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Jane O'Malley

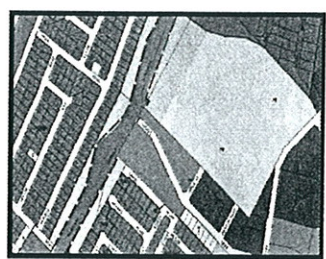
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City of Mandurah

Management Plan - Tindale Reserve (31019, 39085 and Lot 4786)

City Mandurah



Map 730 *Cross Tindale St*
& Mandurah Tce



5 Reserve Environment and Management

5.1 Climate

The CoM experiences a Mediterranean climate with cool wet winters and hot dry summers. The dry period is usually around mid October to the end of March where the average maximum and minimum temperatures range from 21.2°C to 29.5°C and 10.9°C to 17.0°C, respectively (Bureau of Meteorology, 2001). The average maximum and minimum temperatures during the wet periods range from 17.3°C to 24.4°C and 8.6°C to 13.0°C, respectively (Bureau of Meteorology, 2001).

5.2 Landform and Soils

Tindale Reserve is situated within the Vasse system of the Swan Coastal Plain landform unit. The regional geology of the Swan Coastal Plain is primarily alluvial, with shoreline and Aeolian deposits from the Phanerozoic age (approximately 0 to 5 million years ago). The Vasse system is characteristic of low level beach ridges and terraces with shallow to moderately deep sandy loams to loams overlying unconsolidated shell beds or clayey marl.

The Reserve is situated within a depression.

Additional information on landform and soil is provided in Section 5.5.4.1 for the various vegetation units of the Reserve.

5.3 Regional Botanical Context

Beard (1980) has defined boundaries for botanical provinces, districts and sub-districts for Western Australia on the basis of his vegetation mapping of the State. In this framework, the Reserve lies in the Drummond Botanical Sub-district (more or less equivalent to the Swan Coastal Plain and part of the Dandaragan Plateau) of the Darling Botanical District of the South Western Botanical Province of Western Australia.

Heddlé et al (1980) mapped the vegetation of part of the Drummond Botanical Sub-district at a very broad scale, describing the vegetation complexes (related groups of vegetation associations) associated with particular landform-soil units. A total of 38 vegetation complexes on the Swan Coastal Plain were mapped.

Tindale Reserve lies in a seasonally wet area where the Quindalup and Spearwood units meet.

More recently an alternative analysis of the plant assemblages on the Swan Coastal Plain south of Gingin Brook was carried out using a floristic approach (Gibson et al., 1994; Department of Environment Protection, 2000). This work, which is a similar level of synthesis to that of Heddle et al. (1980), identified 66 floristic community types in four floristic 'Supergroups' for the southern Swan Coastal Plain. The four 'super groups' of sites correlate closely with the major geomorphological units on the Swan Coastal Plain (and also to rainfall), with the exception of one group which contained the seasonal wetlands which includes sites across all geomorphological groups (Gibson et al., 1994).

5.4 Flora

5.4.1 Survey Methodology

First, a search was conducted of the Department of Conservation and Land Management's (CALM's) Threatened (Declared Rare) Flora and Priority Flora database and the Western Australian Herbarium Specimen database for rare (DRF) and Priority species previously collected in the Reserve and an extensive surrounding area. The search area was defined by the coordinates 32° 30' S to 32° 38' S and 115° 37' E to 115° 45' E (GDA94 datum). The database search resulted in a target list of rare and priority flora to look for when conducting the flora and vegetation field work in the Reserve.

An initial flora survey of the Reserve was conducted in April 2004, covering that part of the survey area owned by the CoM. That part of the survey area owned by the Education Department adjacent to and on the west and north side of the Mandurah HS oval buildings was surveyed in October 2004, at the time when the CoM area was revisited for a Spring survey. The flora survey comprised recordings of flora at vegetation sites and opportunistic recordings while walking between the vegetation description sites or while undertaking vegetation and weed mapping activities.

Informal vegetation recording sites (releves) were selected in a representative area of each type of vegetation unit. The releve descriptions were based on an estimated 10m x 10m area. Plant species were recorded at the releve sites in the estimated 10m x 10m areas and where time permitted, in the surrounding part of 30m x 30m areas (nested 'plots'). Where plant species were not well known, flora specimens were collected and allocated a specimen number.

Plant specimens were also recorded and where necessary, collected, wherever a species was seen in the survey area that had not already been recorded. An effort was made to note the GPS coordinates for these specimens if it was thought the species may prove to be of particular importance.

Collected specimens were pressed and subsequently dried. They were then sorted and identified. The identifications were made by comparison to specimens in the reference and research collections of the Western Australian Herbarium, by the use of keys in various papers and books and by relevant experts on various groups of flora of the Swan Coastal Plain (see the acknowledgments section below).

A follow-up Spring survey was conducted between the 28th of September to the 11th of October 2004. Each of the sites previously described was revisited and any plant species

observed that had not been previously recorded was noted and if necessary, a specimen collected for identification. Observations of species not previously recorded in the Reserve were also made while walking between sites and on general reconnaissance walks and these were added to the species list. In addition, a flora survey of the Department of Education land was conducted at this time.

