

**An Assessment of the
Regional value of the South Bunbury Bushland Corridor*
with special reference to the area of Spearwood Dunes
vegetation and the area of Spearwood Dunes vegetation
in the TPS 6 Amendment 179 within the Corridor**

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and

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* includes proposed Bunbury Ocean-Preston River Regional Park and may be also called South Bunbury Open Space Link

Introduction

A series of studies on vegetation, plant community patterning and floristics are referred to in this treatment of regional value. These are Heddle *et al.* (1980), Gibson *et al.* (1994) and Department of Environmental Protection (1996). These studies have been used in the determination of regional conservation values in Perth's Bushplan (Government of WA 1998), the update of the recommendations for regional conservation areas in the Swan Coastal Plain portion of the Perth Metropolitan Region. A similar review of the remainder of the Swan Coastal Plain south of the Moore River and the Darling Plateau portion of the System 6 area (Department of Conservation and Environment 1983) will be completed during the next few years.

Specific area information included in this report is incorporated in the Department of Environmental Protection (1996) data and report. Additional information was collected in a field visit made on 7th January 1999 by the authors. Information collected by Dr B. Bischoff from his continuing studies of the Corridor has also been referred to.

General information on the Landforms and Soils of the South Bunbury Bushland Corridor (Corridor or transect) are described to place the Spearwood Dunes section of the transect in context. In the subsequent sections on vegetation and flora the focus is on the Spearwood Dunes. Four areas of bushland are described in the area of the Spearwood Dunes these are

Area A - the Spearwood Dunes (Areas C, D and E)

Area B - the western portion of the Spearwood Dunes west of the Hay Park wetlands* (Areas C and D)

Area C - the area of TPS 6 Amendment 179 within the Spearwood Dunes

Area D - the portion of the Spearwood Dunes immediately west of the Hay Park wetlands

Area E - the eastern portion of the Spearwood Dunes east of the Hay Park wetlands, in the College Grove area.

* Hay Park wetlands refers to the wetlands extending from Hay Park south. These wetlands contain plant communities not found elsewhere on the Plain and have regional affinities with a rare regional floristic plant community group.

Landforms and Soils

The Bunbury area lies entirely on the Swan Coastal Plain. The Corridor traverses four of the five major landform elements of the Plain found in the area (Anon 1981, Curchward and Macarthur 1980), namely the:

Quindalup Dunes The white calcareous sands which form the dunes of the coastal ridge of the Maidens area. These dunes are of Holocene age and are the youngest of the dunes.

Spearwood Dunes Sands associated with limestone. In the Bunbury area this limestone occurs at depth the surface pale grey or cream sands of the Spearwood Dunes overlaying yellow sands and then limestone. This limestone is closest to the surface on the crest of the dunes.

Bassendean Dunes These are the oldest of the dunes, being pale grey leached sands. In the Bunbury area these are low relief sheets of sand that merge with the Spearwood sands to the west and overly the Pinjarra Plain to the east. These sands are found in Manea Park.

Pinjarra Plain The clays and loams of the Pinjarra Plain are the oldest of the soils of the Plain and have been deposited on the east of the Plain and along the rivers. The wetlands of Manea Park and the Airfield lands contain areas of vegetation on these soils. A closely related unit associated with the Hay Park wetlands is composed of alluvial soils which appear to be of estuarine and riverine origin containing calcareous clays.

The fifth major landform element, Foothills, is not vegetated in the Bunbury area and is separated from the Corridor by cleared Pinjarra Plain.

The sequence of vegetated landform elements encompassed in the Corridor is unusual on the Plain. On a few occasions vegetated transects occur elsewhere on the Plain, these are:

- Quindalup/Spearwood/Bassendean Dunes but not through to the Pinjarra Plain. Such an example occurs from Yalgorup National Park through to the state forest in the east. Other examples are well to the north of Perth.

- Spearwood Dunes/Bassendean Dunes/Pinjarra Plain. Such a transect occurs in the Kemerton area but again other examples are to the north of Perth.

The area of Spearwood Dunes in the Corridor is also unusual on the Plain. Typically the Spearwood Dunes have two elements; an area of shallow soil over limestone (Cottesloe soils) and deeper sands with limestone at depth (Karrakatta soils). The Spearwood Dunes in the Bunbury area are represented by the Karrakatta soils. The limestone unit occurs in its southern most extent to the north of Bunbury in the area of Yalgorup National Park. Limestone comes closest to the surface at three points in the Corridor, in two small rises in Area C and a larger rise in Area E. As a consequence Area A is an extensive area of transition between the deep soils of the Spearwood Dunes and the Quindalups to the east and the Bassendean Dunes to the east. In addition this section of the Corridor contains the interface of the Spearwood Dunes and the Hay Park wetlands between Areas D and E. Area B (combination of Areas C and D) is vital in this link as there is no other area of vegetated Spearwood Dunes adjacent to the Hay Park wetlands.

Summary

The sequence of vegetated landform elements (Quindalup/Spearwood/Bassendean Dunes - Pinjarra Plain) encompassed in the Corridor is unusual on the Plain and does not appear to occur elsewhere. The area of Spearwood Dunes in the transect is also unusual on the Plain, being entirely composed of deep Karrakatta sands.

Vegetation and Flora

Vegetation

Plant Communities

Plant communities identified in the Corridor are typical of the Quindalup/Spearwood/Bassendean Dunes - Pinjarra Plain units of the Corridor.

From west to east, the transect within the Area A of the Spearwood Dunes, is vegetated with Tuart Woodlands to Tuart Open Forest to *Banksia attenuata* Woodlands with scattered to dominant Tuart then Jarrah and Jarrah/Marri. The *Banksia attenuata* Woodlands are largely absent from Area C.

The Tuart occurs over a variety of tree layers ranging from Peppermints to the west to combinations of Peppermints, Jarrah, *Banksia grandis* and *Banksia attenuata* to the east. To the east there is a corresponding change in some shrub/herb/sedge /grass species. For example to the west where the Tuart Woodlands merge in to the Tuart Woodlands of the Quindalup Dunes *Austrostipa flavescens* is a dominant grass and this gradually declines to the east and is absent in the *Banksia attenuata* Woodlands.

Vegetation Complexes (Hedde *et al.* 1980)

Plant communities identified are typical of the Quindalup/Spearwood/Bassendean Dunes - Pinjarra Plain units of the transect. being - Quindalup, Karrakatta Central and South, Yoongarillup, Karrakatta Central and South, Bassendean Central and South, and /or Southern River Complex (contains vegetation associations typical of the Bassendean Dunes and Pinjarra Plain).

Areas B (Areas C and D) and E are mapped as Karrakatta Complex Central and South vegetation complex (Hedde *et al.* 1983) and plant communities present in the areas are typical of the southern representations of this vegetation complex.

The Karrakatta Complex Central and South Complex has been selectively cleared for housing, horticulture and plantations across its range. Within the Perth Metropolitan Region 18% remains vegetated (Government of WA 1998), outside the PMR between 20 and 30% remains (Burbidge and Rolfe 1986 and Government of WA 1998 respectively). Within the PMR less than 10% (the target for protection in the PMR) of this complex was able to be recognised in Perth's Bushplan (Government of WA 1998) and the intention is to locate alternative areas beyond the PMR for protection. Outside the PMR 10 - 20% of each major landform element is expected to be recognised for protection.

Floristic Community Types (Gibson *et al.* 1994 and DEP 1996)

Floristic studies have located a series of study plots in the area of the transect. The analysis of these plots have identified regional floristic groups typical of a southern transect of the Quindalup/Spearwood/Bassendean Dunes - Pinjarra Plain units of the transect.

On the Spearwood Dunes floristic community type 25 - Southern *Eucalyptus gomphocephala* - *Agonis flexuosa* woodlands is identified. This regional grouping is predominantly a southern group. Several atypical occurrences occur to the north of Perth but the grouping is most common between Mandurah and Minninup. While this is a relatively widespread unit it is currently not well represented in National Parks or Nature Reserves so is considered poorly reserved.

Area B with its variety of plant communities is an excellent example of the sequence of communities contained within this regional floristic grouping. In addition Area C contains combinations of plant communities, related to the low limestone rises developed in this area, not evident in the flatter Tuart Woodland/Forest area to the south.

Flora

Various studies have already listed nearly 300 species of native plants in the area (Bischoff 1999, Gibson *et al.* 1994, DEP 1996). The diversity of species in the area of the transect would easily exceed 300 species. The plant communities in the transect show high species diversity for Spearwood units some 10X10 metre plots containing 50 -60 taxa (Bischoff 1999). The average species richness of floristic community type 15 over its range is 53 taxa (less taxa found in only one plot, Gibson *et al.* 1994)

Several species of Priority taxa have been identified in Area B, *Jacksonia sparsa* ms and *Lasiopetalum membranaceum*.

Summary

The bushland in Area B contains

- an excellent example of the of the southern Spearwood Dunes plant communities (at the both the vegetation complex and floristic community type level)

- contain excellent examples of the variation within this type

- good examples of the transitional communities between Quindalup

Dunes/Spearwood Dunes to the west and Spearwood Dunes/ Marine- Estuarine- Pinjarra Plain to the east.

- contains significant populations of two priority taxa.

Regionally the plant communities in Area B (Karrakatta Central and South Vegetation Complex) are not adequately protected (Government of WA 1998).

Importance of Area B in the Corridor

All of Area B has high conservation value, as

- a good representation of the southern Spearwood Dunes plant communities

- it contains good examples of the variation within this type

- representation interface Quindalups/Spearwoods and Spearwoods/Estuarine

and is worthy of preservation.

Any reduction in areas will weaken linkage in the corridor and reduce the area of the interface.

Area B is centrally in Very Good to Excellent condition . Towards edges of tracks and roads in Area B, where there as been long term disturbance, weed invasion is significant and the condition of the vegetation is degraded. Presently these degraded edges protect the core, to reduce the area will further degrade the intact core area.

Importance of Area C in the Corridor

Area C is a very significant section of the Corridor as it

- contains a combination of plant communities and their variation not evident elsewhere in the Corridor

- provides a direct link between the Quindalup Dunes and Area D (then through to the Hay Park wetlands and Area E).

As discussed in the previous section Area C (part of Area B) is centrally in Very Good to Excellent condition . Towards edges of tracks and roads in Area C, where there as been long term disturbance, weed invasion is significant and the condition of the vegetation is degraded. Presently these degraded edges protect the core, to reduce the area to a small area adjacent to the disturbed track and its edges on the southern boundary will not effectively conserve the values of this land.

References

Anon. (1981) Bunbury - Burekup Sheet 2035 III and part Sheet 1935, Urban Geology Series. Department of Minerals and Energy, Perth.

Atkins, K. (1998) Declared Rare and Priority List for Western Australia. Department of Conservation and Land Management, WA.

Bischoff, B (1999) Plot and area records for the Bunbury Ocean-Preston River Regional Park.

Burbidge, A.H. and Rolfe, J. (1986) Conservation Status of the Vegetation Types of the Swan Coastal Plain. Unpublished report for the Department of Conservation and Land Management.

Churchward, H.M. and McArthur, W.M. (1980) Landforms and Soils of the Darling System. In "Atlas of Natural Resources, Darling System, Western Australia". Department of Conservation and Environment, Western Australia.

Department of Conservation and Environment. 1983 Conservation Reserves for Western Australia. The Darling System - System 6. Parts 1 & 2. Report 13. Department of Conservation and Environment, Perth.

Department of Environmental Protection 1996 System 6 Update. Unpublished site and area records and analysis.

