A DESCRIPTION OF NATURAL VALUES OF THE SOUTH BUNBURY TO CAPEL COASTAL CORRIDOR

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INTRODUCTION

The South Bunbury to Capel Coastal Corridor is a large natural area containing:

- a large area Quindalup Dunes; and
- a contiguous eastern wetland chain

between the Maidens and Minninup Beach (Map 1).
The Coastal Corridor contains the most southern vegetated remnant of the Quindalup Dunes on the Swan Coastal Plain. The majority of the contiguous eastern wetland chain, is naturally vegetated. Two lakes, containing areas of open water, are known from this chain, Muddy Lake and Dalyellup Lake. To the east the Coastal Corridor is contiguous with areas of naturally vegetated Spearwood Dunes.

The South Bunbury to Capel Coastal Corridor contains areas of privately owned land, some of which is proposed for Regional Open Space (ROS) and an area of reserved land (WAPC 2000). Both the currently reserved land, the Maidens (C70, DCE 1983) and the land proposed for reservation, Muddy Lake ROS and Dalyellup ROS, have been recognised for reservation on the basis of their natural values (DCE 1983 and WAPC 2000 respectively). The natural values of the Coastal Corridor have been identified in a series of regional studies and several area specific studies. While these studies have identified that parts of the Coastal Corridor have high natural values, the studies do not appear to contain sufficient information to:

- adequately assess the area specific natural values at a regional scale; or
- determine the most adequate boundaries of a reserved and/or protected area to conserve the area's substantial natural value.

To better document and understand the values of the Coastal Corridor this report has been prepared from published and unpublished regional and specific area information together with information from field survey. The survey work was performed over two days in June 2002 by BJ Keighery, GJ Keighery and S Santich. A series of transects were walked to observe the range of plant communities mapped by Tingay (1991) and compare these with current aerial photographs. Some plant voucher material was collected. The information on the natural attributes is outlined and discussed, with particular reference to the regional significance of the particular attribute.

NATURAL VALUES

LANDFORM AND SOILS

Description

The South Bunbury to Capel Coastal Corridor (Map 1) is located on the Swan Coastal Plain where the predominant landforms are:

- a large area of over 550ha of naturally vegetated (after Beeston *et al.* 2001) Quindalup Dunes; and
- the contiguous eastern wetland chain of which around 250ha is naturally vegetated (after Beeston *et al.* 2001).

A series of studies map the soils and landforms of the Coastal Corridor. These are outlined below.

- The most recent mapping for the area is that by the Department Agriculture Land Capability group (GIS dataset only). That study describes the Coastal Corridor as lying within the Quindalup and Spearwood Dune Systems. The landforms and soils are described for each System, being:
  - Quindalup Dune landforms as being 'discrete long-walled parabolic dunes' (Qp2) and 'deflation basin' (Qd) with the soils of the dunes being deep pale cream calcareous and the basins moderate deep to deep alkaline calcareous sands over limestone pavement; and
  - Spearwood Dunes landforms (the wetland area) as being 'swales and depressions' (S3, S3b the unit actually mapped has no code given) with soils being acidic sand over loamy sand .

- The Urban Geology Series (Anon. 1981) map the area as being of Holocene age, the Quindalup Dunes being 'Safety Bay Sand' (Qhs) and the eastern wetlands 'swamp deposits mainly peaty sands' (Qhw).

- Churchward and McArthur (1980) map Holocene sands in the Quindalup Dunes, but the large eastern wetland area is mapped in the Vasse System. The eastern wetland area is considered to be 'poorly drained plains with variable undifferentiated estuarine and marine deposits'.

- Semeniuk (1998) places the wetlands as an area of 'contact between Holocene Dunes and Pleistocene Dunes' being formerly an 'estuarine basin now subject to groundwater hydrology and perching of direct precipitation' with the stratigraphy of the soils being 'friable ferricrete and peat overlying muddy sand (peat & clay) and estuarine'. Within the Quindalup Dunes three damplands are mapped with soils of peaty sands.

A series of area specific vegetation studies, and the vegetation work for this study, also give information on the landforms. This information is integrated in this section but described in the section on vegetation.

Discussion

On the basis of the regional information, specific area studies and field observations the Coastal Corridor contains three significant landforms. These are:

- Quindalup Dunes (Photo 1, Appendix 2) - These take the form of a series of parabolic Quindalup Dunes with moderate relief and age. The area forms the most southern band of such dunes on the Swan Coastal Plain.
- Wetlands. - Two types of wetlands are identified.
  Quindalup Dune Swale Damplands (Photos 3 to 6, Appendix 2)
  A series of damplands are found between the ridges of the Dunes and appear to be surface expressions of the ground water. A north-south gradient is apparent in these wetlands. To the north, in the Maidens, the damplands are relatively small in area and locate in the most inland dune swales (Map 2a from Ecoscape 2002). In contrast, at their southern extremity, west of the Quindalup/Spearwood Dune Interface Sumplands and Lakes (Map 2b after Tingay 1991 and Map 2c), these damplands are more numerous, ranging from small areas in the near coastal swales (Photo 3, Appendix 2) to relatively large areas on the more eastern swales (Photo 4, Appendix 2). These wetlands are much more extensive than previously mapped. The soils of these wetlands are variable being humus rich sands and/or peaty sands and sandy clays with calcareous fragments.
  Quindalup/Spearwood Dune Interface Sumplands and Lakes (Photos 9 to 13, Appendix 2)
  This area contains both the open water areas of Dalyellup and Muddy Lake (Maps 1, 2b, 2c and 3)The description from Semeniuk (1998) is considered the most accurate description of these wetlands. The peat layer is substantial and in at least one location (east side of Dalyellup Lake area) is over 1m thick.

This landscape appears to be unique on the Swan Coastal Plain. The only other location where there is similar sequence of dunes and wetlands associated with the Quindalup Dunes and their interface with the Spearwood Dunes is in the Rockingham and Yanchep areas.

VEGETATION, VEGETATION CONDITION AND FLORA

Vegetation Condition and Flora are described separately but, for clarity, the Discussion section is combined.

Vegetation Description

Regional Vegetation Complex Maps (1 250 000 scale)

Heddle *et al.* (1980) maps two vegetation complexes in the area, the Quindalup Complex and the Vasse Complex (see Table 1). While this study gives an indication of what the type of vegetation that may be encountered in the corridor this mapping is most useful for broad regional comparisons.

Table 1: Vegetation complexes (Heddle *et al.*, 1980) and area remaining as native vegetation (Beeston *et al.* 2001 GIS) on the Quindalup Dunes and eastern contiguous wetlands

Vegetation Complex	Native Vegetation (ha)
Quindalup Dunes	
QUINDALUP COMPLEX: Coastal dune complex consisting mainly of two alliances - the strand and foredune alliance and the mobile and stable dune alliance. Local variations include the low closed forest of *Melaleuca lanceolata - Callitris preissii* and the closed scrub of *Acacia rostellifera.*	555
Wetlands	
VASSE COMPLEX : Mixture of the closed scrub of *Melaleuca* species fringing woodland of *E. rudis - Melaleuca* species and open forest of *E. gomphocephala - E. marginata - E. calophylla.*	250

Floristic Community Types (Gibson *et al.* 1994, DEP 1996)
A series of floristic plots were located in an east - west transect from Manea Park to the Maidens for the System 6 and Part System 1 Update (DEP 1996). These plots were analysed with the data from Gibson *et al.* (1994) as described in Government of WA (2000). Three floristic community types were identified in the Maidens (see Table 2). The majority of these plots were located in uplands but one (Gmaid02) was located in an area that is regularly inundated in winter and contains a series of wetland species (*Lepidosperma gladiatum*, *Dichondra repens* and *Gahnia trifida)*. This plot did not allocate to the wetland supergroup in the analysis. Ecoscape (2002) suggested that these wetlands were likely to be from floristic community types 17 or 19. The Rockingham wetlands discussed previously contain floristic community types 17 or 19 and floristic community types 19 is identified in the Yanchep Quindalup wetland (Government of WA 2000). The closest wetlands to the Coastal Corridor that have been sampled are in Hay Park which is found to the north east of the coastal Corridor and is placed in the Yoongarillup Complex (Heddle *et al.* 1980). Four floristic community types were identified in the naturally vegetated wetlands in Hay Park (Table 2).