5.4.2 Survey Limitations

The major limitation of the flora survey is that any such survey is a sampling procedure of a variable environment with plant populations of variable growth habit, life span and flowering season. Some species, including annuals, are only available for collection for part of the year. This means that to locate all species that grow in an area is a substantial task, the success of which is related to the time available and the size and diversity of habitat in the survey. Consequently, it is possible that there are species present on the subject land that were not recorded during this survey as they only have low abundance on the land.

A particular limitation of this flora survey is that it was initially conducted in March/April when few plant species are flowering and when the annual plants have died or 'died back' and are generally difficult to observe and have often disintegrated to the point that they are difficult to identify. However, as part of this study, a second visit to the survey area was undertaken in spring (late September, early October) when annual grasses, cryptophytes and many of the perennials are flowering or setting seed.

The third limitation of the flora survey was that it was restricted to flowering plant species and a few other groups (cycads, and ferns). Fungi, mosses, liverworts, lichens and algae are not generally surveyed systematically for environmental assessments in Western Australia, as surveying these groups (which form a small part of the biomass of the vegetation) is a specialist task and the level of information available to assess them against is quite poor.

Given the above limitations, it is likely that this survey recorded more than 80% of the vascular flora in the survey area. Once a spring survey has been conducted in the survey area, it is likely that more than 85% to 90% of the vascular flora in the survey area will have been recorded. That is, while the flora survey is relatively thorough, it is possible that some species occurring on the subject land have not been recorded.

5.4.3 Tindale Reserve Survey Results

The Department of Conservation and Land Management database searches found four priority plant species had been recorded in the area containing Janis St Reserve, Tindale Reserve, Dawesville Reserve and Beacham Reserve. Table 2 lists these species.

Table 2: Priority flora previously recorded in survey area

Plant Species	Conservation Status
<i>Chamaescilla gibsonii</i>	P3
<i>Dillwynia dillwynioides</i>	P3
<i>Laseopetalum membranaceum</i>	P3
<i>Villarsia submersa</i>	P4

None of these species were recorded in the Tindale Reserve survey area.

The total number of species recorded in this Reserve was 125, of which 60 (or 48 percent) were native species. The species list for Tindale Reserve is provided in Table 3.

No Declared Rare Flora were recorded in the survey areas.

One Priority 2 species, *Haloragis aculeolata*, was recorded at two locations in the Reserve, including within the wetland area on the eastern side of the Reserve and on the north side of Tindale St close to Mandurah Tce.

No species of other conservation interest were recorded in Tindale Reserve during the survey.

Table 3: Flora Species List for Tindale Reserve

FAMILY/TAXA	Common names	Priority Status
GYMNOSPERMAE		
016A ZAMIACEAE		
Macrozamia riedlei	Zamia	
ANGIOSPERMAE		
<i>MONOCOTYLEDONS</i>		
020 TYPHACEAE		
* Typha orientalis	Bulrush	
026 JUNCAGINACEAE		
Triglochin lineare		
Triglochin mucronatum		
031 POACEAE (grasses)		
Austrostipa flavescens		
* Avena barbata	Wild oats	
* Brachypodium distachyon		
* Briza maxima	Blowfly grass	
* Briza minor		
* Bromus diandrus	Great brome grass	
* Cortaderia selloana	Pampas grass	
* Cynodon dactylon	Couch	

* <i>Eragrostis curvula</i>	Love grass	
<i>Hemarthria uncinata</i> var. <i>uncinata</i>		
* <i>Hordeum geniculatum</i>	Mediterranean barley grass	
* <i>Hordeum leporinum</i>	Barley grass	
<i>Lachnagrostis filiformis</i>	(≡ <i>Agrostis avenacea</i>)	
* <i>Lagurus ovatus</i>	Hair's tail grass	
* <i>Lolium perenne</i> x <i>rigidum</i>		
* <i>Lolium rigidum</i>	Annual ryegrass	
* <i>Paspalum dilatatum</i>	Paspalum	
* <i>Pennisetum clandestinum</i>	Kikuyu	
<i>Poa poiformis</i>		
* <i>Polypogon monspeliensis</i>	Annual barb grass	
* <i>Stenotaphrum secundatum</i>	Buffalo	
032 CYPERACEAE (sedges)		
<i>Baumea juncea</i>		
<i>Bolboschoenus caldwellii</i>		
* <i>Cyperus congestus</i>		
<i>Ficinia nodulosa</i>	Knotted club rush	
<i>Gahnia trifida</i>	Coast saw-sedge	
<i>Isolepis cernua</i>		
* <i>Isolepis marginata</i>		
<i>Schoenus nitens</i>		

039 RESTIONACEAE (rushes)		
Meeboldina decipiens subsp. decipiens		
052 JUNCACEAE		
* Juncus bufonius		
Juncus kraussii subsp. australiensis		
* Juncus microcephalus		
054C DASYPOGONACEAE		
Lomandra maritima		
054E PHORMIACEAE		
Dianella revoluta var. divaricata	Blueberry lily	
054F ANTHERICACEAE		
Dichopogon capillipes		
Thysanotus manglesianus	Fringed lily	
Thysanotus sparteus		
054G ASPHODELACEAE		
* Trachyandra divaricata	Dune onion weed	
060 IRIDACEAE (Iris family)		