Government of WA (1998) Perth's Bushplan Prepared by the CALM/NPNCA, DEP/EPA, WRC and MfP/WAPC

Gibson, N., Keighery, B.J., Keighery, G.J., Burbidge, A. and Lyons, M. (1994) A Floristic survey of the southern Swan Coastal Plain. Unpublished report for the Australian Heritage Commission prepared by Department of CALM and the Conservation Council of WA (Inc).

Hedde, E.M., Loneragan, O.W. and Havel, J.J. (1980) Vegetation of the Darling System. In: Atlas of Natural Resources, Darling System, Western Australia. Department of Conservation and Environment, Western Australia.

DRAFT

BJK 16/5/95

AREA INFORMATION

System 6 Area (C or M) or Update Area (Update)

C70

Conservation Area
Nature Reserve
Reserve No
National Park
Reserve No
Local Government
Reserve No
Other
Proposed Conservation Areas
Local Government C70 MAIDENS (BUNBURY)
Reserve No ? Endowment Lands.
Other

Conservation Area

Nature Reserve
Reserve No
National Park
Reserve No
Local Government
Reserve No
Other

TOTAL AREA

Bushland Area	259.375	hectares
Completely Degraded	21.528 ha Sand	
northern third significantly invaded by Veldt Grass, too frequent fires		

AREA MAPPED FLORISTIC UNITS - NOT VISITED

* no CALM bands

Units	Site (Condition) Code	Bound	Area (ha)
	No sites established based on sites sampled elsewhere & map		
	Vegetation units		
25	= 4x3	%	18.675
296	= 4x3 see maps to estimate	%	134.616
306	= 2	%	76.775
Wet Tuart	This area has not been seen, but is mapped in CER.	%	7.781
= 17			

Boundaries determined by use of

aerial photograph	Swan Coastal Plain run SW 5197 28/11/90
orthophoto	2031 - III NE & SW (8/1991 & 12/1991)
vegetation map	CER - Hart Simpson and Assoc June 1994 in assoc. with BK Florists & Assoc.
soil map	

CALM MAP. Bunbury

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THE RAM



NATURE'S WONDERS: Botanist Bronwen Keighery takes a count of the different flora in the Maidens dunes.

Local dunes rich in flora

BOTANISTS from the Environmental Protection Department studied an area from the Maidens to Manea Park in Bunbury early this week.

The research group, headed by botanist Bronwen Keighery, aimed to establish what flora grew in the areas.

The information will be included in a comprehensive study of the plants on the Swan Coastal Plain system six areas.

The system six network, currently being updated by the EPD, is a list of areas deemed to be environmentally important and worth retaining.

The botanists, with the aid of volunteers, visited dozens of South West sites this week to determine what flora grew on the sites.

Other areas studied included some of the 300 nominated by the public for

inclusion in the updated system six report.

Mrs Keighery said the area from the Maidens to Manea Park was important because it featured a range of soil and vegetation types, from coastal to forest.

"It gives a combination of sand and heavy soils and you don't get that very often," Mrs Keighery said.

She said this area gave wildlife and birds the opportunity to move from one area to another.

The coastal area of the Maidens alone featured about 40 different species of plant within a ten by ten metre square study area.

The Bunbury City Council is still considering developing some parts of the Maidens opposite Mindalong Heights for housing.

Drivers lose licences

THE futility of drink driving was highlighted in the Bunbury Magistrate's Court on Monday when two men had their drivers licences disqualified for life.

Martin was stopped on October 15 for a random breath test, giving a breath analysis reading of .215 per cent.

Hooyberg was stopped after weaving across the road and driving slowly in Rowe Street, Bunbury, on October 2.

Department of Environmental Protection System 6 Update: Site Based Flora List for South Bunbury Bushland

(GMaid01-04, NMaid01, 03-05, Hay01-05, Swamp01-03, Sunday01-02, MGK01-04, BMaid02, B.J. Keighery, 13/3/96)

Aizoaceae

Carpobrotus virescens

Amaranthaceae

Ptilotus stirlingii

Anthericaceae

Agrostocrinum scabrum
Arthropodium capillipes
Caesia micrantha
Caesia parviflora
Chamaescilla corymbosa
Corynotheca flexuosissima
Dichopogon preissii
Johnsonia acaulis
Sowerbaea laxiflora
Thysanotus arenarius
Thysanotus manglesianus
Thysanotus multiflorus
Thysanotus patersonii
Thysanotus sp. scps
Thysanotus tenellus
Thysanotus thyrsoides
Tricoryne elatior

Apiaceae

Daucus glochidiatus
Eryngium pinnatifidum subsp. *pinnatifidum* MS
Eryngium rostratum
Homalosciadium homalocarpum
Hydrocotyle alata
Hydrocotyle diantha
Hydrocotyle sp. scps
Platysace compressa
Trachymene pilosa
Xanthosia huegelii

Asphodelaceae

* *Trachyandra divaricata*

Asteraceae

* *Arctotheca calendula*

Asteridea pulverulenta
Brachyscome iberidifolia
Cotula coronopifolia
Cotula cotuloides
* Cotula turbinata
Helichrysum cordatum
Hyalosperma cotula
* Hypochaeris glabra
Lagenifera huegelii
Millotia myosotidifolia
Olearia axillaris
Podolepis gracilis
Podotheca angustifolia
Pogonolepis stricta
Quinetia urvillei
Senecio lautus
Senecio lautus subsp. maritimus
Siloxerus filifolius
Siloxerus humifusus
Siloxerus sp. scps
* Sonchus oleraceus
* Ursinia anthemoides
Waitzia citrina

Campanulaceae

Wahlenbergia preissii

Caryophyllaceae

* Petrorhagia velutina
* Stellaria media

Centrolepidaceae

Aphelia cyperoides
Centrolepis aristata
Centrolepis drummondiana
Centrolepis polygyna
Centrolepis sp. scps

Chenopodiaceae

* Atriplex prostrata
Halosarcia sp. scps
Rhagodia baccata

Colchicaceae

Burchardia congesta
Burchardia multiflora
Burchardia umbellata

Convolvulaceae

Dichondra repens

Crassulaceae

Crassula colorata

Cyperaceae

Baumea juncea

Carex preissii

Cyathochaeta avenacea

* *Cyperus tenellus*

Gahnia trifida

Isolepis cernua

Isolepis marginata

Isolepis nodosa

Isolepis oldfieldiana

Isolepis sp. scps

Lepidosperma angustatum

Lepidosperma gladiatum

Lepidosperma longitudinale

Lepidosperma squamatum

Mesomelaena graciliceps

Schoenus curvifolius

Schoenus discifer

Schoenus elegans

Schoenus grandiflorus

Schoenus odontocarpus

Schoenus rigens

Schoenus rodwayanus

Schoenus sp. 2 (GJK 5739) scps

Schoenus sp. scps

Schoenus subfascicularis

Schoenus tenellus

Tetraria octandra

Dasypogonaceae

Acanthocarpus preissii

Dasypogon bromeliifolius

Dasypogon obliquifolius

Lomandra caespitosa

Lomandra hermaphrodita

Lomandra maritima

Lomandra nigricans

Lomandra preissii

Lomandra sonderi

Lomandra suaveolens

Dilleniaceae

Hibbertia amplexicaulis
Hibbertia cuneiformis
Hibbertia hypericoides
Hibbertia nymphaea
Hibbertia sp. scps
Hibbertia stellaris
Hibbertia subvaginata
Hibbertia vaginata

Droseraceae

Drosera bulbosa
Drosera gigantea
Drosera glanduligera
Drosera menziesii subsp. *penicillaris*
Drosera occidentalis
Drosera pallida
Drosera sp. scps
Drosera stolonifera

Epacridaceae

Astroloma pallidum
Conostephium pendulum
Leucopogon conostephioides
Leucopogon parviflorus
Leucopogon propinquus

Euphorbiaceae

Amperea ericoides
* *Euphorbia peplus*
Monotaxis grandiflora
Phyllanthus calycinus
Poranthera microphylla

Gentianaceae

* *Centaurium* sp. scps
* *Cicendia filiformis*

Geraniaceae

* *Erodium botrys*
* *Erodium cicutarium*
Geranium retrorsum
Geranium solanderi
Pelargonium littorale

Goodeniaceae

Dampiera linearis
Goodenia micrantha
Scaevola anchusifolia
Scaevola crassifolia
Scaevola holosericea
Scaevola phlebopetala
Scaevola sp. scps
Velleia trinervis

Haemodoraceae

Anigozanthos manglesii
Conostylis aculeata
Conostylis aculeata subsp. aculeata
Conostylis aurea
Conostylis candicans
Conostylis setigera
Haemodorum sp. scps
Phlebocarya ciliata
Tribonanthes australis

Iridaceae

Orthrosanthus laxus
Patersonia occidentalis
Patersonia occidentalis (swamp form) sthct
* Romulea rosea
* Romulea rosea var. australis

Juncaceae

* Juncus bufonius
* Juncus capitatus
Luzula meridionalis

Juncaginaceae

Triglochin centrocarpum
Triglochin mucronatum
Triglochin procerum
Triglochin sp. scps
Triglochin trichophorum

Lamiaceae

Hemiandra pungens

Lauraceae

Cassytha glabella
Cassytha micrantha

Cassytha racemosa
Cassytha sp. scps

Lentibulariaceae

Polypompholyx multifida
Utricularia violacea

Lobeliaceae

Lobelia tenuior
Monopsis simplex

Loganiaceae

Logania serpyllifolia
Logania vaginalis
Mitrasacme paradoxa

Loranthaceae

Nuytsia floribunda

Lycopodiaceae

Phylloglossum drummondii

Menyanthaceae

Villarsia parnassifolia
Villarsia sp. scps

Mimosaceae

Acacia alata
Acacia applanata MS
Acacia cochlearis
Acacia flagelliformis
Acacia pulchella
Acacia pulchella var. pulchella
Acacia saligna
Acacia sp. scps
Acacia stenoptera
Acacia willdenowiana

Myoporaceae

Eremophila glabra

Myrtaceae

Agonis flexuosa
Astartea aff. fascicularis scps

Baekkea camphorosmae
Calothamnus lateralis
Calytrix angulata
Calytrix flavescens
Eucalyptus calophylla
Eucalyptus gomphocephala
Eucalyptus marginata
Hypocalymma angustifolium
Kunzea micrantha
Kunzea recurva
Melaleuca incana
Melaleuca lateritia
Melaleuca parviflora
Melaleuca pauciflora
Melaleuca preissiana
Melaleuca raphiophylla
Melaleuca teretifolia
Melaleuca thymoides
Melaleuca thyoides
Melaleuca viminea
Pericalymma ellipticum

Orchidaceae

Acianthus reniformis
Burnettia nigricans MS
Caladenia flava
Caladenia georgei MS
Caladenia latifolia
Caladenia longicauda
Caladenia paludosa MS
Caladenia sp. scps
Diuris sp. scps
Lyperanthus nigricans
Microtis media
Microtis unifolia
* Monadenia bracteata
Prasophyllum parvifolium
Prasophyllum sp. scps
Pterostylis nana
Pterostylis sanguinea
Pterostylis sp. scps
Pterostylis vittata
Thelymitra benthamiana
Thelymitra crinita
Thelymitra flexuosa
Thelymitra nuda
Thelymitra pauciflora
Thelymitra sp. scps

Oxalidaceae

Oxalis perennans

- * Oxalis sp. scps

Papilionaceae

- Bossiaea eriocarpa
- Daviesia divaricata
- Daviesia physodes
- Daviesia preissii
- Eutaxia virgata
- Gompholobium tomentosum
- Hardenbergia comptoniana
- Hovea sp scps
- Hovea trisperma
- Jacksonia furcellata
- Jacksonia sp. scps
- Jacksonia sp. Busselton (G.J. Keighery 4482) PN
- Kennedia coccinea
- Kennedia prostrata
- * Lotus angustissimus
- * Lotus sp. scps
- Nemcia capitata
- * Ornithopus compressus
- Sphaerolobium sp. scps
- Templetonia retusa
- * Trifolium arvense
- * Trifolium campestre
- * Trifolium dubium
- * Trifolium subterraneum
- Viminaria juncea