Table 2: Floristic Community Types in the Maidens and adjacent bushland and Hay Park (identified in Gibson *et al.*, 1994, and in the System 6 and Part 1 Update DEP, 1996)
Key
Column 1: Plot Codes
Column 2: Floristic Community Type Codes
The numbers of the types additional to Gibson *et al.* (1994) are italicised if they are subsets of an existing group (in types 19, 20, 23 and 30) and italicised and preceded by an S if they are supplementary groups.
Column 3: Floristic Community Type
Column 4: Bushland Area

Supergroup 2 - Seasonal Wetlands			
Hay01	08	Herb rich shrublands in clay pans	Hay Park, Bunbury
Hay02	17	*Melaleuca rhaphiophylla - Gahnia trifida* seasonal wetlands	Hay Park, Bunbury
Hay05	**18**	**Shrublands on calcareous silts**	Hay Park, Bunbury
Hay03	*s05*	*Acacia saligna* wetlands	Hay Park, Bunbury
Hay04	*s05*	*Acacia saligna* wetlands	Hay Park, Bunbury
Supergroup 4 - Uplands centred on Spearwood and Quindalup Dunes			
Spearwood Dunes			
#Gmaid01	25	Southern *Eucalyptus gomphocephala – Agonis flexuosa* woodlands	The Maidens (C70 South Bunbury coastal land)
#Gmaid02	25	Southern *Eucalyptus gomphocephala – Agonis flexuosa* woodlands	The Maidens (C70 South Bunbury coastal land)
Gmaid03	25	Southern *Eucalyptus gomphocephala – Agonis flexuosa* woodlands	Bushland to east of the Maidens (Shearwater Forest)
Gmaid04	25	Southern *Eucalyptus gomphocephala – Agonis flexuosa* woodlands	Bushland to east of the Maidens (Shearwater Forest)
Nmaid05	25	Southern *Eucalyptus gomphocephala – Agonis flexuosa* woodlands	Bushland to east of the Maidens (Shearwater Forest)
# The plot soil and landform data indicates that these two plots are in the Quindalup Dunes rather than the Spearwood Dunes.			
Quindalup Dunes			
BMaid02	29a	Coastal shrublands on shallow sands	The Maidens (C70 South Bunbury coastal land)
Nmaid01	29a	Coastal shrublands on shallow sands	The Maidens (C70 South Bunbury coastal land)
Nmaid03	29a	Coastal shrublands on shallow sands	The Maidens (C70 South Bunbury coastal land)
Nmaid04	30b	Quindalup *Eucalyptus gomphocephala* and/or *Agonis flexuosa* woodlands	The Maidens (C70 South Bunbury coastal land)

Specific Area Vegetation Maps

Mapping of vegetation and/or descriptions of areas of the Coastal Corridor from aerial photography and ground truthing has been done by Tingay (1991, Key in Appendix 1), Hart Simpson and Assocs. (1994), DEP (1996), Bischoff (1999), Ecoscape (2002) and this study.

On the basis of these studies the vegetation of the Coastal Corridor can be initially divided according to the landform elements described in the previous section. The vegetation of these units is described below.

Uplands - Quindalup Dunes (Photos 1, 3 to 5, 9 & 10, Appendix 2)

A series of vegetation associations are distinguished on the parabolic dunes. These are summarised in Table 3 and Maps 2a and 2b. Broad descriptions of the units derived from the tallest stratum are given in the studies. It is expected that a larger number of upland units could be identified if all strata were considered and/or units with limited distribution were also mapped. For example, Tingay, discusses but does not map the following units:

- the stable low foredune community dominated by *Spinifex longifolius*; and
- areas with stunted Peppermint and Tuart.

The 'stunted Peppermint and Tuart' are better described as mallees. Photo 2 (Appendix 2) shows a mallee Tuart to the north of Dalyellup Beach Road.

The areas mapped as *E. gomphocephala/A. flexuosa* Forest and *A. flexuosa* Scrub by Tingay (1991) contain both upland and wetland areas (see Table 3 and 4). This is considered further in the next section on wetlands.

Table 3: Upland vegetation associations

Column 1 Description of vegetation unit.
The units are ordered form west to east and, those from the different studies, are grouped where they appear to be referring to units on similar landforms. Plots from DEP (1996) are given for the appropriate vegetation unit.

Column 2 Units shown on Map 2a from Ecoscape (2002, Figure 6).

Column 3 Units shown on Map 2b, modified from Tingay (1991). Underlined symbols indicate the units that have wetland and upland forms

Column 4 Units incompletely, in need of more accurate mapping.

Description of vegetation unit			
Mobile sand dunes Bare to unstable sand dunes		**U**	
Coastal Heath on primary dunes *Spinifex/Olearia* Heath (Nmaid01)	#		#
Coastal Heath on primary dunes *Scaevola crassifolia/Diplolaena dampieri/Hemiandra pungens* Heath	#	**L**	
Coastal Heath on secondary dunes (Bmaid02, Nmaid03) *Acacia cochlearis/Jacksonia furcellata* Heath with *Scaevola paludosa* common	#	**K**	
E. gomphocephala Mallee			#
Agonis flexuosa Mallee *Agonis flexuosa* Scrub		**M**	#
Coastal Heath on secondary dunes *Acacia cochlearis/Jacksonia furcellata* Heath		**J**	
Coastal Heath on secondary dunes *Olearia axillaris/Scaevola crassifolia* Heath	#	**R**	
Interdunal open woodland of Tuart and Peppermint (Nmaid02 & 04, Gmaid01) *E. gomphocephala/A. flexuosa* Forest	#	**E**	
Cleared		**X**	

Wetlands

Quindalup Dune Swale Damplands (Photos 3 to 6, Appendix 2)
Work for this study has identified a significantly greater area of wetlands, and a greater variety of vegetation units associated within this group, than were mapped in the - landform and soils mapping (Anon 1981), the wetland mapping (Semeniuk 1998) and the regional and specific area mapping (see Table 4 and Maps 2a, 2b and 2c). It appears that damplands have developed in many of the swales, particularly those to the east and south of the Coastal Corridor (see previous discussion under Landforms and Soils). These wetlands are dominated by a series of species. These species include:

Understorey wetland species
Shrubs *Xanthorrhoea preissii, Acacia saligna, Calycopeplus oligandrus*
Herbs/Ferns: *Pteridium esculentum, Dichondra repens*
Sedges: *Baumea juncea, Gahnia trifida, Lepidosperma* aff. *squamatum* (BJK&GJK143), *Isolepis nodosus, Lepidosperma gladiatum*
Overstorey wetland species
Trees: *Eucalyptus gomphocephala, Agonis flexuosa, Acacia saligna, Banksia littoralis*
Overstorey wetland and/or upland species
Trees/shrubs: *Eucalyptus gomphocephala, Agonis flexuosa*

Some of these species occur on both the ridges and slopes of the dunes as well as in the wet swales. The variety of species, and the various forms of these species on the different landforms, distinguish the wetlands. Table 4 lists the original units mapped as well as additional units identified in this study.

The areas mapped as *E. gomphocephala/A. flexuosa* Forest and *Agonis flexuosa* Scrub by Tingay (1991) contain both upland and wetland areas (see Table 3 and 4). Some additional wetland areas have been mapped in this study (see Map 2b and 2c). As a consequence Map 2c maps the current known extent of the wetland areas from the Dalyellup Beach Road to the southern boundary of the Coastal Corridor, while Map 2b gives an approximate distribution of the wetlands in relation to the Tingay (1991) mapping.

Quindalup/Spearwood Dune Interface Sumplands and Lakes (Photos 9 to 13, Appendix 2)
This wetland area has been mapped by all previous studies in the area. However these studies and the only known specific area mapping for these wetlands (Tingay 1991) have

(i) underestimated the extent of the wetland as there are significant unmapped areas of the western wetland 'tongues' which are bordered on two sides by steep Quindalup Dunes; and
(ii) inadequately described the variety of vegetation units in the sumpland there being a variety of trees, shrubs and sedges within the area mapped as *Typha orientalis/Juncus pallidus* Sedgeland (Unit O, Tingay 1991).