* <i>Romulea rosea</i>	Guildford grass	
* <i>Watsonia</i> sp.		
066 ORCHIDACEAE (orchids)		
<i>Microtis media</i> subsp. <i>media</i>	Common mignonette orchid	
<i>DICOTYLEDONS</i>		
087 MORACEAE		
* <i>Ficus carica</i>	Edible fig	
090 PROTEACEAE		
<i>Banksia littoralis</i>	Swamp banksia	
<i>Dryandra lindleyana</i> var. <i>lindleyana</i>		
<i>Grevillea crithmifolia</i>		
<i>Grevillea preissii</i> subsp. <i>preissii</i>		
103 POLYGONACEAE		
* <i>Rumex crispus</i>	Dock	
113 CARYOPHYLLACEAE		
* <i>Cerastium glomeratum</i>	Mouse-ear chick weed	
119 RANUNCULACEAE		

*Ranunculus muricatus		
131 LAURACEAE		
Cassytha racemosa forma racemosa		
136 FUMARIACEAE		
*Fumaria capreolata	White fumitory	
149 CRASSULACEAE		
*Crassula natans var. minus		
163 MIMOSACEAE		
Acacia cyclops	Coastal wattle	
Acacia pulchella var. glaberrima	Prickly moses	
Acacia rostellifera	Summer scented wattle	
Acacia saligna	Golden wreath wattle	
165 PAPILIONACEAE		
Hardenbergia comptoniana	Native Wisteria	
Kennedia coccinea	Coral vine	
* Lupinus cosentinii	Sandplain (blue) lupin	
* Melilotus indicus		
Templetonia retusa	Cockies tongue	

* <i>Trifolium campestre</i> var. <i>campestre</i>	Hop clover	
* <i>Trifolium resupinatum</i> var. <i>resupinatum</i>		
167 GERANIACEAE		
* <i>Erodium</i> sp.		
* <i>Geranium molle</i>	Dove's foot	
<i>Geranium solanderi</i>		
* <i>Pelargonium capitatum</i>	Rose Pelargonium	
168 OXALIDACEAE		
* <i>Oxalis corniculata</i>	Yellow wood sorrel	
* <i>Oxalis pes-caprae</i>	Soursob	
183 POLYGALACEAE		
<i>Comesperma volubile</i>		
185 EUPHORBIACEAE		
<i>Adriana quadripartita</i>		
* <i>Euphorbia peplus</i>		
* <i>Euphorbia terracina</i>	Geraldton carnation weed	
<i>Phyllanthus calycinus</i>	False Boronia	
194 ANACARDIACEAE		

* <i>Schinus terebinthifolia</i>	Japanese pepper	
215 RHAMNACEAE		
<i>Spyridium globulosum</i>	Basket bush	
223 STERCULIACEAE		
<i>Guichenotia ledifolia</i>		
265 LYTHRACEAE		
* <i>Lythrum hyssopifolia</i>	Lesser loosestrife	
273 MYRTACEAE		
<i>Eucalyptus gomphocephala</i>	Tuart	
<i>Melaleuca cuticularis</i>	Salt water paperbark	
<i>Melaleuca huegelii</i> subsp. <i>huegelii</i>	Chenille honeymyrtle	
<i>Melaleuca incana</i> subsp. <i>incana</i>	Grey honeymyrtle	
<i>Melaleuca raphiophylla</i>	Swamp paperbark	
<i>Melaleuca viminea</i> subsp. <i>viminea</i>		
276 HALGORACEAE		
<i>Haloragis aculeolata</i>		P2
281 APIACEAE		
<i>Apium prostratum</i> var. <i>filiforme</i>		

Centella asiatica		
Trachymene coerulea subsp. coerulea	Blue laceflower	
288 EPACRIDACEAE		
Leucopogon parviflorus	Coast beard-heath	
293 PRIMULACEAE		
*Anagallis arvensis var. arvensis		
* Anagallis arvensis	Pimpernel	
*Anagallis arvensis var. caerulea		
Samolus repens	Creeping brook weed	
302 LOGANACEAE		
Logania vaginalis	White spray	
303 GENTIANACEAE		
* Centaurium tenuiflorum	Slender centaury	
307A CUSCUTACEAE		
* Cuscuta campestris	Golden dodder	
315 SOLANACEAE		
Anthocercis ilicifolia subsp. ilicifolia		
* Solanum nigrum	Deadly nightshades	

Solanum symonii		
320 OROBANCHACEAE		
* Orobanche minor	Lesser broomrape	
326 MYOPORACEAE		
Myoporum caprarioides	Blueberry tree	
329 PLANTAGINACEAE		
* Plantago lanceolata	Ribwort plantain	
331 RUBIACEAE		
Opercularia hispida	Hispid stinkweed	
340 LOBELIACEAE		
Lobelia alata		
345 ASTERACEAE		
*Arctotheca calendula	Capeweed	
* Centaurea melitensis	Maltese cockspur	
*Cirsium vulgare	Spear thistle	
* Conyza parva		
* Conyza sumatrensis		
Cotula coronopifolia	Waterbutons	