Philydraceae

- Philydrella drummondii
- Philydrella pygmaea

Phormiaceae

- Dianella divaricata
- Dianella revoluta

Poaceae

- * Aira caryophyllea
- Amphipogon debilis
- Amphipogon laguroides
- * Anthoxanthum odoratum
- * Avena barbata
- * Briza maxima
- * Briza minor
- Bromus arenarius
- * Bromus diandrus
- Cynodon dactylon
- Danthonia occidentalis

- Dichelachne crinita
- * Ehrharta calycina
- * Ehrharta longiflora
- * Hordeum marinum
- * Lagurus ovatus
- * Lolium rigidum
- Microlaena stipoides
- * Parapholis incurva
- Poa drummondiana
- Poa poiformis
- Poa porphyroclados
- Poa sp. scps
- * Polypogon monspeliensis
- Polypogon tenellus
- Stipa compressa
- Stipa flavescens
- * Vulpia bromoides

Polygalaceae

- Comesperma virgatum

Polygonaceae

- * Rumex crispus

Portulacaceae

- Calandrinia corrigioloides
- Calandrinia liniflora

Primulaceae

- * Anagallis arvensis
- Samolus junceus

Proteaceae

- Adenanthos meisneri
- Adenanthos obovatus
- Banksia attenuata
- Banksia grandis
- Banksia littoralis
- Grevillea glabrata
- Hakea prostrata
- Hakea sulcata
- Hakea varia
- Persoonia saccata
- Petrophile linearis
- Stirlingia latifolia
- Synaphea spinulosa

Site Based Flora List for South Bunbury Bushland (GMaid01-04, NMaid01, 03-05, Hay01-05, Swamp01-03,
10

Sunday01-02, MGK01-04, Bmaid02, B.J. Keighery, 13/3/96)

Pteridaceae

Pteris vittata

Ranunculaceae

* *Ranunculus muricatus*

Restionaceae

Anarthria laevis

Hypolaena exsulca

Leptocarpus aristatus

Leptocarpus sp. scps

Lepyrodia glauca

Loxocarya fasciculata

Loxocarya flexuosa

Loxocarya pubescens

Lyginia barbata

Sporadanthus strictus MS

Rhamnaceae

Spyridium globulosum

Rubiaceae

Opercularia hispidula

Opercularia vaginata

Rutaceae

Boronia dichotoma

Diplolaena dampieri

Eriostemon spicatus

Santalaceae

Exocarpos sparteus

Santalum acuminatum

Sapindaceae

Dodonaea aptera

Scrophulariaceae

* *Dischisma arenarium*

* *Dischisma sp. scsp*

* *Parentucellia viscosa*

Selaginellaceae

Site Based Flora List for South Bunbury Bushland (GMaid01-04, NMaid01, 03-05, Hay01-05, Swamp01-03,
1 1
Sunday01-02, MGK01-04, Bmaid02, B.J. Keighery, 13/3/96)

Selaginella gracillima

Stackhousiaceae

Tripterococcus brunonis

Sterculiaceae

Lasiopetalum membranaceum

Thomasia cognata

Thomasia pauciflora

Stylidiaceae

Stylidium brunonianum

Stylidium calcaratum

Stylidium dichotomum

Stylidium divaricatum

Stylidium inundatum

Stylidium junceum

Stylidium piliferum

Stylidium schoenoides

Stylidium sp. scps

Thymelaeaceae

Pimelea imbricata var. *piligera*

Tremandraceae

Platytheca galioides

Tetratheca hirsuta

Urticaceae

Parietaria debilis

Violaceae

Hybanthus calycinus

Xanthorrhoeaceae

Xanthorrhoea brunonis

Xanthorrhoea preissii

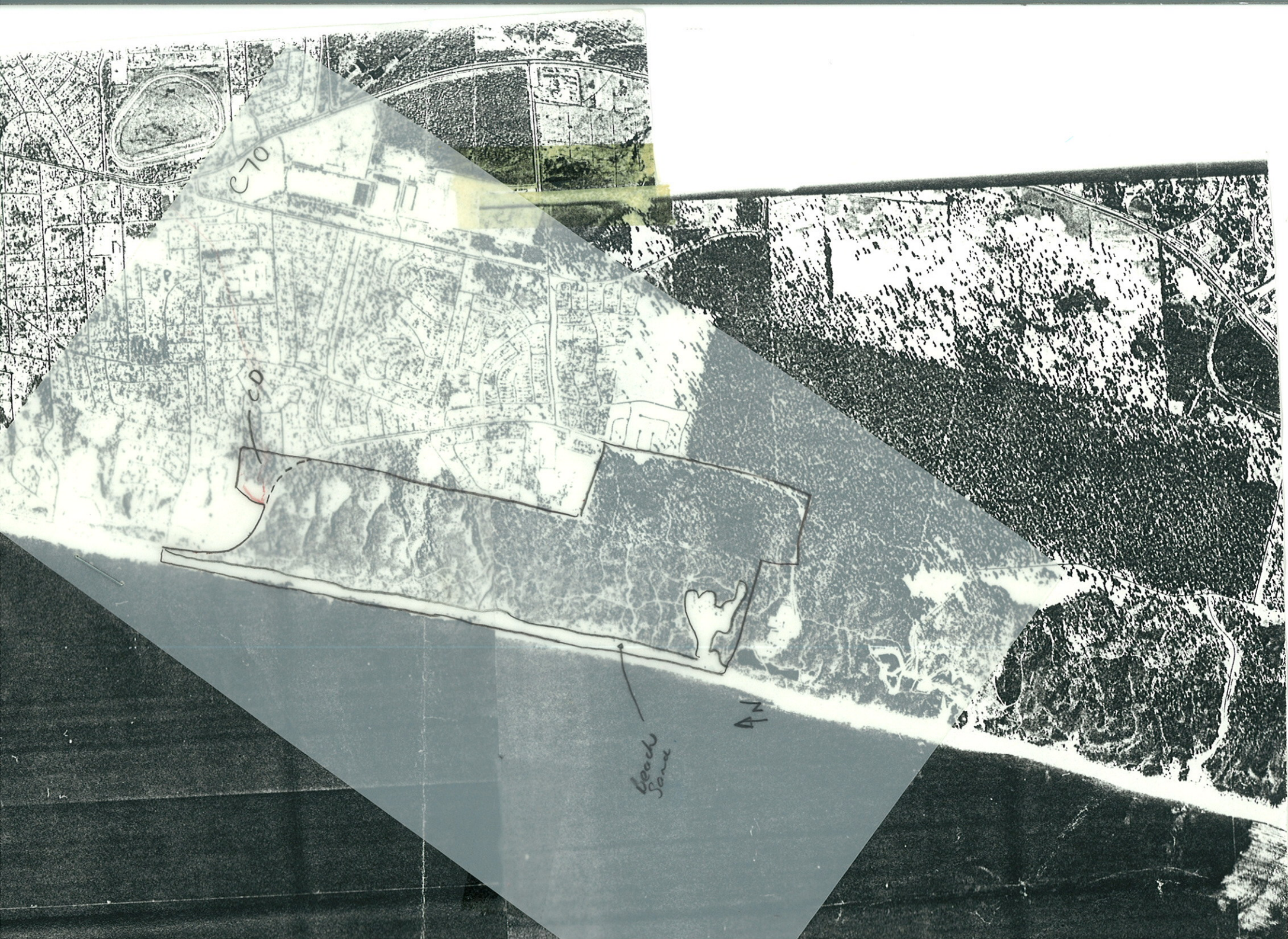
Zamiaceae

Macrozamia riedlei

Zygophyllaceae

Site Based Flora List for South Bunbury Bushland (GMaid01-04, NMaid01, 03-05, Hay01-05, Swamp01-03,
12
Sunday01-02, MGK01-04, Bmaid02, B.J. Keighery, 13/3/96)

Zygophyllum apiculatum



C70

CD

AN

beach sand

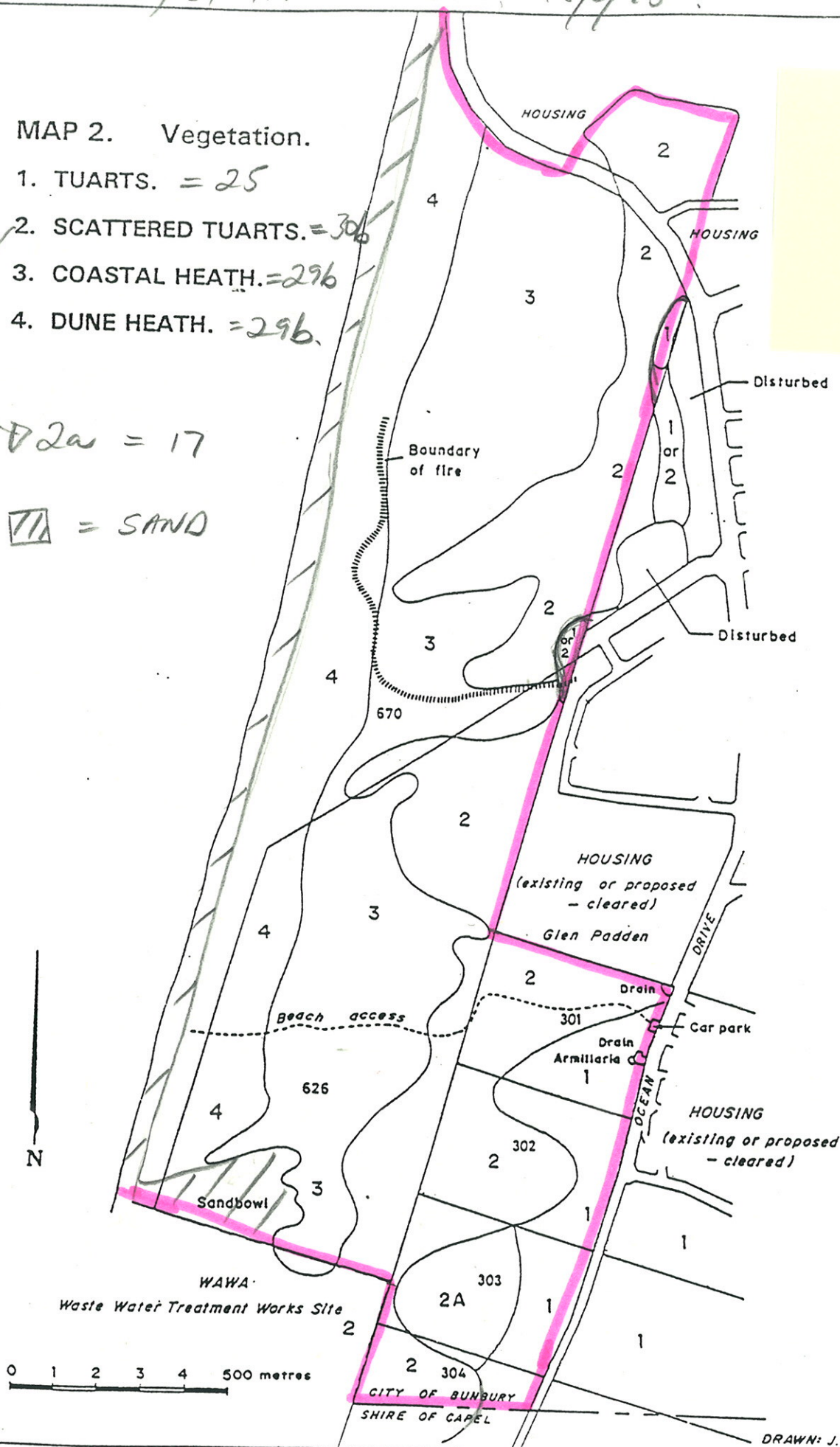
MAP 2. Vegetation.