That is, the vegetation of the sumpland, is more complex than previously mapped. Table 4 lists the original units mapped, as well as additional units identified in this study. The species observed in these units included the following:

- Trees/shrubs: *Acacia saligna, Banksia littoralis, Melaleuca rhaphiophylla, Melaleuca preissiana, Rhadinothamnus anceps, Calycopeplus oligandrus*
- Sedges: *Baumea articulata, B. juncea, *Typha orientalis, T. domingensis, Juncus pallidus, Lepidosperma ?effusum, L. gladiatum, Carex appressa, Carex fasciculata, C. tereticaulis, Schoenoplectus pungens, Schoenoplectus validus, Gahnia trifida*
- Herbs/Ferns: *Centella asiatica, Sonchus hydrophilus, Pteridium esculentum,*

As described in Tingay (1991) *Typha* is present but there appears to be both *Typha orientalis* and *T. domingensis* in the sedgeland area. The other co-dominant described by Tingay, *Juncus pallidus*, is present but is relatively uncommon.

Table 4: Wetland vegetation associations

Column 1 Description of vegetation unit
Column 2 Units shown on Map 2a from Ecoscape (2002, Figure 6).
Column 3 Units shown on Map 2b, modified from Tingay (1991). Underlined symbols indicate the units that have wetland and upland forms
Column 4 Units incompletely, in need of more accurate mapping.

Quindalup Dune Swale Damplands			
E. gomphocephala/A. flexuosa Forest		**E**	
Woodland of Tuart over *Acacia saligna, Diplolaena dampieri* and sedges in dune swales (#Gmaid02)	#		
Banksia littoralis/Xanthorrhoea preissii Shrubland		**L**	
Agonis flexuosa Scrub *Agonis flexuosa* Low Forest		**M**	#
Acacia saligna Scrub		**Q**	
Isolepis nodosus/Lepidosperma angustatum Sedgeland		**T**	
Quindalup/Spearwood Dune Interface Sumplands and Lakes			
Melaleuca rhaphiophylla Low Forest			#
Melaleuca rhaphiophylla Scrub		**N**	
Acacia saligna Scrub		**Q**	
Isolepis nodosus/Lepidosperma angustatum Sedgeland		**T**	
Typha orientalis/Juncus pallidus Sedgeland Sedgelands dominated by *Baumea articulata, B. juncea, *Typha orientalis, T. domingensis, Juncus pallidus, Lepidosperma ?effusum, L. gladiatum, Carex appressa, Carex fasciculata, C. tereticaulis, Schoenoplectus* pungens, *Schoenoplectus validus* and *Gahnia trifida oligandrus* and/or combinations of these		**O**	#
Wetland Rises dominated by *Acacia saligna, Banksia littoralis, Melaleuca rhaphiophylla, ?Melaleuca preissiana, Rhadinothamnus anceps, Calycopeplus oligandrus* and/or combinations of these over sedges			#
E. rudis/Melaleuca preissiana Woodland (confined to the eastern side of the wetland)		**G**	
E. rudis/E. calophylla/A. flexuosa/M. preissiana Woodland (confined to the eastern side of the wetland)		**H**	
E. calophylla/Agonis flexuosa Forest (confined to the eastern side of the wetland)		**V**	
Cleared wetland		**O**	

Threatened Ecological Communities

At this stage no a threatened ecological communities are listed for the Coastal Corridor on the Department of Conservation's database (after English and Blyth 1997 and 1999).

VEGETATION CONDITION

Description

Several of the area specific studies have included vegetation condition maps (Tingay 1991, Ecoscape 2002). Tingay maps the same area as that shown in Map 2b and describes the areas with some natural vegetation (areas of mapped vegetation unit in Map 2b) as ranging from

Natural Condition (trees and understorey largely intact) to Understorey Grazed (Tingay 1991). Ecoscape (2002) maps the Maidens area of the Coastal Corridor using a different scale and describes the mappable area (the northern section had been burnt at the time of the study) of the area as being mostly in Very Good - Excellent condition with the wooded areas in Fair to Good condition.

Overall (this study and Tingay 1991, Ecoscape 2002), the condition of the areas with some native vegetation in the Coastal Corridor, range from

- Very Good to Excellent condition in the wetland areas and near coastal heaths;
- Very Good to Good for the Tuart/Peppermint woodlands and forests and the more inland heaths; and
- Good to Degraded and Completely Degraded for units on the eastern side of the sumpland/lake area.

Within all units, particularly in the area of Map 2b, there are patches of severe localised disturbance. Much of the area of Map 2b appears to have been subject to grazing in the past and some areas have been developed for pasture. Associated with use of the area for grazing, are frequent fire, which is apparently used to induce fresh palatable growth and to open the wetlands for access by animals. However, even with this disturbance, the Tuart/Peppermint woodlands and forests can generally be considered to be some of the most intact remnants of this type remaining on the Swan Coastal Plain. The coastal heaths, particularly those in the Maidens, are also particularly good examples of their type.

FLORA

Description

Limited work has been done on the flora of the Coastal Corridor. The compilation by Bischoff (1999) of his own work together with lists from Hart Simpson and Assocs (1994) and Keighery (1996) lists 139 native vascular plant taxa and 33 weeds from the Maidens. More detailed work over the entire Corridor would be expected to bring this list to over 200 native taxa.

Significant Taxa
No Declared Rare Flora are currently identified from the Coastal Corridor. One priority species, *Lasiopetalum membranaceum*, is known from the Maidens. At least six other significant taxa can be identified in the Corridor, these are briefly outlined below.

Calycopeplus oligandrus
This slender medium shrub is known from two wetland localities on the Swan Coastal Plain, the Coastal Corridor and Big Swamp.

Tuart (*Eucalyptus gomphocephala)*
Tuart grows as both a tree and a mallee the Coastal Corridor, Tuart being found in Woodland, Forest and Mallee associations. This is the only location known where these occur in contiguous vegetation units (the only other known population of Tuart mallee is a small population in the Ningana area, north of Perth (Keighery *et al.* 2002)).

Jacksonia furcellata
A floriferous shrub form of the calcareous dunes is similar to the form found on the calcareous sand ridges in the Point Becher area south of Rockingham.

Lepidosperma aff. *squamatum* (GJK & BJK 143, 135, 137)
This *Lepidosperma* was confined to the some of the Quindalup Dune Swale Damplands, mostly those with *Xanthorrhoea preissii.*

Lepidosperma ?effusum (GJK & BJK 136)
In the wetter areas of the Quindalup Dune Swale Damplands and in the Quindalup/Spearwood Dune Interface Sumplands and Lakes this taxon grew to over 2m in height .

Xanthorrhoea preissii
This robust form (with comparatively broad leaves, longer spikes and more developed trunks) of *Xanthorrhoea preissii* grows in the Quindalup Dune Swale Damplands and on the damp margins of the Quindalup/Spearwood Dune Interface Sumplands and Lakes. A similar form is found in the Point Becher area south of Rockingham.

Also of interest are the diverse sedge beds of the Quindalup/Spearwood Dune Interface Sumplands and Lakes. The combination of species here requires further investigation. A similar combination of taxa is found in Loch Mc Ness at Yanchep.

DISCUSSION – VEGETATION AND FLORA

Of particular significance in the Coastal Corridor are the vegetation units discussed below.

Coastal heaths and shrublands
A variety of heaths and shrublands are found on the near coastal dunes. As the most southern extensive area of such dunes on the Swan Coastal Plain these support significant vegetation. The area of this vegetation in the Maidens is a particularly good example of its type.

Tuart dominated vegetation
The following features of the Tuart dominated vegetation in the Coastal Corridor contribute to the regional significance of this vegetation.

- The most southern Quindalup Dune Tuart dominated vegetation remaining on the Plain.
- A north - south transition area from Tuart dominated vegetation to *Agonis* dominated vegetation.
- The presence of Tuart trees and Tuart mallee, Tuart being found as Woodland, Forest and Mallee associations. This is the only location known where these occur in contiguous vegetation units (the only other known population of Tuart mallee is a small population in the Ningana area, north of Perth (Keighery *et al.* 2002)).
- Tuart dominated vegetation occurs in both wetlands and uplands. Tuart is uncommon in wetlands (Keighery *et al.* 2002).
- The Tuart dominated vegetation on the Quindalup Dunes represents some of the most intact vegetation of this type on the Swan Coastal Plain (Keighery *et al.* (2002). Tingay (1991), also commented on the quality of Tuart dominated vegetation in the area shown in Map 2b however the Tingay study did not distinguish Tuart dominated vegetation on the Quindalup Dunes and the Spearwood Dunes.
- Tuart dominated vegetation of the Quindalup Dunes is contiguous with Tuart dominated vegetation in the Spearwood Dunes.