* <i>Cotula turbinata</i>	Funnel weed	
* <i>Gamochaeta americana</i>		
* <i>Hypochaeris glabra</i>	Smooth catsear	
* <i>Hypochaeris radicata</i>		
* <i>Lactuca saligna</i>	Wild lettuce	
<i>Podolepis lessonii</i>		
* <i>Pseudognaphalium luteoalbum</i>		
<i>Sonchus hydrophilus</i>		
* <i>Sonchus oleraceus</i>	Common sowthistle	
* <i>Symphyrtrichum subulatum</i>	Bushy starwort (= <i>Aster subulatus</i>)	

Notes:

1. The numbers in front of the plant families are the numbers for families used at the Western Australian Herbarium.
2. An asterisk (*) beside the taxon name indicates an introduced species (weed).
3. The priority status column shows the conservation code of any rare or priority plants in the list.

5.5 Vegetation

5.5.1 Survey Methodology

5.5.1.1 Vegetation Units and Condition

The description of the vegetation units in the study areas was undertaken as a basis for the vegetation unit mapping and to enable inference of the Gibson *et al* (1994) floristic community to which those units would belong and hence whether any of the vegetation units would be Threatened Ecological Communities (TEC's).

The vegetation survey was based on informal releve recordings located in an area of vegetation that was considered representative of a particular vegetation unit. The releve areas were based on estimated distances from a centre point. The use of estimated 10 metre by 10 metre areas meant the releve data is, in that regard, consistent with Gibson *et al's* (1994) data set for the Swan Coastal Plain on which Gibson *et al's* floristic community analysis was based.

While the centre of each releve was not permanently marked, it was referenced by recording the releve centre point coordinate (WGS84 datum), using an Etrex GPS unit. GPS coordinate readings were recorded when the GPS unit indicated the locational error was (+/-) 4 to 5 meters. Photographs of each releve are provided in Appendix B. A description of the releve location, the habitat, surface soil texture and colour and any rock outcropping (and rock type) were all recorded and the time since the site was last burnt was estimated. The vegetation structure was described using a modification by Mr M Trudgen (pers comm.) of Aplin's (1979) modification of Specht's vegetation description table (Appendix C). These are the same structural units used in the Bush Forever documentation (Department of Environmental Protection, 2000b), although there are some minor differences in the wording of some of the cover classes. To obtain more representative data for the overstorey cover, the tree layer(s) cover was estimated over a larger area around the releve. All plant species occurring in the releve area were recorded along with their height and percentage cover. Plant species recorded for the releve which were outside the 10 meter by 10 meter estimated area were listed separately.

The condition of vegetation in the releve was recorded using the same scale used by Bush Forever Volume 2 (Department of Environmental Protection, 2000b). The vegetation condition scale and description are provided in Appendix D. Other notes were made regarding vegetation health and any indications of the presence of dieback or indeed other plant diseases. Impacts of dieback on the condition of the vegetation should be included in assessing vegetation condition (Keighery 1994, reproduced in Department of Environmental

Protection Vol 2 (2000)), but where the cause of tree deaths was inconclusive the occurrence of deaths were not given great weight in the assessment of vegetation condition.

The information recorded for each vegetation unit was consistent with the templates developed as part of the Perth Biodiversity Project and should enable completion of the templates if desired.

5.5.1.2 Inferring Floristic Community Types (FCT)

The Floristic Community Type of a vegetation unit was inferred by looking at the floristic communities that had been recorded in the area and a list of the floristic communities on the Swan Coastal Plain with their generalised descriptions and the geomorphological unit on which they occurred (Gibson *et al.* 1994). Then the site species list was compared in detail with a two way table that only showed species which occurred in any one community type with frequencies of at least 50% (Gibson *et al.*, 1994).

5.5.1.3 Determining Floristic Community Type using PATN analysis

Because of difficulties in inferring floristic community type, FCT's are best determined by running computer-based PATN analysis on the site data and the Gibson *et al.* (1994) Swan Coastal Plain data set to generate a grouping of the sites against the Gibson *et al.* floristic community groups. The floristic analysis carried out was based on species presence/absence data from sixteen sites in the four City of Mandurah reserves combined in a database with the 509 sites from Gibson *et al.* (1994). The sixteen sites from the City of Mandurah reserves included five from Tindale Reserve (TS1, TS2, Ts3, TS5, TS10-).

5.5.1.3.1 Data Preparation and Compatibility

The vegetation site data from the sixteen sites in four City of Mandurah reserves was entered into a specially designed computer database developed by E. A. Griffin using Microsoft Access.

To conduct the analysis on the data from the four City of Mandurah reserves and Gibson *et al.* (1994) datasets, it was first necessary to reconcile the flora species names. This step was necessary because of changes in the nomenclature over the last ten years and the potential for survey specific variations in the application of names (Griffin and Trudgen, 2004). The reconciliation involved reducing some infra-specific names to the relevant species name, combining some taxa where confusion is known to have occurred in field observations and identifications and omitting some names (mostly where a taxon had only been identified to genus).