- 1. TUARTS. = 25
- 2. SCATTERED TUARTS. = 30%
- 3. COASTAL HEATH. = 29%
- 4. DUNE HEATH. = 29%

$\nabla 2a = 17$

$\square \text{ / } \square = \text{SAND}$

Veg map



DRAWN: J.L. Montgomerie



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**DEVELOPMENT OF
PART OF SYSTEM 6 C70
SOUTH OF THE MAIDENS.
BUNBURY ENDOWMENT LAND
PART OF LOT 670,
AND PARTS OF LOTS 301-4.**

CONSULTATIVE ENVIRONMENTAL REVIEW.

prepared by

Hart, Simpson and Associates Pty Ltd

in association with

B.K. Masters and Associates

for

City of Bunbury and Homeswest

JUNE 1994

INVITATION

The Environmental Protection Authority (EPA) invites people to make a submission on this proposal.

The Consultative Environmental Review (CER) proposes further urban development of a small portion of the West Withers Area in the south west corner of the City of Bunbury. In accordance with the Environmental Protection Act, a CER has been prepared by the City to assess the values of the land, and describe land use proposals and management requirements. The CER is available for public review period of 4 weeks from 2 June 1994 closing on 4 July 1994.

Comments from government agencies and from the public will assist the EPA to prepare an assessment report in which it will make recommendations to government.

Why write a submission?

A submission is a way to provide information, express your opinion and put forward you suggested course of action - including any alternative approach. It is useful if you indicate any suggestions you have to improve the proposal.

All submissions received by the EPA will be acknowledged. Submissions will be treated as public documents unless specifically marked confidential, and may be quoted in full or in part in each report.

Why not join a group?

If you prefer not to write your own comments, it may be worthwhile joining with a group or other groups interested in making a submission on similar issues. Joint submissions may help to reduce the workload for an individual or group, as well as increase the pool of ideas and information. If you form a small group (up to 10 people) please indicate all the names of the participants. If your group is larger, please indicate how many people your submission represents.

Developing a submission.

You may agree or disagree with, or comment on, the general issues discussed in the CER or the specific proposals. It helps if you give reasons for your conclusions, supported by relevant data. You may make an important contribution by suggesting ways to make the proposal environmental more acceptable.

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WAWA are collecting data for use in a computer model to predict whether the 1000 metre buffer zone can be modified. However, regardless of the model's findings, urban development will not be allowed within 500 metres of the treatment plant.

ASSESSMENT OF ALTERNATIVES

Four key issues affect the assessment of alternative land use proposals for the subject land:

ENVIRONMENTAL PROTECTION

- use of land consistent with its environmental values,
- benefits to the community of retaining undeveloped bushland,
- access and use of beach areas, and
- management of undeveloped bushland areas.

ECONOMIC DEVELOPMENT OF URBAN LAND.

- efficient use of existing infrastructure,
- location of existing facilities and services,
- the design of urban subdivision areas and the resulting interaction with retained bushland, and
- maximising urban development within environmental constraints to meet community needs for residential land.

EQUITY CONSIDERATIONS FOR THE COMMUNITY.

- provision of access to the south Bunbury beach areas for existing and future residents, and
- concentrating urban development near existing suburban and city facilities to reduce travel distances and gain economic and environmental benefits.

OPTION	ENVIRONMENTAL BENEFITS	ECONOMIC BENEFITS	EQUITY BENEFITS	QUALITY OF LIFE BENEFITS
1	LOW	HIGH	MEDIUM	MEDIUM
2	MEDIUM TO HIGH	MEDIUM TO HIGH	HIGH	HIGH
3	MEDIUM TO HIGH	MEDIUM	HIGH	HIGH
4	MEDIUM TO HIGH*	LOW	LOW	MEDIUM

* The lower rating base for the City of Bunbury reduces the financial ability of the City to manage all environmental land within its boundaries.

OPTION 2 is preferred on the basis of the above assessment. However, its implementation is dependent on resolving the generation of odours from the No. 2 wastewater treatment plant.

OPTION 3 is the second preference.

Approval is sought for both options, with OPTION 3 to proceed immediately and OPTION 2 to proceed if the final buffer around the wastewater treatment plant allows it.

If OPTION 2 proceeds, urban development will occur within about 40 hectares, representing less than 18% of the 224 hectares of the C70 area. If OPTION 3 proceeds, urban development will occur within about 21 hectares or about 9% of the C70 area. In addition approximately 1.5 hectares will be cleared for the development of a water supply facility on a high point in the south.



SYSTEM 6
BOUNDARY →

THE MAIDENS

670


OCEAN
DRIVE

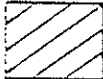
COMPOSITE MAP
SHOWING PROPOSED
CONSERVATION/RECREATION
AND URBAN AREAS
Nov. '93

INDIAN
OCEAN

EXISTING
RESIDENTIAL
R15 ZONING
BOUNDARY →

AREAS PROPOSED FOR
URBAN DEVELOPMENT
UNDER:-

 OPTION 2

 OPTION 3

TOTAL COUNCIL
URBAN
49.5ha

COUNCIL
WEST
12.1ha

COUNCIL
SOUTH
18.8ha

EXISTING URBAN

HOMESWEST
8.5ha

EXISTING URBAN

301

302

626

500m BUFFER

1km BUFFER

WATER STORAGE
FACILITY

PROPOSED ROAD

WAWA WASTEWATER
TREATMENT PLANT

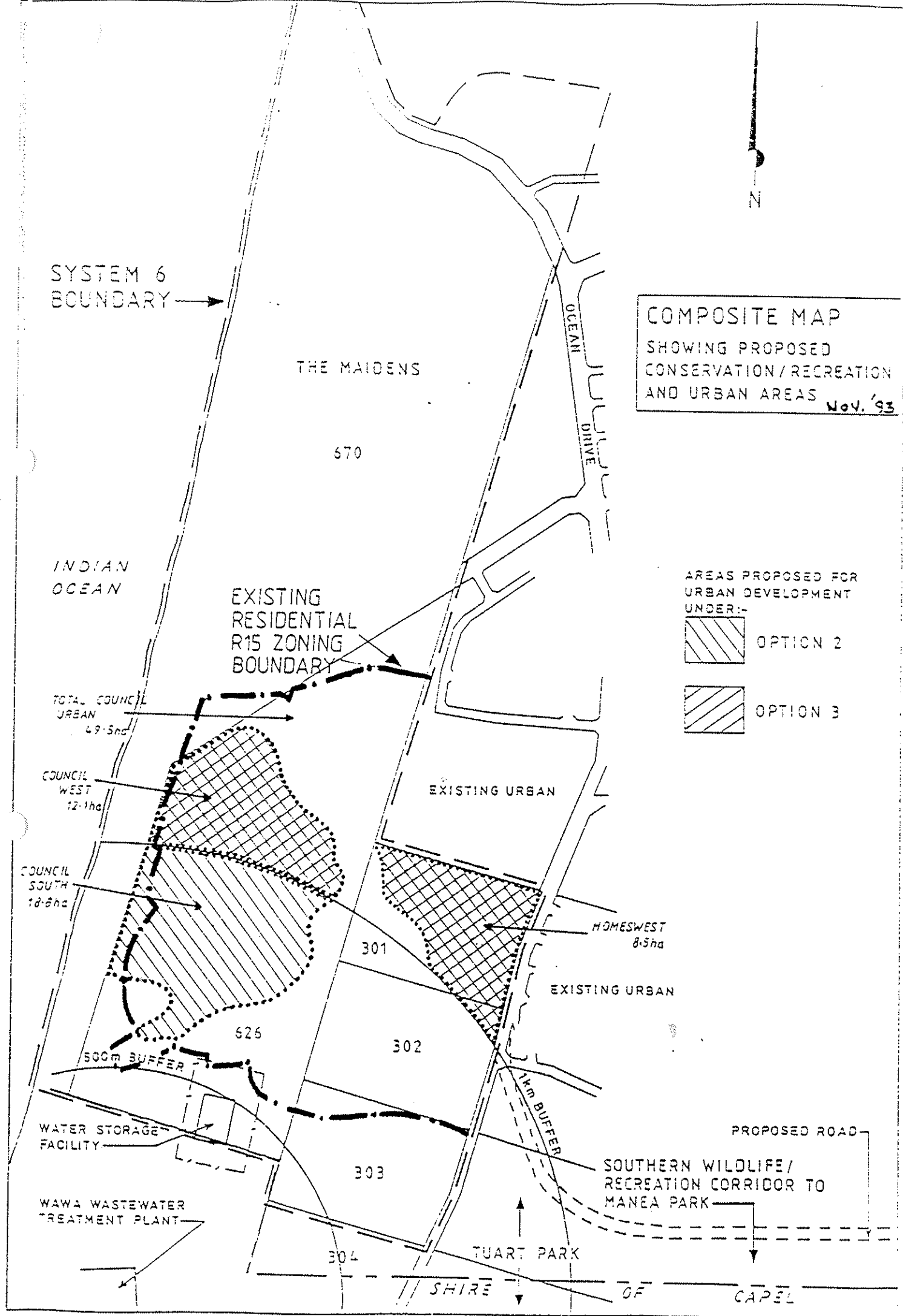
SOUTHERN WILDLIFE/
RECREATION CORRIDOR TO
MANEA PARK

303

TUART PARK

304

SHIRE OF CAPEL



3. THE LAND.

3.1 LOCATION AND LAND USE.

The land is parts of Lots 301-3 and 626 on the south-western corner of Bunbury (Map 1, next page). All of the land is in the City of Bunbury.

Lots 301-3 are owned by Homeswest and Lot 626 is owned by the City of Bunbury. The land is currently zoned Residential (the central bulk of the land) or Parks, Recreation and Drainage (the coastal strip and the northern and southern edges) in accordance with previous development plans which have not proceeded. The adjacent Maidens area is on Reserve 670 for Bunbury Endowment and Reserve 35020 for Public Recreation on the eastern side.

Adjacent land has been or is being developed for conventional housing (Map 1).

The land is covered by System 6 recommendation C70 (Map 1). The recommendation was (EPA 1983), "That areas of Public Open Space, containing attractive and important features such as "The Maidens" and important stands of Tuart, be set aside at the time of subdivision of the coastal land south of Bunbury".

The area is also affected by an existing waste water treatment plant to the south (Map 1), for which the Water Authority of Western Australia (WAWA) currently requires a buffer zone of 1 kilometre, within which some land uses including urban development are prohibited.

The area is also affected by a draft coastal management plan (DPUD 1993) which proposes coastal setbacks but makes few specific recommendations for the area discussed here because of the unresolved issues of the System 6 recommendation, possible development of the land, and the uncertain buffer around the waste water treatment plant.

The area is held under Exploration Licence E70/911 for mineral sands exploration. There is no active exploration and any proposal to explore on the land would be subject to separate environmental assessment.

3.2 LANDFORMS AND SOILS.

LANDFORMS.

The site is part of the Quindalup dunes which occur along the entire coast in the region. These dunes are a series starting from the present beach, passing through unstable beach dunes, to older dunes which have been stabilised by vegetation. On the eastern side the dunes fall onto a flatter area which is part of the Karrakatta system, an older set of dunes. Further east, outside the present study area, there are wetlands.