Wetlands
The following features of the wetland vegetation in the Coastal Corridor contribute to the regional significance of this vegetation. These values are best considered in relation to the two groups distinguished.

Quindalup Dune Swale Damplands (Maps 2a, 2b and 2c and 3)
This is the only sequence of this type known on the Plain. As a consequence it is expected wetlands in the chain would qualify, on floristic grounds, as threatened ecological communities. Of particular interest in the sequence is the *Banksia littoralis/Xanthorrhoea preissii* Shrubland. The most similar known floristic community type is type 19. Floristic community type 19 is a threatened ecological community (English and Blyth 1997). The other wetlands also have floristic similarities with floristic community types 17, 18 and S5 (see Table 2 for identified locations in the near Bunbury area). Floristic community type 18 is also a threatened ecological community and type S5 is only known from two bushland areas. Ecoscape (2002) discussed the wetlands in the Maidens and considered that they could be allied with floristic community types 17 and 19. A detailed investigation is required of each of these wetlands to better determine their regional floristic affiliations. There is a need for paired plots to be located in each floristic unit to allow for the poor representation of the floristic units in the available floristic data set for the Swan Coastal Plain.

Quindalup/Spearwood Dune Interface Sumplands and Lakes (Maps 2b and 2c and 3)
The other major area of wetland in the Coastal Corridor, the Quindalup/Spearwood Dune Interface Sumplands and Lakes, are also unusual. The floristic database is of limited use in this case as extensive sedgelands were not sampled by Gibson *et al.* (1994) or DEP (1996). The only other known area of this type on the Plain is Loch Mc Ness in Yanchep National Park. Loch Mc Ness contains similar sedge species in similar structural formations. Big Swamp which also supports similar vegetation has been altered to such an extent that comparisons are limited.

Coastal Corridor
The Coastal Corridor vegetation forms a contiguous relatively intact area of near coastal heaths and shrublands, Tuart (both trees and mallees) dominated vegetation, Quindalup Dune Swale Damplands and Quindalup/Spearwood Dune Interface Sumplands and Lakes. The Corridor forms a unique assemblage of communities, no other similar area being known on the Plain.

WETLANDS

Description (after Hill *et al.* 1996b and Semeniuk 1998)

Wetland Types (Hill *et al.* 1996b, see Map 3)
Dampland, sumpland and lake wetland types are mapped within the Coastal Corridor. The largest wetland is a sumpland containing a smaller area of lake (corresponds approximately with the area of open water called Muddy Lake). Three small damplands are located within the Quindalup Dunes.

Consanguineous suite (Semeniuk 1998)
The sumpland and lakes in the Coastal Corridor are mapped as the Minninup Suite while the damplands within the Quindalup Dunes appear to be from the Big Swamp Suite. The

landform and soil characteristics are described in the Landforms and Soils section. Both suites are confined to the Bunbury area, the Minninup Suite (also named Minninup Lake) is confined to the Coastal Corridor.

Wetland Management Objective (Semeniuk 1998)
The wetlands in the Coastal Corridor are currently designated in the Conservation and Multiple Use Categories. The wetlands in the various categories are outlined below.

- Conservation Category – the majority of the sumpland north of the Dalyellup (excluding the lot to the north of the drain) and Muddy Lake (see L 17, Map 3), part of the sumpland lying parallel to Minninup Road (S15, Map 3) and two Quindalup Dunes damplands (D19 and D20 on Map 3).
- Multiple Use – the remainder of the mapped wetlands in the Coastal Corridor as shown on Map 3 (Note: S14 may be designated as Resource Enhancement).

Lake's EPP (Government of WA 1992)
Two areas are mapped as Swan Coastal Plain Lakes under the EPP (Map 1 for boundaires of these Lakes), a section of the sumpland near its northern extremity, Dalyellup Lake and an area of sumpland and lake around Muddy Lake to the south.

Discussion

As outlined previously the area of wetland mapped in the Quindalup Dunes and some of the western dampland extensions of the sumpland are incompletely mapped (see Maps 2a, 2b and 2c). This information also establishes that all naturally vegetated damplands (Damplands 1 – 12, Map 2c) in the Coastal Corridor support vegetation of a type and quality that places them as Conservation Category Wetlands. That is they contain regionally significant vegetation, in Good or better condition. Many of these damplands provide habitat, or potential habitat, for threatened fauna (Dell and Hyder-Griffiths 2002). The entire area of sumpland and lake is also considered to be Conservation Category. While sections of this area (see Map 2b) were mapped as 'Cleared' by Tingay (1991) they are contiguous with the naturally vegetated areas and are hydrologic ally part of the same sumpland/lake. The extent of the sedge beds is influenced by the grazing and burning management regimes currently and historically practised in the sumpland. It is expected that the sedges would expand with different management. The Tingay (1991) mapping can be used as a guide to the natural vegetation in the area but would need to be updated for a determination of the currently naturally vegetated area.

The Coastal Corridor contains landscape features and vegetation that appears to be unique on the Swan Coastal Plain. The only other location where there is a similar sequence of dunes and wetlands associated with the Quindalup Dunes and their interface with the Spearwood Dunes is in the Rockingham and Yanchep areas. However there are significant differences between the Coastal Corridor and these two areas, that is:

- Rockingham - the extensive wetlands within the Quindalup Dunes (Becher Natural Wetland Suite, Semeniuk 1996) are associated with the Beach Ridge Plain rather than parabolic dunes, and the wetlands at the interface of the Spearwood and Quindalup Dunes (Lakes Cooloongup and Walyungup), are from the Cooloongup Natural Wetland Suite and are predominantly saline wetlands; and
- Yanchep – the sequence here is more similar but the Quindalup Dune wetland area is restricted, only one wetland being currently identified from within the parabolic dunes (Government of WA 2000), but the wetlands at the interface of the Spearwood and

Quindalup Dunes (Loch Mc Ness form the Yanchep Natural Wetland Suite) is more similar to the wetland chain in the Coastal Corridor.

NATURAL REGIONAL VALUES

Discussion

A previous report (Keighery and Santich 2002) identified the following values for the Muddy Lake Proposed ROS and associated lands:

- Contiguous linked vegetated areas of the Quindalup and Vasse Complexes (Heddle *et al.*, 1980);
- A diverse mosaic of vegetation units in variable condition, from completely degraded to excellent (interpretation of Tingay 1991);
- A diverse mosaic of wetland units management categories varying from Conservation to Multiple Use;
- Wetland boundaries appear to go beyond those shown in the WRC database especially within the Quindalup Dunes, these wetlands are intact and would be Conservation Category; and
- EPP Lake (note - goes beyond the boundaries in the ROS).

This examination of the landform and soils, vegetation, flora and wetlands clearly establishes that the Coastal Corridor is regionally significant. A series of features of this vegetation contribute to its regional significance, these include the following:

- unique assemblage of upland and wetland units of the Quindalup Dunes and its interface with the Spearwood Dunes;
- the quality and type of Tuart dominated communities;
- presence of rare wetland vegetation and unique association of different wetlands;
- only occurrence of the Minninup Suite of wetlands; and
- at least one floristic association (*Banksia littoralis/Xanthorrhoea preissii* Shrubland) is expected to meet the criteria for identification as a threatened ecological community.

The Coastal Corridor wetlands and associated uplands are deserving of the same level of recognition and protection as the Point Becher and Yanchep wetlands and uplands.

The current wetland mapping does not show the full extent of the wetlands, especially those within the Quindalup Dunes, and underestimates the area of Conservation Category wetland in the Costal Corridor. The WRC database should be amended to map the full extent of the predominantly naturally vegetated wetlands and identify these as Conservation Management Category wetlands. As it appears that all the sumpland/lake area is a connected unit the entire area should be designated as a Conservation Category wetland unless more information on the hydrological connections and wetland function indicates that a lesser area should be identified as Conservation Category.

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EPA - Environmental Protection Authority

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WRC - Water and Rivers Commission

WRC 2002 - Water and Rivers Commission Wetland Extent, Type and Suite Database.

APPENDIX 1: Vegetation Associations or Formations Mapped in Tingay (1991).

