been reduced by at least 90% **and either or both** of the following apply (i or ii):

i) geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is imminent (within approximately 10 years);

ii) modification throughout its range is continuing such that in the immediate future (within approximately 10 years) the community is unlikely to be capable of being substantially rehabilitated.

B) Current distribution is limited, **and one or more** of the following apply (i, ii or iii):

i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the immediate future (within approximately 10 years);

ii) there are very few occurrences, each of which is small and/or isolated and extremely vulnerable to known threatening processes;

iii) there may be many occurrences but total area is very small and each occurrence is small and/or isolated and extremely vulnerable to known threatening processes.

C) The ecological community exists only as highly modified occurrences that may be capable of being rehabilitated if such work begins in the immediate future (within approximately 10 years).

Endangered (EN)

An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or was originally of limited distribution and is in danger of significant modification throughout its range or severe modification or destruction over most of its range in the near future.

An ecological community will be listed as **Endangered** when it has been adequately surveyed and is not Critically Endangered but is facing a very high risk of total destruction in the near future. This will be determined on the basis of the best available information by it meeting **any one or more of** the following criteria (A, B, or C):

A) The geographic range, and/or total area occupied, and/or number of discrete occurrences have been reduced by at least 70% since European settlement **and either or both** of the following apply (i or ii):

i) the estimated geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is likely in the short term future (within approximately 20 years);

ii) modification throughout its range is continuing such that in the short term future (within approximately 20 years) the community is unlikely to be capable of being substantially restored or rehabilitated.

B) Current distribution is limited, **and one or more** of the following apply (i, ii or iii):

i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the short term future (within approximately 20 years);

ii) there are few occurrences, each of which is small and/or isolated and all or most occurrences are very vulnerable to known threatening processes;

iii) there may be many occurrences but total area is small and all or most occurrences are small and/or isolated and very vulnerable to known threatening processes.

C) The ecological community exists only as very modified occurrences that may be capable of being substantially restored or rehabilitated if such work begins in the short-term future (within approximately 20 years).

Vulnerable (VU)

An ecological community that has been adequately surveyed and is found to be declining and/or has declined in distribution and/or condition and whose ultimate security has not yet been assured and/or a community that is still widespread but is believed likely to move into a category of higher threat in the near future if threatening processes continue or begin operating throughout its range.

An ecological community will be listed as **Vulnerable** when it has been adequately surveyed and is not Critically Endangered or Endangered but is facing a high risk of total destruction or significant modification in the medium to long-term future. This will be determined on the basis of the best available information by it meeting **any one or more of** the following criteria (A, B or C):

A) The ecological community exists largely as modified occurrences that are likely to be capable of being substantially restored or rehabilitated.

B) The ecological community may already be modified and would be vulnerable to threatening processes, is restricted in area and/or range and/or is only found at a few locations.

C) The ecological community may be still widespread but is believed likely to move into a category of higher threat in the medium to long term future because of existing or impending threatening processes.

DEFINITIONS AND CRITERIA FOR PRIORITY ECOLOGICAL COMMUNITIES PRIORITY ECOLOGICAL COMMUNITY LIST

Possible threatened ecological communities that do not meet survey criteria or that are not adequately defined are added to the Priority Ecological Community Lists under Priorities 1, 2 and 3. These three categories are ranked in order of priority for survey and/or definition of the community, and evaluation of conservation status, so that consideration can be given to their declaration as threatened ecological communities. Ecological Communities that are adequately known, and are rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list, are placed in Priority 4. These ecological communities require regular monitoring. Conservation Dependent ecological communities are placed in Priority 5.

Priority One: Poorly-known ecological communities

Ecological communities with apparently few, small occurrences, all or most not actively managed for conservation (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) and for which current threats exist. Communities may be included if they are comparatively well-known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range.

Priority Two: Poorly-known ecological communities

Communities that are known from few small occurrences, all or most of which are actively managed for conservation (e.g. within national parks, conservation parks, nature reserves, State forest, unallocated Crown land, water reserves, etc.) and not under imminent threat of destruction or degradation. Communities may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under threat from known threatening processes.

Priority Three: Poorly known ecological communities

(i) Communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation or:

(ii) communities known from a few widespread occurrences, which are either large or within significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat, or;

(iii) communities made up of large, and/or widespread occurrences, that may or not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, and inappropriate fire regimes.

Communities may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and/or are not well defined, and known threatening processes exist that could affect them.