The Quindalup dunes have a characteristic profile with low linear dunes along the coast which rise to larger parabolic dunes further inland, and relatively steep slopes down to the edge of the Karrakatta system. The dunes often exceed 40m in elevation, and may reach 60m.

SOILS.

The soils are white calcareous and quartz sands with increasing organic matter further inland, but become more yellow in the Karrakatta system. Limestone is present at depth below the sands.

The soils along the coast are inherently unstable, and natural blowouts are a feature. There is one large blowout on the southern edge of the study area, known locally as "the Sandbowl" (Map 1).

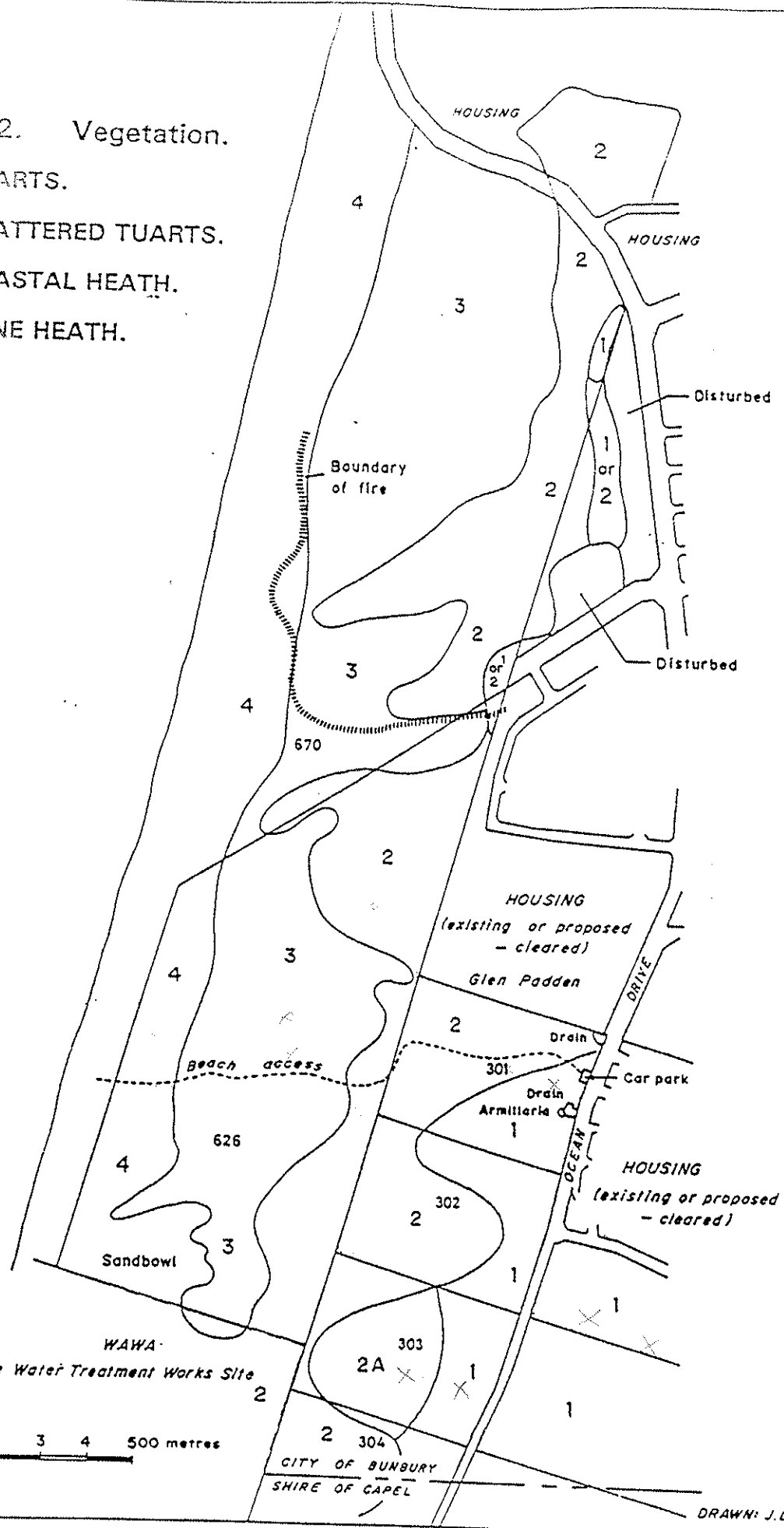
Despite their instability, the soils are capable of supporting intensive development which requires removal of the vegetation, provided that the development immediately stabilises the new surface with structures or vegetation. Similar landforms have been widely used along the coast for residential and recreational developments.

The coastal dunes are now generally regarded as capable of supporting development but development is often regarded as undesirable for aesthetic reasons and to protect the potentially unstable beach line and dunes.

The beach itself is stable (DPUD 1993).

MAP 2. Vegetation.

- 1. TUARTS.
- 2. SCATTERED TUARTS.
- 3. COASTAL HEATH.
- 4. DUNE HEATH.



CITY OF BUNBURY
SHIRE OF CAPEL

DRAWN: J.L. Montgomerie

The vegetation is in good condition with limited weed invasion except along the tracks. Trachyvandra divaricata (often misidentified as Asphodelus fistulosus) is the most aggressive weed present. Grass weeds include Wild Oats, Lacurus ovatus, Bromus diandrus and Couch.

4. Coastal heath on primary dunes.

Species on the youngest dunes close to the sea include Spinifex longifolius and Tetragonia decumbens with the common naturalised species Arctotheca populifolia, Cakile maritima and Ammophila arenaria.

Behind these dunes the low coastal heath is dominated by Diplolaena dampieri. Other common shrubs include Olearia axillaris, Acacia cochlearis, Hemiandra pungens and Scaevola crassifolia. Lepidosperma gladiatum and Acanthocarpus preissii are also common. In more sheltered leeward positions the heath is taller, exceeding 1 m. There are also occasional small thickets of Peppermint reaching up to 3m in height.

The vegetation is in good condition with little sign of any weed invasion except for Pelargonium capitatum in many places and other common naturalised species along the beach front.

The distribution of these vegetation units follows the topography very closely. The Tuart woodland and forest, with the tallest trees and most diverse tree stratum, is found only on the lower slopes of the inland edge of the dunes and in the flat areas behind the dunes in the Karrakatta system. The Tuart open woodland has scattered Tuarts over heath and is found on the lee slopes of the dunes (with an abrupt end at the crest), in the swales, and in the east-west valleys between the parabolic dunes. The coastal heath occurs in two different forms, one on the windward faces and crests of the large dunes and another on the mobile dunes along the coast.

Most of the Maidens area had been burnt prior to the present survey and could not be examined closely because most of the vegetation had been removed by the fire. The boundary of the fire is shown on Map 2. The Maidens area consists largely of units 2, 3 and 4 in the same sequence as further south, with smaller areas of unit 1 on the eastern edge but these have been heavily disturbed by past activities including grazing, particularly on Reserve 35020.

A few significant variations occurred to these average values. Along Ocean Drive south of Glen Padden there was a disturbed strip with serious weed invasion due to previous road works, and there were smaller areas of weed invasion along tracks and where other disturbances had occurred, such as rubbish dumping. A small part of the Maidens reserve isolated north of Ocean Drive has been used for urban development or has been degraded by loss of most of the understorey. There have been several small areas cleared by work on adjacent urban developments in Glen Padden, although one of these has been carefully rehabilitated. Reserve 35020 was generally in poor condition, apparently due to past grazing, and part of it has been used as a sand pit. There are many small unstable areas along the coast, and one large one, known as the Sandbowl, has encroached right through unit 2 almost 500 metres inland. Although spectacular, this blowout is a natural part of the landscape and is actually moving inland very slowly. All of the large dunes, including the Maidens, were formed by similar blowouts in the past which moved inland and eventually became stabilised.

Part of the area 2A in Map 2 appeared to have been excavated for the extraction of marl (a form of limestone) many years ago. The vegetation has regenerated and the only evidence remaining was old heaps of soil and rubbish.

One small patch of severe deaths of Banksia attenuata was found along Ocean Rd (Map 2) which was consistent with the presence of dieback due to the Phytophthora fungi. Two dead trees were tested. No Phytophthora were found, but a fungus which appeared to be Armillaria was found on the dead trees. The damage was accepted as due to Armillaria and not dieback.

FLORA.

The flora of the study area was also examined. A list of the plant species identified in each vegetation unit is given in Appendix 2. This not a complete list of the flora. Most of the field work was carried out in late November 1992 and some additional work was carried out in the Maidens area in June 1993. Many annual species would not have been seen, such as the orchids. As for the vegetation, most attention was paid to the central and eastern areas rather than the coastal strip.

INTRODUCED SPECIES.

Weeds are a significant component of the flora and a survey carried out in spring would detect many more annual species. The weeds recorded were grasses (11 species), herbaceous legumes (five species), daisies (four species) and a range of other herbs. In general the weeds are invasive in vegetation units 1 and 2, and to a much lesser extent in 3, but are represented by common naturalised species in the coastal dunes where the species have occupied niches not taken by native species. The most significant weeds are the grasses.

THE TUART ECOSYSTEM.

The System 6 Atlas of Natural Resources (DCE 1980) maps five complexes with Tuart trees (the Karrakatta North, Karrakatta Central and South, Cottesloe, Yoongarillup and Vasse). In combination these complexes have a minimum width of about one kilometre on the north-west side of the Peel Inlet and a maximum of eight kilometres in the Lake Preston area. Around Bunbury, Tuarts occur in belts from 1.5 to 4 kilometres wide. Tuarts occur from the Sabina River east of Busselton north to the Hill River, a distance of over 400 kilometres.

Traditionally Tuarts have been regarded as growing only on shallow sands over limestone, but they occur on a variety of soils including acidic sands with little or no limestone such as on the Leschenault ridge on the east side of the Leschenault Inlet.

Tuart can be readily regenerated (Forests Dept, undated) simply by ensuring a very hot fire which kills the grasses and leaves a clean ash-bed, but young Tuarts are fire-sensitive. An excessive fire frequency favours annual weeds which in turn leads to frequent low intensity fires which both kill the young Tuarts and promote weeds in a cycle of degradation. This trend has probably been exacerbated by past grazing which also promoted weed invasion.

Tuarts readily develop hollows and this gives them a high value for wildlife, but they also regularly drop limbs which makes them dangerous. For this reason Tuarts are rarely retained in urban areas, and are unsuitable as shade trees in recreational areas where people are likely to remain for long periods.

The number of native species listed as possibly present in each habitat is:

Habitat	1	2	3	4
Amphibians	8	9	8	3
Reptiles	29	30	28	21
Birds	71	77	56	35
Mammals	16	17	12	10
TOTAL	124	133	104	69

The potentially most diverse habitats are 1 and 2 with habitat 4 being the least diverse.

Most fauna species listed in Appendix 3 are common or widespread, and are not restricted to the habitats considered here. The Tuart woodlands include a diverse fauna and the Tuarts themselves are an important habitat feature, particularly for birds. The trees provide roosting and nesting sites and a food resource for many of the bird species and are important to the Brushtail and Ringtail Possums. Frogs and reptiles are not dependent on the Tuarts in the same way, except for obvious tree dwelling species, but some species prefer the heavier leaf litter found in the Tuart woodlands. The legless lizard Aprasia repens, for example, would be expected to be most common in the dense leaf litter.

Few species are restricted to the coastal heaths. These are small birds which prefer open areas of low vegetation. The coastal heaths have fewer species of conservation interest because this habitat is widespread along the coast.

RARE SPECIES.

One mammal species listed in Appendix 3 is gazetted in Schedule 1 under the Wildlife Act as likely to become extinct or rare.