Tingay (1991) used 1 : 10 0000 aerial photography and ground survey to map 21 vegetation associations and two cleared units as listed below and shown in Map 1. Twelve of these vegetation units occur within the Coastal Corridor (bold units).

A. *Eucalyptus gomphocephala/Agonis flexuosa* Forest with *E. marginata and Banksia attenuata* sub-dominant
B. As above but with *E. calophylla* included
C. *E. gomphocephala / A flexuosa/Acacia saligna* Forest
D. *Banksia attenuata* Woodland
E. *E. gomphocephala/A. flexuosa* Forest
F. *E. marginata/E. calophylla/Banksia attenuata* Woodland
G. *E. rudis/Melaleuca preissiana* Woodland
H. *E. rudis/E. calophylla/A. flexuosa/M. preissiana* Woodland
I. *Banksia littoralis/Xanthorrhoea preissii* Shrubland
J. *Acacia cochlearis/Jacksonia furcellata* Heath
K. As above with *Scaevola paludosa* common
L. *Scaevola crassifolia/Diplolaena dampieri/Hemiandra pungens* Heath
M. *Agonis flexuosa* Scrub
N. *Melaleuca rhaphiophylla* Scrub
O. *Typha orientalis/Juncus pallidus* Sedgeland
P. Cleared wetland
Q. *Acacia saligna* Scrub
R. *Olearia axillaris/Scaevola crassifolia* Health
S. *Isolepis nodosus/Lepidosperma angustatum* Sedgeland
T. *Melaleuca viminea* Scrub
U. Bare to unstable sand dunes
V. *E. calophylla/Agonis flexuosa* Forest

X Cleared

APPENDIX 2: Photographs of the natural areas in the Coastal Corridor

Captions

Photo 1: Quindalup Dunes to the west of Muddy Lake looking north to Bunbury over *Scaevola crassifolia/Diplolaena dampieri/Hemiandra pungens* Heath and *Agonis flexuosa* Mallee Shrubland (*Agonis flexuosa* Scrub). Photo GJ Keighery

Photo 2: Mallee Tuart Photo GJ Keighery

Photo 3: View from the crest of a parabolic dune over *Scaevola crassifolia/Diplolaena dampieri/Hemiandra pungens* Heath and *Agonis flexuosa* Mallee Shrubland to a small swale dampland with *Agonis flexuosa* Low Forest over *Lepidosperma gladiatum* Sedegland. Photo GJ Keighery

Photo 4: Quindalup Dune Swale Damplands - View from the crest of a parabolic dune over a large swale dampland with a mosaic of vegetation associations including : *Agonis flexuosa* Low Forest over *Lepidosperma gladiatum* and/or *L. ?effusum* Sedegland and *Banksia littoralis/Xanthorrhoea preissii* Shrubland.
Photo GJ Keighery

Photo 5: Quindalup Dune Swale Damplands - View from the crest of a low parabolic dune between two swale damplands over the western end of a large swale dampland with *Banksia littoralis/Xanthorrhoea preissii* Shrubland. Photo GJ Keighery

Photo 6: Quindalup Dune Swale Damplands - *Banksia littoralis/Xanthorrhoea preissii* Shrubland.
Photo GJ Keighery

Photo 7: Floristic community type 19 in a swale dampland on the Beach Ridge Plain (Quindalup Dunes) at Port Kennedy -- Bush Forever Site 377 (Government of WA 2000)
Photo GJ Keighery

Photo 8: Community allied to, or equivalent to, Floristic community type 19 in a swale dampland on the Beach Ridge Plain (Quindalup Dunes) at Secret Harbour
Photo GJ Keighery

Photo 9: Quindalup/Spearwood Dune Interface Sumplands and Lakes, Dalyellup Lake area - View from the slope of a parabolic dune over the western side of the sumpland over the fringing - *E. gomphocephala/A. flexuosa* Forest and *Melaleuca rhaphiophylla* Low Forest; and Sedgelands dominated by *Baumea articulata* and other sedges. Photo BJ Keighery

Photo 10: Quindalup/Spearwood Dune Interface Sumplands and Lakes, Dalyellup Lake area - View from the sumpland to the west over mixed sedgelands (*Acacia saligna* and

Lepidosperma gladiatum and/or *L. ?effusum* in the foreground) to fringing - *E. gomphocephala/A. flexuosa* Forest and *Melaleuca rhaphiophylla* Low Forest
Photo GJ Keighery

Photo 11: Quindalup/Spearwood Dune Interface Sumplands and Lakes, Muddy Lake area - View from the crest of a parabolic dune to the eastern side of the sumpland and lake over the fringing - *Agonis flexuosa* Low Forest and Sedgelands. . The eastern margins of the sumpland are mostly cleared with patches of *Eucalyptus rudis, Melaleuca rhaphiophylla, Acacia saligna* and *Xanthorrhoea* preissii and on the on the Spearwood Dune, Tuart Woodland. Photo GJ Keighery

Photo 12: Quindalup/Spearwood Dune Interface Sumplands and Lakes , Muddy Lake area - View from the edge of the drain to the south - eastern side of the sumpland over the Sedgelands and Fernland with patches of Pampas Grass and *Melaleuca rhaphiophylla* Low Forest. The south eastern margins of the sumpland are mostly cleared with patches of *Eucalyptus rudis* and *Melaleuca rhaphiophylla,* and on the on the Spearwood Dune, Tuart Woodland. The Sedgelands and Fernland in the foreground have been recently burnt. Photo GJ Keighery

Photo 13: Quindalup/Spearwood Dune Interface Sumplands and Lakes , Muddy Lake area - View from the edge of the sumpland over Sedgelands and Fernland and a rises with *Banksia littoralis* and *Acacia saligna.* The over Sedgeland and a rise with *Banksia littoralis* s has been recently burnt. To the south - east the Spearwood Dune with its Tuart Woodland can be seen.
Photo GJ Keighery