Priority Four: Ecological communities that are adequately known, rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list. These communities require regular monitoring.

(a) Rare. Ecological communities known from few occurrences that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These communities are usually represented on conservation lands.

(b) Near Threatened. Ecological communities that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable.

(c) Ecological communities that have been removed from the list of threatened communities during the past five years.

Priority Five: Conservation Dependent ecological communities

Ecological communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years.

DECLARED RARE AND PRIORITY FLORA - CONSERVATION CODES (ATKINS 2008)

R: Declared Rare Flora - Extant Taxa

Taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection, and have been gazetted as such.

X: Declared Rare Flora - Presumed Extinct Taxa

Taxa which have not been collected, or otherwise verified, over the past 50 years despite thorough searching, or of which all known wild populations have been destroyed more recently, and have been gazetted as such.

1: Priority One - Poorly known Taxa

Taxa which are known from one or a few (generally <5) populations which are under threat, either due to small population size, or being on lands under immediate threat, e.g. road verges, urban areas, farmland, active mineral leases, etc., or the plants are under threat, e.g. from disease, grazing by feral animals, etc. May include taxa with threatened populations on protected lands. Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.

2: Priority Two - Poorly Known Taxa

Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.

3: Priority Three - Poorly Known Taxa

Taxa which are known from several populations, and the taxa are not believed to be under immediate threat (i.e. not currently endangered), either due to the number of known populations (generally >5), or known populations being large, and either widespread or protected. Such taxa are under consideration for declaration as 'rare flora' but are in need of further survey.

4: Priority Four - Rare Taxa

Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors. These taxa require monitoring every 5-10 years.

Note, the need for further survey of poorly known taxa is prioritised into the three categories depending on the perceived urgency for determining the conservation status of those taxa, as indicated by the apparent degree of threat to the taxa based on the current information.

APPENDIX 2 Tamala Park Development Area Species List

Family	Species name after ID	Form	Vegetation Type No.											
			1	2	3	4	5	6	7	8	9	10	11	12
Aizoaceae	**Carpobrotus edulis*	Herb	✓	✓	✓	✓	✓		✓	✓	✓		✓	✓
	Sarcozona bicarinata (Priority 3)	Herb	✓											
Amaranthaceae	*Ptilotus drummondii*	Herb			✓				✓					
	Ptilotus manglesii	Herb							✓					
	Ptilotus polystachyus	Herb											✓	
Apiaceae	*Daucus glochidiatus*	Herb		✓	✓	✓		✓	✓					
	Eryngium pinnatifidum	Herb	✓	✓					✓					