It should be noted that the data from the four reserves was compatible with the Gibson *et al.* (1994) data. Both datasets were based on data collected from sites of similar sizes, with the Gibson *et al.* (1994) sites being 10 metre by 10 metre quadrats and the City of Mandurah reserve sites being relevés of estimated 10 metre by 10 metre areas. The Gibson *et al.* (1994) sites and the City of Mandurah reserve sites were visited twice to record plant species present, including a spring visit. Weed species were included in both the Gibson *et al.* (1994) and City of Mandurah reserve data sets.

5.5.1.3.2 PATN Analysis

The PATN modules used were ASO (calculation of similarity matrix), FUSE (classification), DEND (representation of classification) and NNB (determination of sites most similar to each site) (Griffin and Trudgen, 2004). The results of the analyses were imported into a database so that site characteristics and previous classifications (eg Floristic Community Types derived in earlier classifications) could be associated with them.

Two types of PATN analysis were used. The first method (using the PATN ASO, FUSE and DEND modules) ran an analysis of the combined City of Mandurah reserves and Gibson *et al.* (1994) data sets to produce a classification of the sites vegetation in the form of a dendrogram of the combined data sets, with the Floristic Community Types defined by Gibson *et al.* (1984) assigned to the Gibson *et al.* (1994) sites. The appropriate Floristic Community Type to assign to the City of Mandurah reserve sites could then be interpreted by the relative position of those sites to the Gibson *et al.* sites in the dendrogram.

The second method (Nearest Neighbours method) used the NNB module of PATN to investigate which 20 sites in the combined data set were most similar to each of the City of Mandurah reserve sites.

A final assignment of a Floristic Community Type was then made to each of the City of Mandurah reserve sites taking into account the results of both methods and the fact that the dendrogram relationships can be arranged in a more 'spread out' and less easily interpretable manner.

5.5.1.4 Identification of Threatened Ecological Communities (TEC)

Once each of the City of Mandurah reserve sites was assigned to a Floristic Community Type, a table of Floristic Communities Types on the Swan Coastal Plain and their TEC status (Department of Environmental Protection, 2000) was consulted to determine if any of the City of Mandurah Reserves sites were TEC's. No new TEC's have been assessed for the

western part of the Swan Coastal Plain (which includes the survey area) since the publication of *Bush Forever Vol 2* (B.J. Keighery, pers. comm.).

5.5.2 Survey Limitations

5.5.2.1 Vegetation Survey

There is a limit to the accuracy of the assignment of the different strata in the vegetation descriptions to structural units (for example, low open woodland, low woodland, low open forest, open shrubland, shrubland etc.). Referral of a stratum to a structural category depends on assessment of its cover. Such estimation is notoriously imprecise and it is not unusual for different observers to give quite different estimates of the cover of a species, or stratum in a stand. However, descriptive exercises such as that carried out for this report require only a moderate level of accuracy, sufficient to determine which of a few cover categories a species or stratum falls into (or close to).

For this report, vegetation cover was estimated for each plant species recorded in the quadrats by estimating each species canopy cover. The assumption was made that for most species, canopy cover and projected foliar cover are reasonably similar, or that the difference is less than the level of accuracy of the estimates. Conducting the main survey in April meant that the estimation of cover of the annual grasses was particularly difficult because they were in various stages of break down and decomposition and had often at least partial collapsed and were lying across the ground. This was not a significant problem in Tinsdale Reserve because of the dominance of perennial weeds (couch, buffalo and kikuyu).

5.5.2.2 Inferring Floristic Community Type

Inferring floristic community type is not an easy process. Many species can be common to a number of floristic communities. The method depends on using existing floristic communities and a poor outcome might occur if sites are forced into existing floristic communities.

Another problem arises for floristic communities that have been determined more recently and which cannot be accessed from the Gibson *et al.* (1994) data set.

5.5.2.3 PATN Floristic Analysis

It has been found in other floristic analysis that the addition of new sites to the Gibson *et al.* (1994) data set to produce a combined classification may disrupt the original classification of sites (Griffin and Trudgen, 2004). The more data entered, the higher the level of disruption.

If this occurs it can make it difficult to assign the new sites to the Floristic Community Types of Gibson *et al.* (Griffin and Trudgen, 2004).

Another limitation in conducting a PATN floristic analysis using the above methods may arise depending on the degree of success in reconciling the two data sets. A further limitation may arise from any significant differences in data collection methods between the two surveys. This is unlikely to have caused a material difference in the results for this study.

5.5.3 Mapping

5.5.3.1 Vegetation Units

Vegetation units were recorded generally between plant community and plant association level. Vegetation unit boundaries were noted on computer generated aerial photographs while traversing between vegetation releve sites. The aerial photographs were at 1:1000 scale, colour, orthorectified and overlain with the UTM coordinate grid (GDA94 datum). GPS coordinate readings were sometimes used to confirm boundary locations. In each reserve, the alignment of GPS readings and coordinates of points on the aerial photographs were checked at least once. Some additional traversing of the survey areas was undertaken, as required, to complete vegetation unit boundaries.