Photo 1

Photo 2

Photo 3

Photo 4

Photo 5

Photo 6

Photo 7

Photo 8

Photo 9

Photo 10

Photo 11

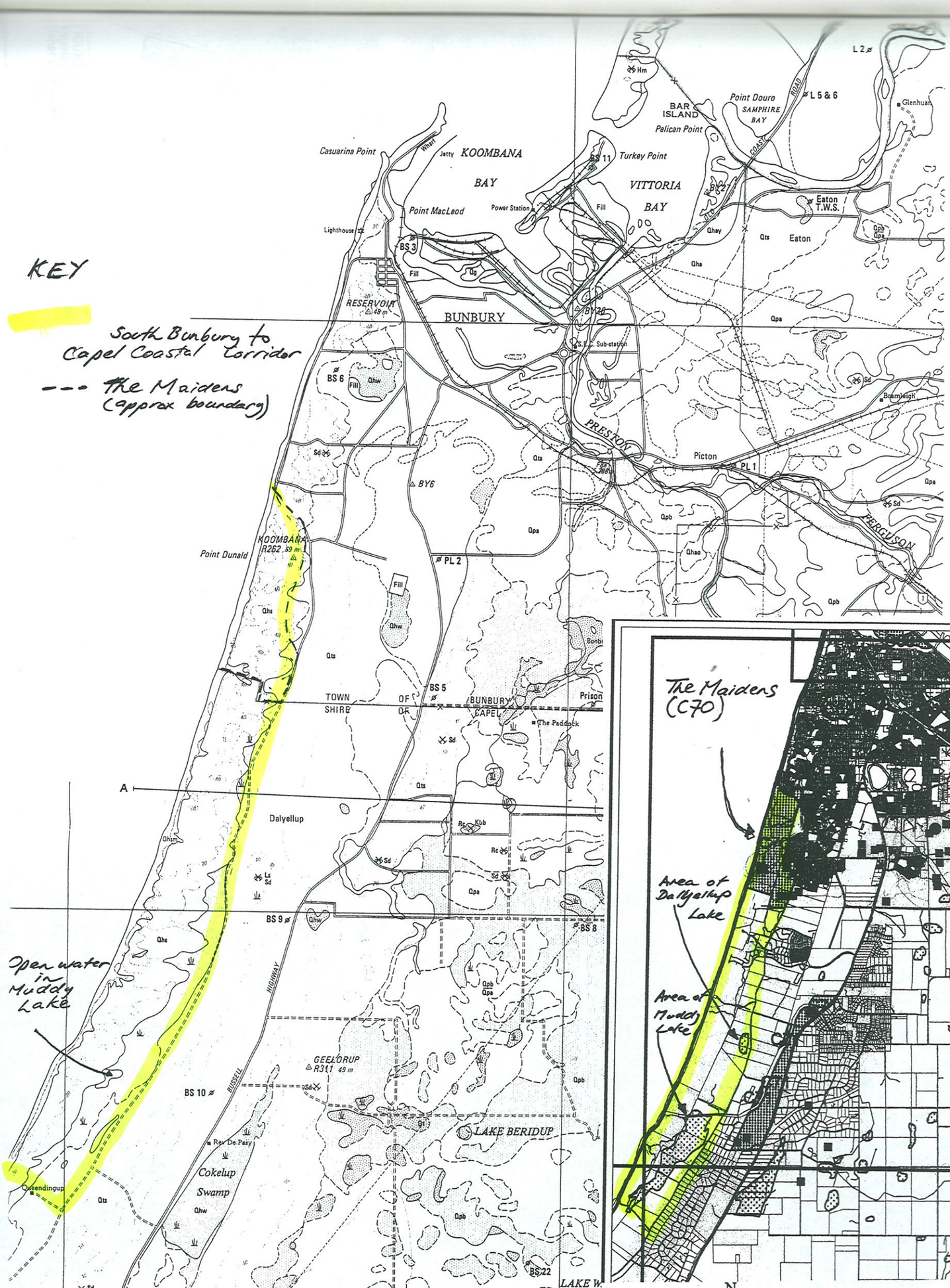
Photo 12

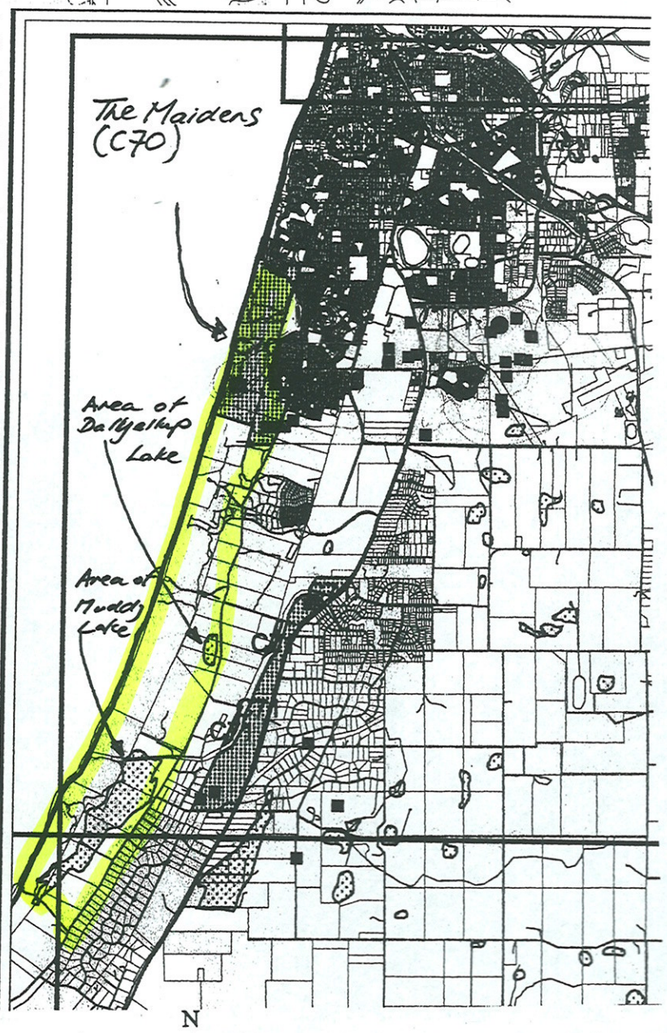
Photo 13

KEY

South Bunbury to Capel Coastal Corridor

--- The Maidens (approx boundary)





N

GDA

0 1 2 3 4 5 Kilometers

1:100000

HON. P.V. JONES, M.L.A.
MINISTER FOR MINES
A.F. TRENDALL, DIRECTOR, GEOLOGICAL SURVEY

SCALE 1:50 000

1 0 1 2 3 4 5 6
KILOMETRES

CONTOUR INTERVAL 20 m

Ticks inside the sheet edge represent 2000 metre intervals of the superimposed Australian Map Grid, Zone 50. AUSTRALIAN NATIONAL SPHEROID.

80% reduction

GOVERNMENT OF WESTERN AUSTRALIA

Department of Environmental Protection, Western Australia

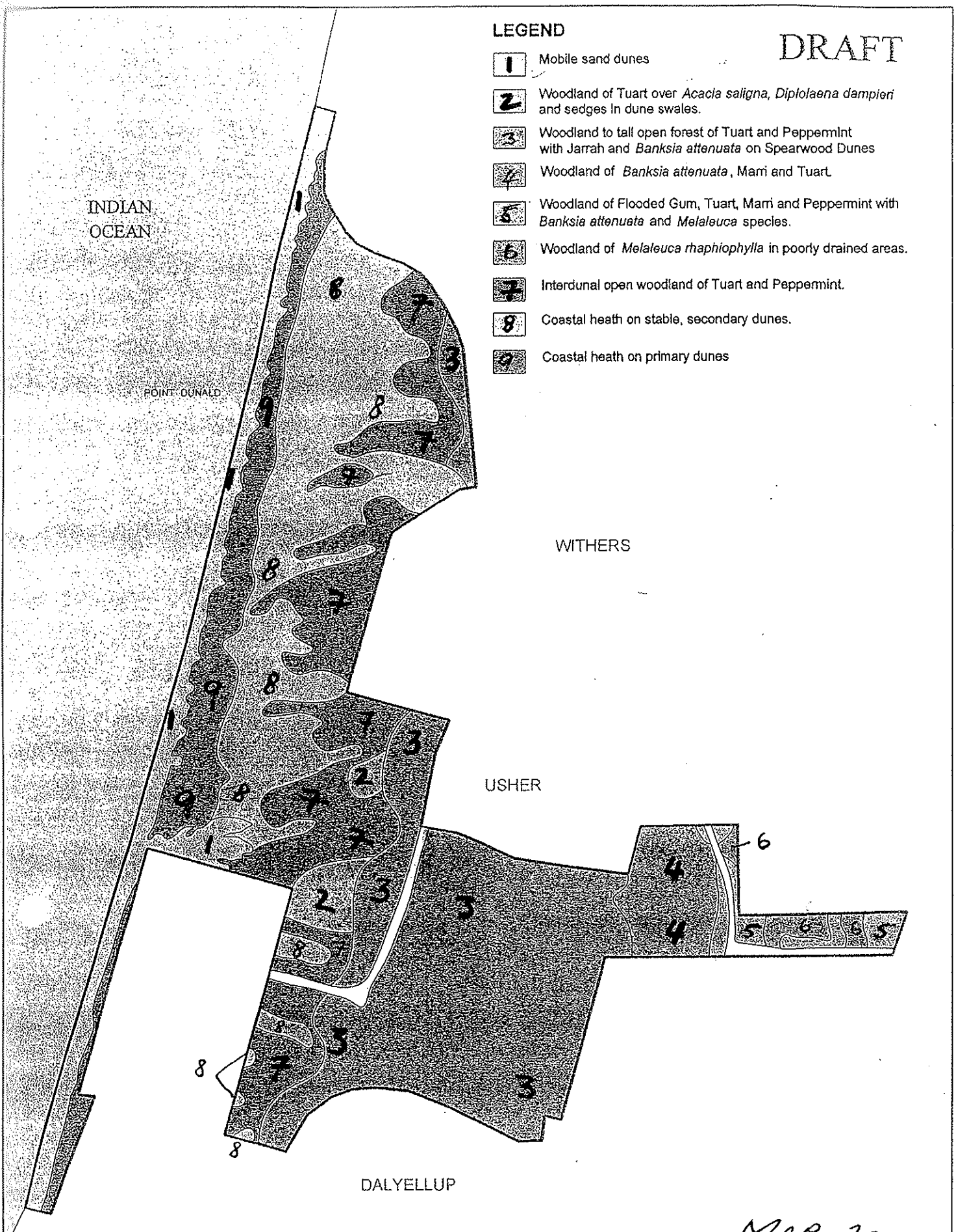
WARNING: This map has been prepared for DEP internal use only. The information should not be published or used outside DEP without consultation with the GIS Branch.