The Western Ringtail Possum Pseudocheirus occidentalis is rare in total and now occupies a severely reduced area. It is a leaf eating species, and is now found mainly in Peppermint vegetation as well as forest to the east. This species is likely to be present in vegetation units 1 and 2 where it would use the Peppermints and Tuarts. The area to the south towards Busselton is well known as a major stronghold of this species. It is able to survive in even remnants of Peppermint vegetation, such as at Peppermint Grove near Capel and within the Busselton townsite.

Another bird of interest which may be present in the area is the Masked Owl. This subspecies is considered to be rare by Garnett (1992) and is known to occur in forest and woodland in a broad coastal strip around southern and eastern Australia. In Western Australia it inhabits forest dominated by Tuart (Garnett 1992). Major threats to its survival include destruction of nest trees and pesticide ingestion. This species could be protected by retaining old trees with nest hollows.

INTRODUCED SPECIES.

Introduced animals are represented by a suite of mammals (rabbit, cat, fox, mouse and rat) found in almost any site in the South-West, and two birds. The birds are the Laughing Turtle-Dove which is found mainly around human settlements or disturbed areas and has little impact on the native fauna, and the Kookaburra which is common and feeds on many small native animals. Both of these introduced birds are widespread and common.

All of these introduced species are common and widespread, and any control would need to be part of a larger regional programme.

The Yarragadee Formation is considered one of the most productive aquifers in the southern part of the Swan Coastal Plain. It contains much sand and little clay or secondary cementation, and water quality is high.

The Cockleshell Gully Formation was tested by one of the Picton bore holes near the corner of Bussell Highway and Robertson Drive. Water quality and available volume were high.

Commander (1984) indicates that there is narrow north-south zone immediately inland from the coast where water flows upwards from the Yarragadee Formation into the sands and limestones of the superficial formations. There is no bore data to confirm that this actually occurs within the study area, but such movement may be present along the eastern edge of the high sand dunes. This may explain the apparent speedy regeneration that occurred to sections of Tuart vegetation (in unit 2A in Map 2) that had been damaged by marl extraction many years ago. This also helps to explain the vigorous health and density of the understorey beneath the Tuarts on the west side of Ocean Road.

3.6 CONSERVATION VALUES.

The conservation values of the land considered here can be derived from three sources:

- the presence of rare species,
- the presence of valuable landforms, vegetation types, habitats or communities, and
- the local and regional context of the land.

RARE SPECIES.

Only one plant of conservation significance was found. This was Lasiopetalum membranaceum, a Priority 2 species which although rarely collected is apparently widespread. Priority species have no legal protection and the presence of this species alone is insufficient to place a high value on the land.

Several rare animal species are probably present. The most significant is the Ringtail Possum which is a seriously endangered species both locally and in total. It is largely dependent on the Peppermint tree, and the region to the south is known to be a stronghold of this species. The actual or probable presence of this species gives the land conservation value. No other fauna species gives the land such a high value.

VALUABLE LANDFORMS, VEGETATION TYPES, HABITATS OR COMMUNITIES.

The landforms of the study area are common along the coast, but the Maidens area is a landform of significance because of the size of the dunes, their form and their aesthetic appeal.

The vegetation, habitats and communities can be considered together because they are closely related.

Tuart communities are widespread along the coast in a relatively narrow strip, and while Tuart is popularly regarded as growing mainly alone and on shallow sand over limestone, it also commonly occurs on a variety of soils and often mixed with Jarrah and Marri on the eastern side of its coastal distribution. A typical example can be seen along Bussell Highway to the east of the area considered here.

the vegetation of the coastal area around Mandurah and found Tuart communities to be common and in good condition unlike most other areas of Tuart. This good condition was sufficient to give them a very high conservation value.

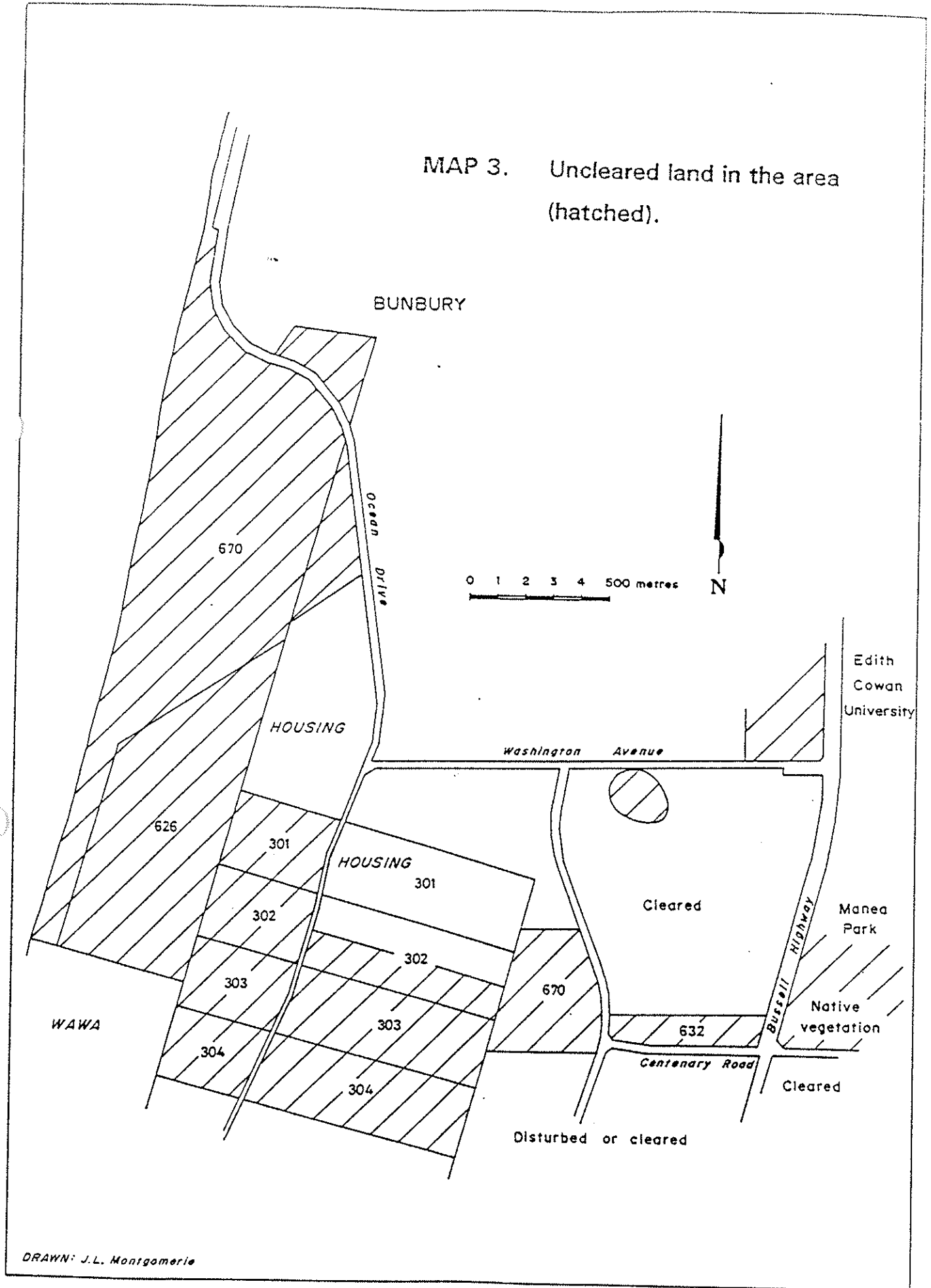
The Tuart-dominated communities are very sensitive to disturbance and fire. Much of the Tuart country has historically been used for grazing, and there have been major changes in fire patterns. A cycle of disturbance, weed invasion and excessive fire frequency has been set up, and most Tuart areas now show the impact of this degrading influence. Young Tuarts are fire sensitive and are killed before they can reach a sufficient size to survive fires. Normal bushfires or grass fires are not hot enough to achieve Tuart regeneration. Regular low intensity fires therefore prevent the regeneration of Tuarts, damage the understorey and promote weeds.

More recently, Tuarts have been affected by a form of tree decline believed to be due to excessive insect attack (Fox and Curry 1980). This is poorly understood but may be related to the increasing disturbance and isolation of the remaining Tuart trees or to changes in fire patterns. Chilcott (1992) re-examined this problem and concluded that in fact only the Tuarts near urban and particularly industrial areas were in decline and that the Tuarts in rural areas were not affected even where they were in vegetation which had been badly degraded by grazing or loss of the understorey. Chilcott concluded that air pollution was the most likely cause.

The vegetation, habitats and communities represented by the Tuart woodlands and forests in the present study area must all be given a high conservation value because of their good condition and because of the general scarcity of this unit in good condition, particularly in conservation reserves. It must be emphasised that the Tuart itself is widespread and is well represented in Reserves, but that Tuart-dominated vegetation in good condition is not.

The coastal heath units are part of common and widespread units which occur along much of the coast. These have been well reserved in many areas and will be further protected by the general trend to avoiding coastal development.

MAP 3. Uncleared land in the area (hatched).



DRAWN: J.L. Montgomerie

Accordingly, the amount of land within the C70 area to be set aside for recreation and for its intrinsic value, as well as for conservation, is far in excess of what would otherwise be the case. Similar large areas of reserved land are expected to be allocated when detailed urban planning extends south into the Shire of Capel with a significant area of land to be incorporated in the proposed Tuart Park.

3.10 CURRENT MANAGEMENT.

The City of Bunbury currently undertakes significant management within the general Maidens area. This includes:

- firebreak maintenance.
- revegetation where erosion is excessive,
- chemical control of garden weeds on the perimeter,
- some fencing to control access,
- formalising walking trails by signs and closure of some existing tracks, and
- controlled burning.

This level of management is probably not adequate to deal with the increasing pressures from urban development and recreational use of the land, and particularly with increasing pressure from fires.

This environmental study has identified areas which may be suitable for urban development both outside the 1000 metre buffer zone and within the 500 to 1000 metre section of the buffer. The proponent considers that 500 metres represents both the physical limit to urban development and the closest likely approach within which unpleasant odours from the No. 2 treatment plant cannot realistically be excluded.

These potential development areas are considered to have comparatively low environmental values and their development for urban and related purposes will cause only a small reduction in the conservation and environmental values of the site and region.

Delineation of the 1000 metre buffer zone has been achieved by determining the likely extent of strongly smelling odours emanating from the sewerage treatment plant. Since a number of variable factors control the creation and movement of odours, the zone itself is somewhat variable, depending on:

- weather patterns,
- topography,
- vegetation,
- treatment plant design,
- treatment plant operation and maintenance,
- wastewater disposal techniques, and
- variation in sewerage quality.

The first three factors are essentially controlled by the site's existing physical and natural environment and, as such, are a separate issue to the next three factors which are primarily related to the economics of plant design and operation.

DISCUSSION OF ALTERNATIVES.

The opportunities and constraints for undertaking the full range of possible activities within the buffer area, from all to no urban development, can be considered under the headings of environmental protection, economic aspects of urban land development, equity considerations for existing residents of south-west Bunbury, and general quality of life issues.

The key issues are:

ENVIRONMENTAL PROTECTION

- Utilisation of land consistent with its environmental values as determined by this study.
- The short and long term benefits to the community of retaining undeveloped bushland areas.
- Access and enjoyment of beach areas in the south west corner of the City of Bunbury.
- Maintenance and enhancement of undeveloped bushland areas.

ECONOMIC DEVELOPMENT OF URBAN LAND

- Efficient use of existing infrastructure.
- The location and convenience of existing facilities such as shops, public transport and other social, welfare and medical services.
- The design of urban subdivision areas and the resulting interaction with retained bushland, along with providing appropriate access to the south Bunbury beach areas.
- Maximising urban development with existing environmental constraints in order to provide an equitable solution that meets community needs for residential land.