Vegetation mapping unit descriptions were based on the releve vegetation descriptions. In some cases where the vegetation was ecotonal or very variable, it was mapped as a mosaic of described vegetation units.

Mapping vegetation units is very subjective and the vegetation boundaries mapped for the survey areas are a particular interpretation of the vegetation of the area. However, boundaries should delineate areas of vegetation with consistently different dominant species, significantly different percentage cover of the dominants or significantly different species composition.

5.5.3.2 Vegetation Condition

The vegetation condition was mapped using the vegetation condition assessment at each of the releves and using the same approach as outlined for the vegetation unit mapping in Section 5.5.3.1.

5.5.4 Tindale Reserve Survey Results

5.5.4.1 Vegetation Units

Twelve vegetation units were mapped for the Tindale Reserve and adjacent bushland (including the Department of Education land). Figure 3 delineates the location of the vegetation units. Tindale Reserve lies in a swale east of the Quindalup dune in an area where heavy (clay) soils have been exposed. The vegetation in this area is typically *Eucalyptus gomphocephala* (Tuart) woodland over *Melaleuca* sp. over *Gahnia trifida*, *Baumea juncea* sedgeland. Photos of the vegetation units are provided in Appendix B. Appendix E provides additional information for each site and the species within these sites.

The codes that discriminate the vegetation units are shown at the head of the vegetation units below and on the vegetation map (Figure 3). The codes are derived from the generic and species names of the more abundant genera or species in the different strata present in the unit. Where there is more than one species in the genus, or where two genera have the same initial, a lower case letter is used to distinguish which species is being referred to (see Table 4).

Table 4: Species Abbreviations and Names

Ac	<i>Acacia cyclops</i>	Lg	<i>Lepidosperma gladiatum</i>
As	<i>Acacia saligna</i>	Mc	<i>Melaleuca cuticularis</i>
Ar	<i>Acacia rostellifera</i>	Mc	<i>Melaleuca cuticularis</i>
Bj	<i>Baumea juncea</i>	Mr	<i>Melaleuca raphiophylla</i>
Ca	<i>Centella asiatica</i>	Mv	<i>Melaleuca viminea</i> subsp. <i>viminea</i>
Eg	<i>Eucalyptus gomphocephala</i> (Tuart)	Sg	<i>Spyridium globulosum</i>
Gt	<i>Gahnia trifida</i>	*To	<i>*Typha orientalis</i>
Gp	<i>Grevillea preissii</i> subsp. <i>preissii</i>		

The vegetation structure/species dominance/floristic units defined for the area are considered to be mostly described at the plant community level but may represent broader units. Some stands of some of the vegetation units occurring in the areas mapped for vegetation units are quite small and as a result are not shown on the vegetation maps.

- **EgGt** - (unit represented by site TS1)

Eucalyptus gomphocephalus open forest over *Acacia saligna*, *Acacia cyclops* scattered tall shrubs over *Templetonia retusa* scattered shrubs over *Gabnia trifida*, *Baumea juncea* open to closed sedgeland with *Opercularia hispidula* very open herbland and **Cynodon dactylon*, **Pennisetum clandestinum* open to closed weed grassland.

Habitat and Soil: Seasonally wet, broad flat area, with a dune (Quindelup?) about 50m to the west. The soil appearance and texture is dark grey clay.

- **EgBj** - (unit represented by site TS2. Similar to TS1 but less *Gabnia trifida*)

Eucalyptus gomphocephala woodland over *Acacia saligna* low woodland over scattered *Templetonia retusa* shrubs over scattered *Myoporum caprarioides* over *Baumea juncea*, *Poa poiformis*, (*Gabnia trifida*) closed sedgeland/grassland with *Trachymene coerulea* very open tall herbland and *Opercularia hispidula*, *Lobelia alata*, *Centella asiatica* very open low herbland.

Habitat and Soil: Seasonally wet, broad flat area, with a dune (Quindelup?) about 50m to the west. Soil is dark grey clay.

- **EgMc** - (unit represented by site TS3)

Eucalyptus gomphocephala woodland over *Melaleuca cuticularis* low open woodland over *Melaleuca viminea*, *Templetonia retusa*, *Adriana quadripartita* shrubland over *Gabnia trifida*, *Baumea juncea* closed sedgeland with *Samolus repens* very open herbland and **Cynodon dactylon*, **Stenotaphrum secundatum* very open grassland

Habitat and Soil: Seasonally wet, very shallow depression within a broad, flat area. The soil appearance and texture is black clay.

- **EgSgGt** - (unit represented by site TS4)

Eucalyptus gomphocephala open forest over *Acacia saligna* low open woodland over *Spyridium globulosum* high open shrubland over *Templetonia retusa* open shrubland over *Gabnia trifida* sedgeland with **Avena barbata*, **Bromus dilatata* annual weed grassland.

Habitat and Soil: Low lying (seasonally wet) flat area. The soil appearance and texture is grey loamy clay.

Notes: This was a small area with small islands of bushland vegetation between disturbances.