DISCLAIMER: This map has been produced using various data from other agencies. No responsibility is accepted for any error or omission.

KEY

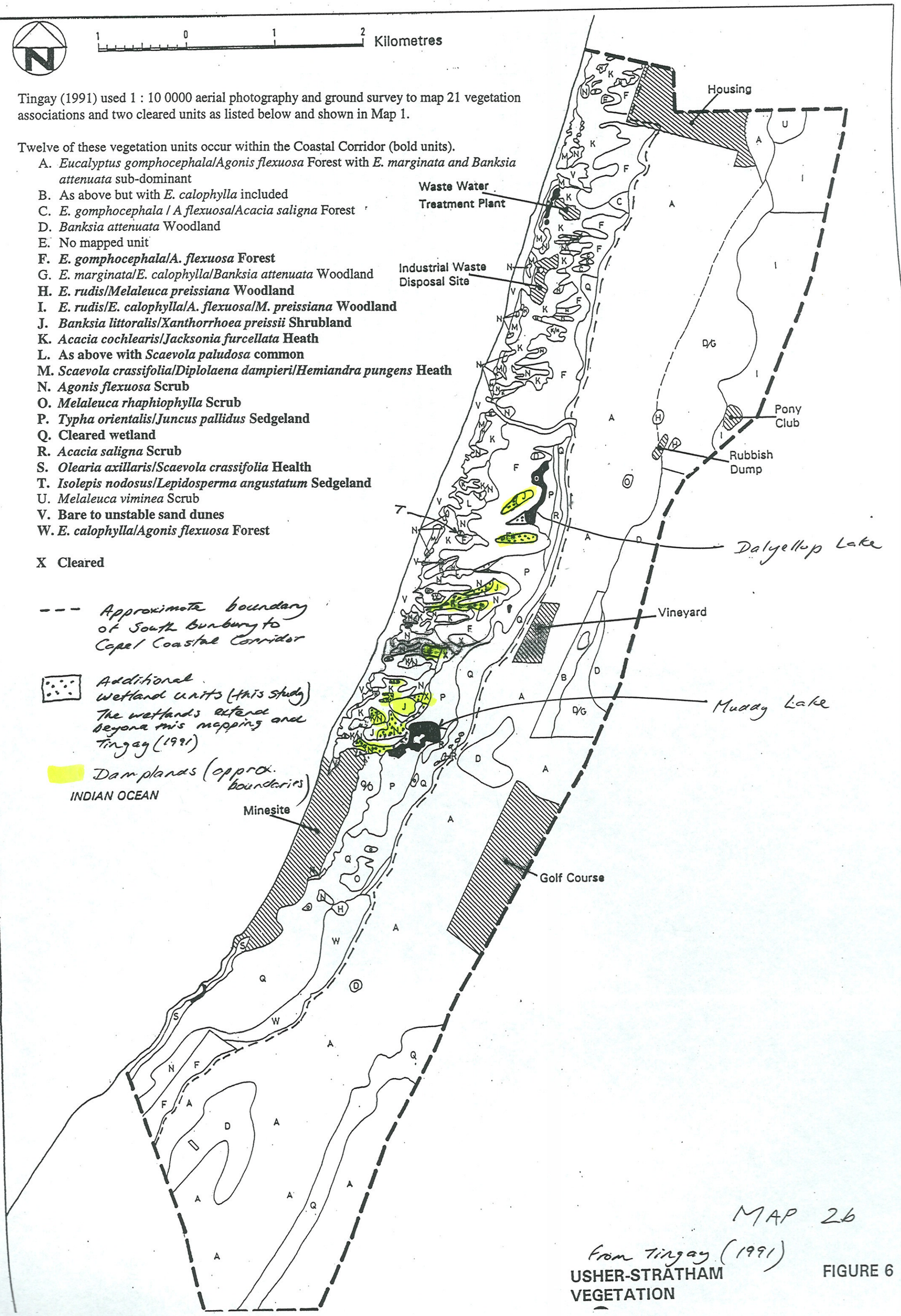
- Lakes EPP
- System 6
- CALM Threatened Ecological Communities
- Gibsonsites
- Eagriffin
- Gjksites
- S6year1
- S6year2
- NLWRA Remnant Vegetation

MAP 1



MAP 2a from (2602)

FIGURE 6: Vegetation Communities of Usher Dalyellup Region Park.	PROJECT: Usher Dalyellup Region Park Management Plan. CLIENT: Ministry for Housing	• E C O S C A P E • ECOSCAPE (AUSTRALIA) PTY LTD ACN 070 128 675 LANDSCAPE ECOLOGISTS ENVIRONMENTAL CONSULTANTS 21A Pakenham Street Fremantle Western Australia, 6160 Telephone (08) 9430 8955 • Facsimile (08) 9430 8977 email: ecoscape@iinet.net.au	SCALE: 1:20000 DATE: 25/10/01 DRAWING No: 0825_veg_3.dgn



Tingay (1991) used 1 : 10 0000 aerial photography and ground survey to map 21 vegetation associations and two cleared units as listed below and shown in Map 1.

Twelve of these vegetation units occur within the Coastal Corridor (bold units).

A. *Eucalyptus gomphocephala/Agonis flexuosa* Forest with *E. marginata and Banksia attenuata* sub-dominant
B. As above but with *E. calophylla* included
C. *E. gomphocephala / A flexuosa/Acacia saligna* Forest
D. *Banksia attenuata* Woodland
E. No mapped unit
F. *E. gomphocephala/A. flexuosa* Forest
G. *E. marginata/E. calophylla/Banksia attenuata* Woodland
H. *E. rudis/Melaleuca preissiana* Woodland
I. *E. rudis/E. calophylla/A. flexuosa/M. preissiana* Woodland
J. *Banksia littoralis/Xanthorrhoea preissii* Shrubland
K. *Acacia cochlearis/Jacksonia furcellata* Heath
L. As above with *Scaevola paludosa* common
M. *Scaevola crassifolia/Diplolaena dampieri/Hemiandra pungens* Heath
N. *Agonis flexuosa* Scrub
O. *Melaleuca rhaphiophylla* Scrub
P. *Typha orientalis/Juncus pallidus* Sedgeland
Q. Cleared wetland
R. *Acacia saligna* Scrub
S. *Olearia axillaris/Scaevola crassifolia* Health
T. *Isolepis nodosus/Lepidosperma angustatum* Sedgeland
U. *Melaleuca viminea* Scrub
V. Bare to unstable sand dunes
W. *E. calophylla/Agonis flexuosa* Forest