Asparagaceae	**Asparagus asparagoides*	Herb									✓			
	Lepidosperma sp.	Herb				✓								
	Lomandra caespitosa	Herb			✓									
	Lomandra hermaphrodita	Herb								✓		✓		✓
	Lomandra maritima	Herb	✓	✓			✓	✓		✓				
	Lomandra sp.	Herb	✓						✓					
	Sowerbaea laxiflora	Herb			✓			✓	✓					
	Thysanotus patersonii	Climber	✓	✓	✓			✓	✓					
Asphodelaceae	**Asphodelus fistulosus*	Herb												✓
Asteraceae	**Arctotheca calendula*	Herb	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	**Conyza sp.*	Herb				✓								
	**Dittrichia graveolens*	Herb	✓										✓	✓
	**Hypochaeris glabra*	Herb	✓	✓	✓	✓	✓	✓		✓	✓		✓	✓
	**Leontodon sp.*	Herb	✓											
	**Sonchus oleraceus*	Herb	✓	✓		✓	✓	✓		✓				
	**Ursinia anthemoides*	Herb		✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
	?Waitzia suaveolens var. suaveolens	Herb	✓	✓	✓		✓	✓						
	Euchiton sphaericus	Herb						✓						
	Lagenophora huegelii	Herb							✓					
	Olearia axillaris	Shrub		✓				✓	✓	✓				
	Ozothamnus cordatus	Shrub		✓		✓				✓				
	Podolepis lessonii	Herb							✓					
	Podotheca angustifolia	Herb		✓				✓	✓			✓		
	Quinetia urvillei	Herb			✓				✓					
Brassicaceae	**?Brassica tournefortii*	Herb					✓							✓
	**Brassica ?barrelieri subsp. oxyrrhina*	Herb							✓					
	**Brassica barrelieri subsp. oxyrrhina*	Herb						✓						
	**Brassica tournefortii*	Herb		✓				✓	✓	✓		✓		✓
	**Capsella bursa-pastoris*	Herb		✓										
	**Heliophila pusilla*	Herb			✓	✓			✓					
Campanulaceae	*Isotoma hypocrateriformis*	Herb							✓					
Caryophyllaceae	**Cerastium glomeratum*	Herb				✓								
	**Petrorhagia dubia*	Herb	✓	✓				✓						
Casuarinaceae	*Allocasuarina fraseriana*	Tree							✓	✓	✓	✓		✓
	Allocasuarina humilis	Shrub		✓				✓	✓		✓	✓		
Centrolepidaceae	*Centrolepis sp.*	Herb		✓										
Chenopodiaceae	*Rhagodia baccata subsp. baccata*	Shrub		✓	✓			✓						
Colchicaceae	*Burchardia congesta*	Herb		✓	✓	✓	✓	✓	✓	✓	✓		✓	
Crassulaceae	*Crassula colorata*	Herb		✓	✓	✓	✓	✓	✓	✓		✓		✓
	Crassula decumbens	Herb	✓							✓				
Cyperaceae	*Centrolepis ?mutica*	Sedges and rushes			✓									
	Mesomelaena pseudostygia	Sedges and rushes		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Schoenus curvifolius	Sedges and rushes							✓					
	Schoenus grandiflorus	Sedges and rushes			✓									
	Schoenus latitans	Sedges and rushes			✓			✓	✓					
	**Isolepis marginata*	Sedges and rushes		✓	✓	✓								
	Lepidosperma ?squamatum	Sedges and rushes						✓		✓				
	Lepidosperma sp. Coastal Dunes	Sedges and rushes	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	
	Lepidosperma sp. Darling Range Heath	Sedges and rushes							✓					
	Lepidosperma squamatum	Sedges and rushes		✓			✓			✓				
Dasypogonaceae	*Acanthocarpus preissii*	Herb				✓	✓			✓		✓	✓	
Dilleniaceae	*Hibbertia hypericoides*	Shrub		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Hibbertia racemosa	Shrub							✓					
Droseraceae	*Drosera erythrorhiza*	Herb			✓	✓	✓		✓					
	Drosera macrantha	Herb					✓		✓					
	Drosera macrantha subsp. macrantha	Herb		✓			✓	✓	✓	✓				
	Drosera menziesii subsp. penicillaris	Herb						✓	✓		✓			
	Drosera pallida	Herb						✓						