- **EgMrGt** - (unit represented by site TS6)

Eucalyptus gomphocephalus open woodland to woodland over *Melaleuca raphiophylla*, (*Acacia saligna*) low woodland over *Melaleuca viminea*, *Acacia cyclops* high open shrubland over *Templetonia retusa* scattered shrubs over *Gabnia trifida* open sedgeland and **Cynodon dactylon* closed grassland with *Centella asiatica* open herbland.

Habitat and Soil: Low lying (seasonally wet) flat area. The soil appearance is dark grey loamy clay.

- ***To** - (unit represented by site TS6. Very small unit)

**Typha orientalis* closed tall sedgeland over **Juncus microcephalus*, **Paspalum dilatatum* very open sedgeland/grassland over *Centella asiatica* very open herbland.

Habitat and Soil: shallow storm water sump. The soil appearance and texture is grey clay.

- **EgAr** - (unit represented by site TS7. Small unit)

Eucalyptus gomphocephala woodland over *Acacia rostellifera* open scrub over *Templetonia retusa* open shrubland over **Stenotaphrum secundatum*, **Cynodon dactylon* closed grassland.

Habitat and Soil: Low lying flat area.

- **EgAcMv** - (unit represented by site TS8. Weedy area)

Eucalyptus gomphocephala open woodland to woodland over *Acacia cyclops* scattered tall shrubs over *Melaleuca viminea* shrubland to open shrubland over **Pennisetum clandestinum* (kikuyu) closed grassland.

Habitat and Soil: Broad flat area, with a dune (Quindelup?) about 50m to the west.

- **AsCa** - (unit represented by site TS9)

Acacia saligna low open woodland over *Centella asiatica* closed herbland with *Schoenus nitens* sedgeland and areas of **Stenotaphrum secundatum* and **Cynodon dactylon* weed grassland.shrubs over *Melaleuca viminea* shrubland to open shrubland over **Pennisetum clandestinum* (kikuyu) closed grassland.

Habitat and Soil: Flat area surrounding the **Typha* seasonal wetland.

- **EgAsGt** - (this site is probably ecotonal of a TS5 type vegetation)

Eucalyptus gomphocephala woodland over *Melaleuca raphiophylla* scattered trees over *Gabnia trifida* closed sedgeland over *Centella* herbland with areas of **buffalo* and **couch* grassland.

EgAcGt

Eucalyptus gomphocephala scattered trees to open woodland over *Acacia saligna* scattered low trees over *Acacia cyclops* open scrub over *Templetonia retusa* scattered shrubs over *Ghania trifida*, (*Baumea juncea*, *Juncus kraussii* subsp. *australiensis*) closed sedgeland with patches of **Stenotaphrum secundatum* (buffalo) closed grassland and *Podolepis lessonii* scattered herbs.

Habitat and soil: Flat swale floor. Grey clay.

Notes: This unit was represented by site TS10.

EgAsGp

Eucalyptus gomphocephala woodland to open forest over *Acacia saligna* scattered low trees over *Anthocercis illicifolia* subsp. *illicifolia* scattered tall shrubs over *Acacia pulchella* var. *glaberrima*, *Grevillea preissii* subsp. *preissii*, *Hibbertia hypericoides* low shrubland over *Schoenus grandiflorus* very open sedgeland and **Ehrharta calycina* annual grassland with *Acanthocarpus preissii* very open hermland.

Habitat and soil: Broad flat area (swale), east of a low dune. Pale brown silicious sand (Spearwood sand).

Notes: This unit was represented by site TS11. The area was in a very poor condition with high **Ehrharta calycina* weed cover and physical disturbance.

EgAsLg

Eucalyptus gomphocephala open forest over *Acacia saligna* low woodland over *Templetonia retusa* scattered tall shrubs over *Acacia pulchella* var. *glaberrima* open shrubland over *Lepidosperma gladiatum* sedgeland and **Pennisetum clandestinum* (kikuyu), **Stenotaphrum secundatum* (buffalo) grassland

Habitat and soil: Broad flat area, with a dune (Quindelup?) about 50m to the west.

Notes: This unit was represented by site TS12. The area of this site had high weed cover.

5.5.4.2 Vegetation Condition

The vegetation condition at the Reserve and adjacent areas was in the range of Completely Degraded (physical disturbance of soil and high cover of aggressive weeds) to Very Good (particularly areas of high *Gahnia trifida* cover which resulted in significantly lower weed covers. The eastern end of the Tindale St survey area (opposite the school) had a high cover of **Ehrharta calycina* (perennial veldt grass) and patches of *Watsonia*'s.

Figure 4 delineates the condition of vegetation in the Reserve and adjacent bushland.

5.5.5 Determination of Floristic Community Types

Two floristic communities, FCT 17 and FCT 19, were inferred for Tindale Reserve and adjacent bushland (Table 5 below). However, there was considerable uncertainty about the inferred FCT's, as FCT 17 and FCT 19 are quite difficult to differentiate.