X Cleared

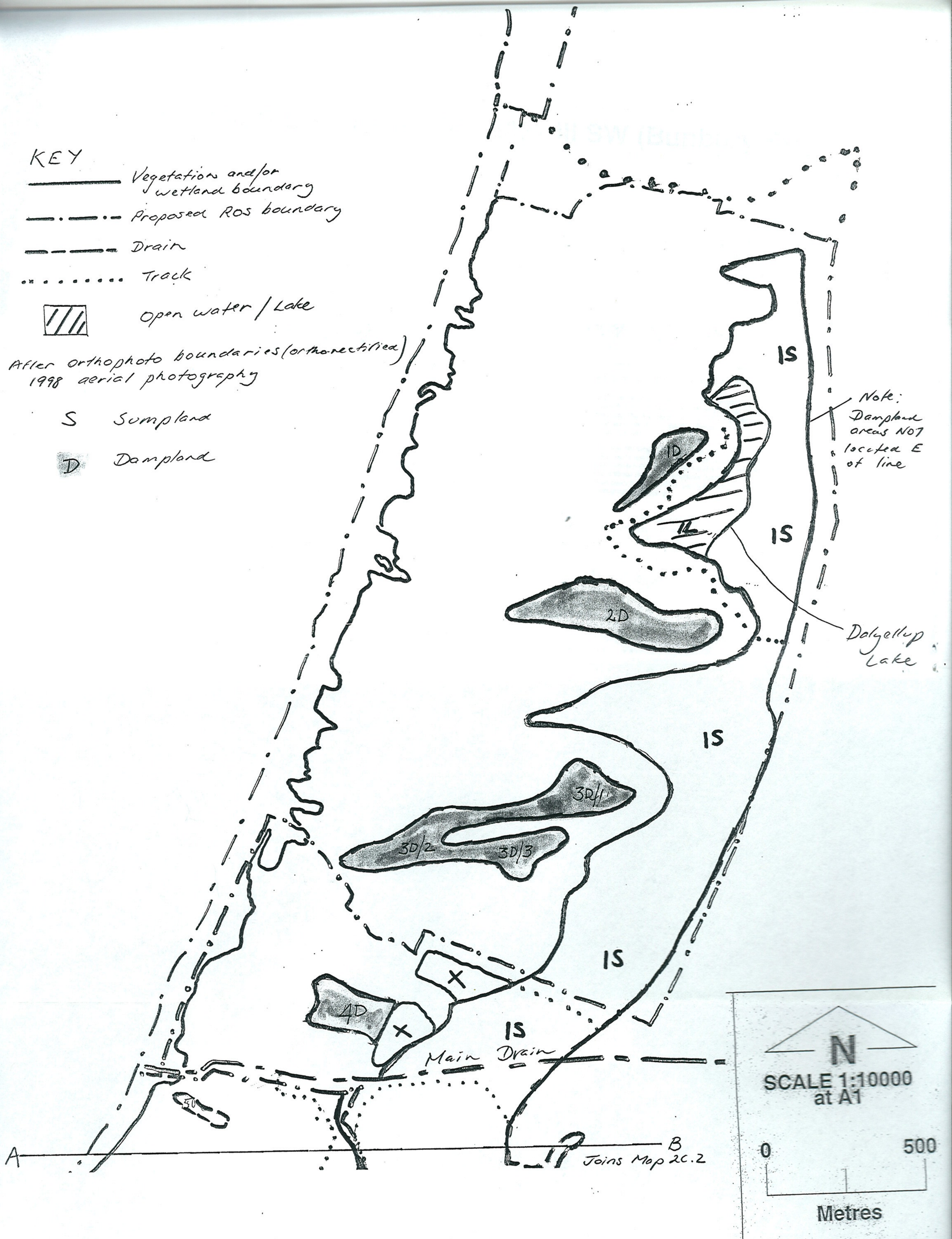
MAP 26

From Tingay (1991)

USHER-STRATHAM VEGETATION **FIGURE 6**

KEY TO MAP 2C: Wetland and Upland Vegetation of the Dalyellup Lakes to Minninup Road area and this study.

UPLANDS	All areas to the west of the sumpland (excluding the dampland areas) are naturally vegetated uplands except areas of cleared uplands are shown as X and mined areas shown with a M.
WETLANDS	
Quindalup Dune Damplands	
Code	**Description of vegetation unit after Tingay (1991) and this study**
1D	*Acacia saligna* Scrub
2D	*E. gomphocephala/A. flexuosa* Forest
3D/1	*Banksia littoralis/Xanthorrhoea preissii* Shrubland
3D/3&2	*E. gomphocephala/A. flexuosa* Forest
4D	*Banksia littoralis/Xanthorrhoea preissii* Shrubland
5D	*Agonis flexuosa* Scrub or *Agonis flexuosa* Low Forest (this dampland is inferred form aerial photography)
6D	*Banksia littoralis/Xanthorrhoea preissii* Shrubland
7D	*Banksia littoralis/Xanthorrhoea preissii* Shrubland
8D	*Xanthorrhoea preissii* Shrubland
9D	*Agonis flexuosa* Scrub or *Agonis flexuosa* Low Forest
10D	*Banksia littoralis/Xanthorrhoea preissii* Shrubland
***11D/1**	*Agonis flexuosa* Low Forest
11D/2	*Banksia littoralis/Xanthorrhoea preissii* Shrubland
***12D**	*Banksia littoralis/Xanthorrhoea preissii* Shrubland and/or *Agonis flexuosa* Low Forest
*These two damplands are connected to the eastern sumpland. The vegetation of damplands 11D/1 and 11D/2 merge.	
Quindalup/Spearwood Dune Interface Sumplands and Lakes	
Code	**Description of vegetation unit after Tingay (1991) and this study**
1S	Contains areas of: *Melaleuca rhaphiophylla* Low Forest; *Melaleuca rhaphiophylla* Scrub; *Acacia saligna* Scrub; *Typha orientalis/Juncus pallidus* Sedgeland; Sedgelands dominated by *Baumea articulata, B. juncea, *Typha orientalis, T. domingensis, Juncus pallidus, Lepidosperma ?effusum, L. gladiatum, Carex appressa, Carex fasciculata, C. tereticaulis, Schoenoplectus pungens, Schoenoplectus validus* and *Gahnia trifida* and/or combinations of these; Wetland Rises dominated by *Acacia saligna, Banksia littoralis, Melaleuca rhaphiophylla, ?Melaleuca preissiana, Rhadinothamnus anceps, Calycopeplus oligandrus* and/or combinations of these over sedges; *E. rudis/Melaleuca preissiana* Woodland (confined to the eastern side of the wetland); *E. rudis/E. calophylla/A. flexuosa/M. preissiana* Woodland (confined to the eastern side of the wetland); *E. calophylla/Agonis flexuosa* Forest (confined to the eastern side of the wetland) and Cleared wetland (NOTE: There is a dampland margin on the western side of the sumpland, vegetated with *E. gomphocephala* and/or *A. flexuosa* Forest; to the east are woodlands dominated by various species. The boundaries of the damplands have not been defined.).
2S	*?Eucalyptus rudis/Melaleuca preissiana* and/or *M. rhaphiophylla* Woodland
1L	Approximate area of the lake, that is area of open water
X	Cleared


KEY
Vegetation and/or wetland boundary
Proposed ROS boundary
Drain
Track
Open water / Lake
After orthophoto boundaries (orthorectified) 1998 aerial photography
S Sumpland
D Dampland
IS
IS
IS
IS
IS
1D
2D
3D/1
3D/2
3D/3
4D
1L
Note: Dampland areas NOT located E of line
Dalyellup Lake
Main Drain
A
B
Joins Map 2C.2
N
SCALE 1:10000 at A1
0
500
Metres

MAP 2C.1

N

SCALE 1:10000
at A1

0 500

Metres

3D/1

3D/2

3D/3

1S

4D

1S

Main Drain

5D

A

B

Joins Map 2C.1

1S

6D

7D

8D

9D

10D

11D/2

11D/1

1K

12D

Note: Dampland areas not identified east of line.

Muddy Lake

1S

2S

1S

1S

KEY

Vegetation and/or wetland boundary

Proposed ROS boundary

Drain

Track

Open water/lake

After orthophoto boundaries 1998 aerial photography

S Sumpland

D Dampland

MAP 2C.2

WETLANDS OF MAP SHEET 2031 III SW (Bunbury SW)

BASIN AND FLAT WETLANDS

- lake (permanently inundated), estuary (permanently inundated)
- sumpland, floodplain (seasonally inundated), estuary (peripheral)
- dampland, palusplain (seasonally waterlogged)
- other basin wetlands

CHANNEL WETLANDS

- River (permanently inundated)
- Creek (seasonally inundated)
- Artificial channel
- Gravity or Pressure Drainage Pipes (metro area)

WETLAND TYPE

L	Lake
CR	Creek
S	Sumpland
D	Dampland
AL	Artificial Lake
F	Floodplain
P	Palusplain
R	River
EW	Estuary (Waterbody)
E	Estuary (Peripheral)
PS	Paluslope

ZONES OF INFLUENCE

- ------ Zone of Critical Influence 50 metre boundary
- — · — Zone of Secondary Influence 200 metre boundary

Road Boundary — Property Boundary

WETLAND MAP IDENTIFICATION NOS. EG. 12, 320, 678

Map Identification Numbers have been assigned to each wetland according to their type and method of classification. Map Identification Numbers less than 300 represent wetlands mapped by the V & C Semeniuk Research Group for the Water Authority.

Map Identification Numbers ranging from 301 to 600 have been assigned to basin wetlands (mostly rock pools and dams) and numbers 601 and greater to channel wetlands (rivers, creeks, and artificial channels). Wetlands numbered 301 and greater have been described from complimentary DOLA digital hydrographic mapping.

SCALE 1:50 000

0 0.5 1 1.5 2
kilometres

NORTH

WETLANDS OF THE SWAN COASTAL PLAIN VOLUME 2b, WETLAND ATLAS. DECEMBER 1995

Map 3

MAP 2031 III SW (Bunbury SW)