OPTION 4. Conserve the entire C70 area and prevent any future development through appropriate zoning.

An assessment of these four options in relation to the four key issues discussed is given here as a matrix of the degree of benefit given:

OPTION	ENVIRONMENTAL BENEFITS	ECONOMIC BENEFITS	EQUITY BENEFITS	QUALITY OF LIFE BENEFITS
1	LOW	HIGH	MEDIUM	MEDIUM
2	MEDIUM TO HIGH	MEDIUM TO HIGH	HIGH	HIGH
3	MEDIUM TO HIGH	MEDIUM	HIGH	HIGH
4	MEDIUM TO HIGH*	LOW	LOW	MEDIUM

* The lower rating base for the City of Bunbury reduces the financial ability of the City to manage all environmental land within its boundaries.

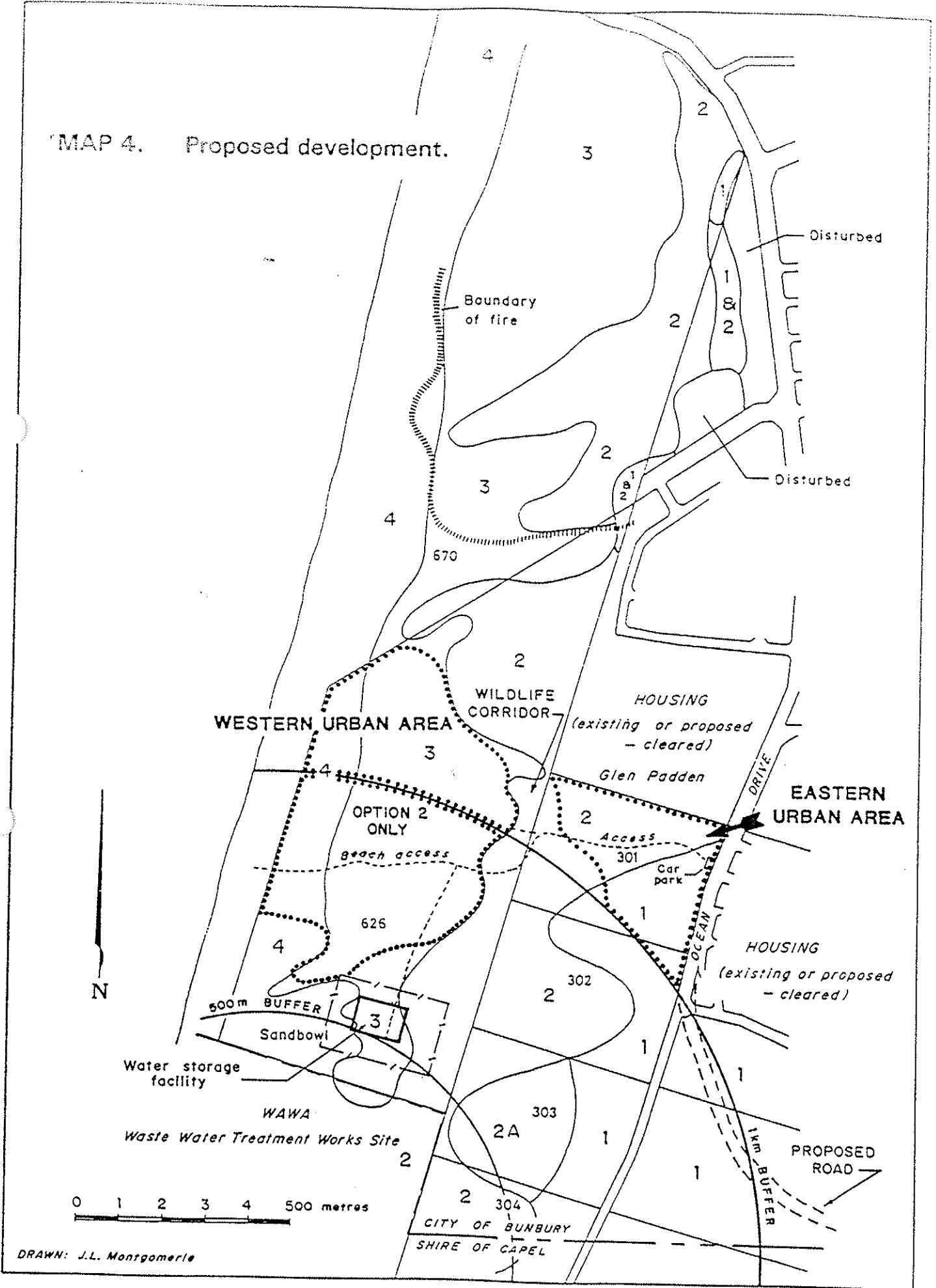
While there is subjectivity inherent in this assessment of benefits, the matrix allows comparison of four complex issues and highlights the most and least advantageous options.

While OPTION 2 is preferred on the basis of the above assessment, its implementation is dependent upon resolving the generation of odours from the No. 2 sewerage treatment plant. This can only be achieved by future successful negotiations between WAWA and the City of Bunbury.

OPTION 3 is the proponent's second preference and, subject to environmental approval being gained, it can proceed immediately with the support of WAWA.

This CER therefore aims at gaining approval for both OPTION 2 and OPTION 3, with implementation of the former option subject to agreement being reached between WAWA and the City of Bunbury over the nature and financing of the No. 2 sewerage treatment plant upgrade.

MAP 4. Proposed development.



WILDLIFE CORRIDOR.

To maintain a wildlife corridor between the Maidens and the southern corridor a strip of vegetation with a minimum width of 100 metres will be left between the two urban areas. Most of this will be Tuart vegetation, and will provide habitat for species requiring the Tuarts.

Where the access road crosses this corridor it will be restricted to two lanes and will have wildlife underpasses constructed beneath it with fences to prevent the fauna entering the road.

EASTERN URBAN AREA.

An area of Tuart on the north-eastern corner adjacent to existing developed areas will be developed on Lot 301 owned by Homeswest. This will be offset by retention of an area of Tuart outside the area considered here on Lot 303 also owned by Homeswest (Map 5). This new area will be part of a Tuart Park which will form part of the conservation corridor linking the Maidens to Manea Park.

This is an area of 8.5 hectares of Tuart vegetation.

Typical views of the two areas proposed for development are given in Plates 1 and 2 (next page).

In total, there will be about 21 hectares, or about 9% of the C70 area, developed for urban use if option 3 proceeds, and some 40 hectares, representing less than 18% of the C70 area, if option 2 proceeds.

WATER SUPPLY FACILITY.

The Bunbury Water Board proposes to build a water supply facility on a high point in the southern end of the area considered here (Map 4). Due to the need for a high point, there is limited scope for moving this facility. The site is 4.5 hectares but only the central 40% will be cleared with the rest remaining as a buffer. The outside walls will also be rehabilitated so that the final cleared area will be 30-35% of the 4.5 hectares. The cleared area will be mainly within vegetation unit 3 with a small area within the edge of the adjacent Tuart unit 2. The buffer will extend into unit 2. The access track will be integrated into other access tracks, and will form part of the firebreak system. This facility will require the clearing of an additional 1.5 hectares of coastal heath.

PROTECTION OF THE MAIDENS.

The Maidens area has been assessed as having high conservation, recreation and other values, and no development is proposed except for appropriate recreation.

Reserve 35020 is seen as part of the Maidens area, but because of its degraded state it is likely to be used more for recreation than conservation.

EAST-WEST CORRIDOR.

A corridor is proposed which links the Maidens, the coastal setback land and the wildlife corridor, the Tuart Park, part of the eastern Endowment Land on Reserve 670, Lot 632 and Manea Park (Map 5).

This corridor will be south of a road required from Ocean Road across to Parade Road to prevent a major road cutting through the Tuart Park south to Capel.

This corridor has clear values for recreation, for aesthetics, and for allowing for the movement of species, and it also protects a complete cross section of the vegetation and landforms from the coast inland to Manea Park.

Management of this corridor will be by the Bunbury City Council and the Shire of Capel, and the implementation requires the agreement of the Shire of Capel and future planning decisions.

MANAGEMENT OF NATURAL LANDS.

There is a clear need for additional management of all the natural lands to stop the present degrading influences and to protect the lands from increasing urban pressure and recreational use. This will require the preparation of appropriate management plans to address fire, weed and feral animal control, access by people, recreational activities, rehabilitation, and related issues.

OTHER USES OF THE LAND.

Within the balance of Lot 626 there would be minor developments such as an upgraded access road to the beach to replace the present informal four wheel drive track, and limited recreational facilities. These will be essentially within vegetation units 3 and 4 and are seen as compatible with the System 6 recommendation.

MANAGEMENT OF THE SANDBOWL.

The possibility of flattening and revegetating the Sandbowl was considered, thus extending southwards the land potentially suitable for urban development. This was rejected because it would impact on existing recreational users and WAWA. There will be active management of the Sandbowl, either to revegetate the area or manage it as a recreational area with the involvement of off-road vehicle users. The future of this land is uncertain, and this is discussed in Section 6.6.

NATIVE TREES WITHIN URBAN AREAS.

Where possible native trees (Banksias, Peppermints and the few Jarrahs) will be retained within urban areas, but this will not include the Tuarts because of the significant safety risk from falling limbs.

6. IMPACTS AND MANAGEMENT.

6.1 ALTERNATIVES.

The alternatives considered have been described in the introduction to the proposed development because it was not possible to explain the proposed development without having considered the alternatives.

The opportunities and constraints presented by the four options can be summarised as

1. Develop the majority of the land in line with previous proposals.

Opportunities: This would meet coastal setback and other planning requirements.

Constraints: This would not achieve the aim of the System 6 recommendation and would not comply with the current 1km buffer around the waste water treatment plant.

2. Develop part of the land in accordance with the conservation values of the land and local and regional planning considerations, and take the opportunity to integrate the development with surrounding areas. This represents both options 2 and 3 and is dependent on the final outcome of the position of the buffer around the wastewater treatment plant.

Opportunities: This achieves a high degree of protection of the conservation value of all the lands in the area, and all conservation and planning goals are met or exceeded.

Constraints: There will be only limited income to the proponents.

6.2 LAND USE.

The proposed development will result in the zoning of small areas as urban residential, while the remainder will be protected with a zoning allowing for conservation and appropriate recreational use. This protection will be extended to all of the coastal vegetation, the corridor extending south from the Maidens as well as the corridor linking these areas to Manea Park.

This zoning meets all of the conservation and planning proposals which impinge on the area, including the System 6 recommendation, the Bunbury Coastal Plan, the Usher, Gelorup and Dalyellup District Structure Plan and the Bunbury-Wellington Region Plan.

This proposal will also see the corridor from the Maidens to Manea Park protected, in accordance with public interest which has been expressed.

6.3 COASTAL SETBACK.

The proposed coastal setback is the existing edge of Lot 626, which is approximately 130 metres from the coast.

A distance of 100 metres separating the seaward edge of permanent vegetation from the seaward edge of urban development would normally be acceptable, based on many factors, as outlined in the draft Bunbury Coastal Plan (DPUD 1993), including the actual topography, vegetation and its conservation value, shoreline stability, dune stability, soil development, existing land use and proposed adjoining uses, current and potential demand for recreational activity, heritage features, access, public attitudes and management objectives.

The topography of the coastal zone is steep with undulating dunes reaching as high as 21 metres, but averaging between 10 and 15 metres in height. As well, the diversity of dune topography is greatest in this 100 metre wide zone, with the dunes generally flattening out further inland.