The dendrogram generated by the PATN analysis from the combined data set of the City of Mandurah Reserves survey area sites and Gibson *et al.* (1994) Swan Coastal Plain sites (Appendix H) grouped sites TS1, TS2, TS3, TS5 and TS10 close together, indicating they are floristically similar to each other. None of these sites had a high similarity to Gibson *et al.* (1994) sites, with all of them having high dissimilarity coefficients with their nearest neighbours (Appendix H). The grouping of the Tindale St Reserve sites is most probably because they are very geographically close (within 200 to 300 meters of each other) relative to the distance between them and the other Gibson *et al.* (1994) sites.

The dendrogram grouped the Tindale St Reserve sites with FCT's 17 and 19. The nearest neighbour analysis (Appendix H) showed that the Tindale St Reserve sites had a fairly high level of 'dissimilarity' with their nearest neighbours and that sites TS1, TS5 and TS10 were grouped with FCT 17. Site TS2 grouped first with FCT 17, but showed a strong affinity for FCT 19 (Table 5). Melissa Hoskins and Val English (*pers. comm.*; WATSCU, Dept of CALM), having seen the site and reviewed the results of the PATN analysis, concluded that the vegetation at the site was probably ecotonal but predominantly FCT 17 with only small patches of FCT 19. They would map it all as FCT 17. Site TS3 grouped first with FCT 15, but also showed strong affinity with FCT 17. Again, it was concluded this vegetation type was closer to FCT 17 and was unlikely to be FCT 15 which had significantly lower species richness and because of the absence of species typical of FCT 15 (Melissa Hoskins, *pers. comm.*, (WATSCU, Dept of CALM). Table 5 shows the Floristic Community Type (FCT) to which the Tindale Reserve sites were assigned.

FCT 17 is a '*Melaleuca raphiophylla* – *Gabnia trifida* seasonal wetland' type predominantly occurring in the Quindelup and Spearwood landform units (Gibson *et al.*, 1994).

Table 5: The inferred floristic community, the floristic community generated from the PATN dendrogram and nearest neighbour analysis and the overall assigned Floristic Community Type for vegetation units in the Tindale St Reserve and adjacent areas.

fc= floristic community

TEC=Threatened Ecological Community:

CR=Critically endangered

VU=Vulnerable

Vegetation sites	Inferred fc	fc from Dendrogram	fc from Nearest Neighbr	Floristic Community Types Assigned	TEC's
TS1	≥19	17/19	17	17	
TS2	≥19	17/19	19/17	17	
TS3	17	17/19	15/17	17	
TS5	17	17/19	17	17	
TS10		17/19	17	17	

5.5.5.1 Threatened Ecological Communities

The Department of Conservation and Land Management has developed a procedure for identifying TEC's (Department of Environmental Protection 2000b; English and Blythe 1997). Threatened ecological communities are assigned to one of four categories: 'Presumed Totally Destroyed'; 'Critically Endangered'; 'Endangered' or 'Vulnerable' (Department of Environmental Protection, 2000b).

On the Swan Coastal Plain, twenty five ecological communities delineated by a number of floristic studies and freshwater organism studies have been assessed for TEC status. Twenty four of these have assessed as 'threatened' (Department of Environmental Protection 2000b). Sixteen of these are floristic community types as identified by Gibson et al. (1994) (Department of Environmental Protection 2000b).

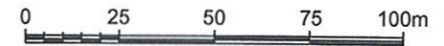
The Department of Conservation and Land Management TEC database search resulted in two records of TEC's from a wide area, which incorporated the Reserve, including SCP15 (Forests and woodlands of deep seasonal wetlands of the Swan Coastal Plain) and SCP07 (herb rich saline shrublands in clay pans). Neither of these were recorded in the Reserve. It was concluded that only FCT 17 could be mapped in the Tindale Reserve and adjacent bushland. FCT 17 is not a TEC vegetation type. FCT 19, (a TEC in the Critically Endangered category) was considered to occur in small patches of vegetation in the survey

area (adjacent to Mandurah Tce between Tindale St and Reserve Dve), but not large enough to map it or consider it as a defineable unit in the area (Mellisa Hoskins, *pers. comm.*, (WATSCU, Dept of CALM)).

Table 5 indicates the inferred floristic communities and their TEC status.



NOTES: MS1 - MS13 = VEGETATION RECORDING SITES
 Aco, Ah, affAr, Ar, Eg, ArGp, EgSgOa, Ht, Mh, SaAhGp = VEGETATION UNITS
 CD = COMPLETELY DEGRADED
 SEE DESCRIPTIONS IN MAIN TEXT



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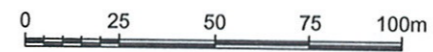
TINDALE VEGETATION UNITS

Project Number: 36413
 Figure Number: FIGURE 3

L:\Projects\06413 - Mandurah Management Plans - Tindale\Figure 3 - New Vegetation Units.dwg, 15/02/2005 11:56:53 AM, 1:1,000:3



LEGEND: P = PRISTINE
 E = EXCELLENT
 VG = VERY GOOD
 G = GOOD
 D = DEGRADED
 CD = COMPLETELY DEGRADED



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TINDALE
 VEGETATION CONDITION

Project Number: 36413
 Figure Number: FIGURE 4