? denotes that specimen collected was not adequate to make full identification; * denotes introduced (or weed) species.

Family	Species name after ID	Form	Vegetation Type No.											
			1	2	3	4	5	6	7	8	9	10	11	12
Epacridaceae	*?Conostephium preissii*	Shrub							✓					
	Astroloma pallidum	Shrub						✓						
	Conostephium pendulum	Shrub		✓										
	Conostephium preissii	Shrub							✓					
	Leucopogon ?racemulosus	Shrub			✓			✓		✓				
	Leucopogon aff ? squarrosus	Shrub					✓							
	Leucopogon parviflorus	Shrub	✓	✓		✓	✓		✓	✓		✓		
	Leucopogon propinquus	Shrub							✓	✓			✓	
	Lysinema ciliatum	Shrub					✓							
Euphorbiaceae	**Euphorbia ?lathyris*	Herb		✓										
	**Euphorbia terracina*	Herb	✓							✓	✓			
	**Ricinus communis*	Shrub												✓
	Phyllanthus calycinus	Shrub		✓	✓	✓	✓	✓	✓	✓		✓	✓	
Fabaceae	*Acacia cochlearis*	Shrub							✓					
	Acacia cyclops	Shrub	✓			✓	✓	✓		✓	✓		✓	
	Acacia rostellifera	Shrub	✓	✓		✓		✓				✓		
	Acacia truncata	Shrub	✓							✓				
	Acacia pulchella	Shrub		✓	✓	✓	✓			✓	✓	✓	✓	✓
	Acacia saligna	Shrub			✓	✓			✓		✓		✓	
	Daviesia triflora	Shrub									✓			✓
	**Trifolium arvense var. arvense*	Herb			✓	✓			✓				✓	
	**Trifolium campestre*	Herb		✓	✓	✓			✓	✓	✓			
	**Trifolium dubium*	Herb	✓		✓	✓								
Fabroniaceae	***Fabronia hampeana (Priority 2)***	Moss			✓									
Geraniaceae	**Erodium botrys*	Herb			✓	✓	✓	✓					✓	
	**Pelargonium capitatum*	Herb		✓	✓		✓			✓	✓		✓	
Geraniaceae	*Geranium solanderi*	Herb	✓	✓			✓							
Goodeniaceae	*Dampiera linearis*	Herb					✓	✓						
	?Scaevola repens	Shrub		✓		✓			✓					
	Lechenaultia linarioides	Shrub			✓			✓						
	Scaevola canescens	Shrub			✓			✓			✓			
	Scaevola crassifolia	Shrub	✓											
	Scaevola thesioides	Shrub		✓						✓				
Haemodoraceae	*Conostylis aculeata*	Herb		✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
	Conostylis setigera subsp. setigera	Herb							✓			✓		
	Haemodorum ?paniculatum	Herb							✓	✓				
	Haemodorum laxum	Herb							✓					✓
Hemerocallidaceae	*Dianella revoluta*	Herb		✓				✓	✓	✓	✓		✓	
	Tricoryne elatior	Climber	✓				✓							
	Corynotheca micrantha	Herb			✓									
Iridaceae	**Gladiolus caryophyllaceus*	Herb		✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
	**Romulea rosea*	Herb	✓	✓	✓		✓	✓		✓		✓		
	Orthrosanthus laxus var. laxus	Herb			✓									
	**Moraea flaccida*	Herb		✓	✓	✓	✓	✓	✓	✓			✓	✓
Lamiaceae	**Lavandula dentata*	Herb											✓	✓
Lauraceae	*Cassytha ?racemosa*	Climber								✓				
	Cassytha sp.	Climber	✓							✓		✓		
Loranthaceae	*Nuytsia floribunda*	Tree			✓							✓		
Myoporaceae	*Myoporum insulare*	Shrub								✓				
Myrtaceae	*Calothamnus quadrifidus*	Shrub		✓		✓	✓	✓				✓		
	Calothamnus sanguineus	Shrub									✓			
	Eremaea pauciflora	Shrub									✓			✓
	Eucalyptus todtiana	Tree									✓	✓		✓
	Hypocalymma angustifolium	Herb						✓						
	Melaleuca huegelii	Shrub	✓							✓				
	Melaleuca systena	Shrub	✓	✓		✓	✓	✓		✓		✓		
	Eucalyptus decipiens	Shrub		✓				✓						
	Eucalyptus gomphocephala	Tree							✓					✓
	Eucalyptus marginata	Tree							✓					✓
Orchidaceae	*Caladenia arenicola*	Herb			✓									
	Caladenia flava	Herb		✓	✓		✓	✓	✓	✓		✓		
	Caladenia latifolia	Herb		✓	✓					✓				
	Diuris corymbosa	Herb			✓									
	Leptoceras menziesii	Herb			✓				✓					
	Thelymitra sp.	Herb							✓					
Orobanchaceae	**Parentucellia latifolia*	Herb							✓					
Papilionaceae	**Lupinus angustifolius*	Herb						✓			✓	✓	✓	✓
	**Lupinus cosentinii*	Herb	✓				✓	✓				✓	✓	✓
	Bossiaea eriocarpa	Shrub		✓		✓	✓		✓	✓				
	Daviesia divaricata	Shrub		✓										
	Gastolobium capitatum	Shrub		✓						✓	✓			✓
	Gompholobium tomentosum	Shrub		✓		✓		✓	✓	✓				
	Hardenbergia comptoniana	Shrub	✓	✓	✓	✓		✓	✓		✓	✓		
	Hovea pungens	Shrub										✓		
	Hovea stricta	Shrub		✓		✓								
	Hovea trisperma	Shrub		✓		✓					✓			

Family	Species name after ID	Form	Vegetation Type No.											
			1	2	3	4	5	6	7	8	9	10	11	12
Papilionaceae	*Isotropis cuneifolia subsp. cuneifolia*	Herb						✓	✓					
	Jacksonia calcicola	Shrub				✓	✓	✓				✓		
	Jacksonia sternbergiana	Shrub			✓			✓		✓			✓	
	Kennedia prostrata	Herb					✓		✓	✓		✓	✓	
	Sphaerolobium medium	Shrub								✓				
	**Trifolium subterraneum*	Herb		✓	✓	✓	✓	✓	✓	✓		✓	✓	
	Templetonia retusa	Shrub	✓	✓						✓				
Poaceae	**?Briza sp.*	Grass			✓				✓					
	**Aira sp.*	Grass				✓		✓						
	**Avena barbata*	Grass		✓				✓			✓		✓	✓
	**Briza ?minor*	Grass	✓											
	**Briza maxima*	Grass							✓					
	**Briza minor*	Grass			✓			✓						
	**Bromus diandrus*	Grass							✓	✓	✓			
	**Ehrharta ?calycina*	Grass									✓			
	**Ehrharta brevifolia*	Grass	✓	✓	✓			✓			✓	✓	✓	✓
	**Ehrharta calycina*	Grass		✓		✓		✓			✓	✓	✓	✓
	**Ehrharta longiflora*	Grass	✓	✓				✓		✓				
	**Ehrharta sp.*	Grass		✓				✓		✓	✓			
	**Lagurus ovatus*	Grass						✓						
	**Lolium rigidum*	Grass	✓	✓		✓					✓		✓	✓
	**Vulpia sp.*	Grass				✓		✓					✓	
	Austrodanthonia ?occidentalis	Grass							✓	✓				
	?Austrostipa sp.	Grass		✓										
	Catapodium rigidum	Herb	✓											
Portulacaceae	*Calandrinia ?brevipedata*	Herb				✓								
Primulaceae	**Anagallis arvensis*	Herb	✓	✓		✓		✓		✓				
Proteaceae	*Banksia attenuata*	Tree			✓			✓	✓		✓	✓	✓	
	Banksia dallanneyi var dallanneyi	Shrub		✓	✓	✓	✓	✓		✓		✓		
	Banksia grandis	Tree							✓					
	Banksia ilicifolia	Tree							✓					
Proteaceae	*Banksia menziesii*	Tree			✓				✓	✓	✓		✓	
	Grevillea preissii subsp. preissii	Shrub	✓	✓						✓		✓		
	Hakea costata	Shrub		✓										
	Hakea lissocarpha	Shrub		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
	Hakea prostrata	Shrub		✓	✓	✓	✓			✓		✓	✓	
	Hakea trifurcata	Shrub		✓		✓		✓						✓
	Stirlingia latifolia	Shrub							✓		✓	✓		✓
	Banksia sessilis	Shrub	✓	✓	✓	✓	✓	✓		✓		✓	✓	
	Petrophile linearis	Shrub							✓		✓			✓
	Petrophile macrostachya	Shrub			✓	✓		✓	✓		✓			
	Petrophile media	Shrub		✓	✓									
	Petrophile sp.	Shrub		✓										
Ranunculaceae	*Clematis linearifolia*	Climber		✓						✓				
Restionaceae	*?Desmocladus flexuosus*	Sedges and rushes		✓										
	Desmocladus ?asper	Sedges and rushes			✓	✓								
	Desmocladus flexuosus	Sedges and rushes	✓	✓	✓	✓	✓	✓	✓	✓		✓		
	Lyginia imberbis	Sedges and rushes							✓					✓
Rhamnaceae	*Spyridium globulosum*	Shrub	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	
	Trymalium ledifolium var. ledifolium	Shrub	✓							✓		✓		
Rubiaceae	**Galium murale*	Herb	✓	✓										
	Opercularia vaginata	Herb	✓	✓						✓			✓	
Rutaceae	*Diplolaena angustifolia*	Shrub						✓						
	Philotheca spicata	Shrub		✓						✓				
Santalaceae	*Santalum acuminatum*	Shrub	✓											
	Exocarpos sparteus	Herb	✓											
Sapindaceae	*Diplopeltis huegelii subsp. huegelii*	Shrub	✓							✓				
Scrophulariaceae	**Dischisma capitatum*	Herb							✓					✓
Solanaceae	**Solanum linnaeanum*	Herb								✓				
Stylidiaceae	*Stylidium piliferum*	Herb							✓					
	Stylidium neurophyllum Wege ms	Herb							✓					
Thymelaeaceae	*Pimelea cf. angustifolia*	Shrub		✓										
	Pimelea calcicola	Shrub		✓						✓		✓		
Violaceae	*?Hybanthus calycinus*	Herb			✓			✓		✓				
	Hybanthus calycinus	Herb		✓		✓	✓	✓		✓		✓		
Xanthorrhoeaceae	*Xanthorrhoea brunonis*	Herb		✓	✓			✓	✓	✓		✓	✓	
	Xanthorrhoea preissii	Herb	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
Zamiaceae	*Macrozamia riedlei*	Tree (cycad)			✓			✓	✓		✓	✓	✓	✓

APPENDIX 3 Graceful Sun Moth Information Kit and Survey Methods