Vegetation is well established over most sections of the proposed setback zone. It consists of commonly occurring plant species and has only a low intrinsic conservation value, although the function that it performs in stabilising the dunes is of great importance.

The proponents believe that a 130 metre setback zone is more than adequate for the long-term management needs of the zone itself and adjoining urban and associated areas.

In fact, a 100 metre width would be consistent with past studies. The Usher-Stratham Environmental Study (Tingay and Associates 1991) states in Section 3.2.2 that, "development should be separated from the coast by a foreshore reserve designed to protect views of the coast with a set back of 100m from the line of permanent vegetation as a guideline for the width of such a reserve". The Country Coastal Planning Policy No. DC 6.1 (State Planning Commission, undated) suggests that, "a setback of 100 metres should be regarded as a guideline for a wind erosion buffer and for public recreation purposes where landforms are stable. Setbacks will be greater where there is evidence of coastal recession and where landforms are unstable".

Since the landforms are stable in the project area and since there is no evidence of coastal recession, a 130 metre setback distance is easily consistent with the Commission's recommendations.

Further support for the suitability of only a 100 metre setback distance is found in the DPUD report on Coastal Reserves and Building Setbacks within Geographe Bay (DPUD 1992). For most of the 30 kilometre section of coast studied, a setback distance of 100 metres or less is generally favoured. This is in spite of the dune systems within this portion of Geographe Bay coast containing much smaller volumes of sand and hence being a much less effective buffer to erosion during severe storm events.

For example, most of the Shire of Busselton's coastal dune system attains heights of less than 5 metres. By contrast, dunes within this study area average 10 to 15 metres, suggesting a contained volume of sand some 4 to 8 times greater than dunes further south. This much greater volume provides a significant increase in the ability of the dunes to withstand erosive forces before erosion extends inland beyond the inner edge of even the 100 metre setback zone.

Similarly, should there be an increase in water flow laterally, the overall rises in adjacent groundwater or surface water levels would be minimal. The surrounding urban areas are themselves built on highly porous quartz sands and the overall impact of urbanisation on groundwater volumes is predicted to be of no consequence.

Under a worst case scenario, larger volumes of surface water may flow into the wetland chain that runs down the eastern side of the Quindalup dune system. In Perth, urbanisation surrounding formerly seasonally wetlands such as Lake Claremont has turned them into permanently wet areas. However, large areas of bushland will be present within and adjacent to the project area and any rise in surface water levels will only cause the wetland chain to flow a little more strongly over the winter and spring periods.

Impacts on Groundwater Quality.

Urbanisation can have noticeable impacts on the quality of groundwater beneath. Although the proposed urban sites within the project area will be deep sewered, nutrients from lawns and gardens and heavy metals and organic compounds from road surfaces and illegal or accidental sources will reduce groundwater quality.

These impacts are unlikely to be of concern.

Soils that are high in limestone (calcium carbonate) have a moderately high capacity to react with phosphorous present within groundwater and precipitate out insoluble calcium phosphate compounds (for example, see Lance 1977). Studies in Perth (Gerritse *et al.* 1990) have found that, even in long established suburban areas, groundwater quality exceeds drinking water standards.

Processes that operate to maintain high water quality include denitrification and death of pathogens when more than 2 metres of unsaturated sand is present beneath a site. Volatile organics appear to be in diffusional equilibrium with levels in the urban atmosphere, while heavy metals are largely absorbed onto soil particles.

Overall, urban development of the two small sites within the project area is expected to have minimal adverse impacts on groundwater quality.

6.6 RECREATION.

The major existing recreational activities on the land will not be prevented and more appropriate facilities for them will be provided.

The existing beach access will be improved, with a car park and other facilities which provide for access without causing degradation of the area. Degradation is likely to result if the present uncontrolled vehicle use were to increase along the sandy access track and parking area close to the beach.

Passive recreation such as walking and running, nature observation and cycling would be compatible with the conservation purpose of the land, and would be encouraged by providing appropriate paths and access. These paths would encourage access but prevent the physical disturbance of the vegetation.

Both the upgraded beach access and smaller paths could be integrated into the network of firebreaks which will be required, to minimise any additional clearing.

THE SANDBOWL.

The Sandbowl occupies an area of about 6 hectares and is an unvegetated section of the coastal dune system that extends inland from the frontal dune for almost 500 metres. Due to the action of strong westerly winds, it continues to move inland, enveloping native vegetation as it proceeds. Despite its appearance, its rate of progress inland is very slow and likely to be less than one metre per year.

While the leading edge of this moving dune is causing a loss of vegetation types 2 and 3 (scattered tuart woodland and coastal heath), this process of sand being blown from the beach to form large dunes is entirely natural. Without this process having operated in the past, the topographic features of "the Maidens" and much of Bunbury's elevated coastal country would not exist.

At present, the Sandbowl is entirely located within the one kilometre buffer zone that surrounds the WAWA sewerage treatment plant. It is therefore unlikely to be required for any use other than recreation or wastewater infiltration ponds while this buffer zone remains in force.

The Bunbury City Council favours two options at present: either options 3 and 4 in combination or option 5 in isolation.

Options 3 and 4 combined:

On a trial basis, the Council is prepared to adopt options 3 and 4 in combination in an attempt to have those sections of the community using the site accept some responsibility for their usage.

Accordingly, after holding mutually satisfactory negotiations with WAWA, the Council proposes to request the Four Wheel Drive Club of Bunbury and other existing or potential users of the site to be formally and actively involved in management of the Sandbowl. The priorities for management include:

- rationalisation of the existing network of tracks so that only one track leads into the site and one track leads out,
- rehabilitation by appropriate methods of tracks no longer required, as determined by the rationalisation study,
- determining what sections of the Sandbowl are the source of sand that is picked up by the wind and moved inland,
- brush matting, revegetation and the use of other techniques to stabilise those sand source areas.
- fencing off all places where vehicular and pedestrian access is not allowed,
- erection of Council-supplied signs,
- assistance in community education of responsible use of the Sandbowl and other coastal dune areas, and
- assistance in the enforcement of Council regulations controlling vehicle and other use of the Sandbowl through training and the appointment of honorary rangers.

These actions will result in some sections of the Sandbowl being closed to vehicle use and revegetated, other areas will have vehicles confined to small areas only, and the remaining robust sections will remain open to responsible use.

Since this option may have implications for future uses of land adjoining or within several hundred metres of the Sandbowl, this option will require careful investigation before the Council supports it.

As well, the Council is conscious of the recreational usage of the Sandbowl by four-wheel drive users and, since many of these users are residents and ratepayers of Bunbury, it is appropriate that the Council seeks their views before deciding whether to fully accept this option.

The Council has also made commitments including having community-based management committees for open space areas.

6.7 CUMULATIVE IMPACTS.

Most areas of native vegetation in the southern Bunbury area have been cleared for urban development, and the remaining areas are suffering increasing degradation due to too frequent fires, physical disturbance, rubbish dumping, weed invasion, fragmentation, dieback and other influences. The cumulative effect of these impacts is to degrade the conservation values of the land. The only way that these cumulative impacts can be controlled is by firstly designating appropriate conservation areas as part of the planning process, and secondly by actively managing these areas so that the conservation values are maintained.

Bunbury is well supplied with public open space areas, some with native vegetation, but the proposal described here and associated management plans is seen as an excellent opportunity to limit these cumulative impacts in the south Bunbury area and to improve the management of the areas which are to be retained for their natural conservation values.

7. COMMITMENTS.

The commitments made in this CER are listed here and numbered, along with the agency responsible for carrying out the work and the regulatory authority.

1. Commitment: The subdivisions will be deep sewered.
Responsibility for action: Proponents.
Regulatory authority: WAWA.
2. Commitment: A wildlife corridor of 100 metres will be included to provide a continuous habitat with Tuart trees between the Maidens and the Tuart park.
Responsibility for action: Proponents.
Regulatory authority: EPA.
3. Commitment: The areas to be cleared will be compensated for by preserving other areas of native vegetation.
Responsibility for action: Proponents.
Regulatory authority: DPUD.
4. Commitment: The access road to the western urban area will be fenced and have wildlife underpasses.
Responsibility for action: Proponents.
Regulatory authority: EPA.
5. Commitment: The Maidens area will be protected from all development.
Responsibility for action: Proponents.
Regulatory authority: DPUD.
6. Commitment: The areas of native vegetation which will be preserved will form a continuous corridor between the Maidens and Manea Park.
Responsibility for action: Proponents.
Regulatory authority: DPUD.

9. Commitment: There will be rehabilitation of some areas, particularly the disturbed areas within the Maidens and two areas on either end of Lot 632 north of Centenary Avenue. This rehabilitation would be seen as an integral part of the management plan.
- Responsibility for action: Proponents.
- Regulatory authority: EPA.
10. Commitment: Access to native vegetation areas will be controlled by designing the subdivisions so that house lots back onto areas of native vegetation.
- Responsibility for action: Proponents.
- Regulatory authority: Proponents.
11. Commitment: Public access to the beach will be upgraded and suitable facilities will be constructed to allow appropriate use of the area.
- Responsibility for action: Proponents.
- Regulatory authority: DPUD.
12. Commitment: Appropriate recreational use of the areas of native vegetation will be promoted and suitable facilities will be developed.
- Responsibility for action: Proponents.
- Regulatory authority: Proponents.
13. Commitment: The existing appropriate recreational use of the Sandbowl area will be encouraged if users become involved in management of the site and a suitable agreement can be reached with the Shire of Capel.
- Responsibility for action: Proponents.
- Regulatory authority: Proponents.
14. Commitment: Native trees will be retained within the urban areas as far as possible, except for Tuarts because of the safety risk.
- Responsibility for action: Proponents.
- Regulatory authority: Proponents.

8. REFERENCES.

- Beard, J.S. and B. S. Sprenger (1984). Geographical data from the Vegetation Survey of Western Australia. Occasional Paper No. 2. Vegmap Publications, Perth
- Bennett, E.M. (1991). Common and Aboriginal names of Western Australian plant species. Wildflower Society of Western Australia, Eastern Hills Branch, Boya.
- Commander, D.P. (1984). Bunbury shallow-drilling groundwater investigation. Report 12, Professional papers for 1982, Geological Survey of W.A.
- Chilcott, C. (1992). Tuart (*Eucalyptus gomphocephala* DC.) decline in remnant bushland of the Kwinana area. Unpublished Honours Degree Thesis, Murdoch University, November 1992.
- Cole, J. and T. Gepp (1992). Results of a residential survey of recreation in Bunbury's coastal zone. Technical Report No 4, City of Bunbury Coastal Management Plan. Department of Planning and Urban Development, Perth.
- DCE (1980). System 6, Atlas of Natural Resources. Department of Conservation and Environment, Perth.
- DPUD (1992). Recommendations for Coastal Reserves, Building Setbacks for Development Controls. Department of Planning and Urban Development, Perth, with the assistance of the Shire of Busselton.
- DPUD (1993). Bunbury Coastal Plan (Draft). Department of Planning and Urban Development, Perth.
- DPUD (1993a). Bunbury-Wellington Region Plan. Department of Planning and Urban Development, Perth.
- Environmental Protection Authority 1983 Conservation reserves for Western Australia. The Darling System - System 6. Part 1: General principles and recommendations. Department of Conservation and Environment, Perth.
- Environmental Protection Authority 1983 Conservation reserves for Western Australia. The Darling System, System 6. Part 2: Recommendations for specific localities. Department of Conservation and Environment, Perth.

Tingay, A. & Associates (1991). Working Paper No. 4 Usher-Stratham Environmental Study. In Bunbury - Wellington Regional Planning Study. Department of Planning and Urban Development, Bunbury.

Trudgen, M.E. (1984). Flora and vegetation of the Leschenault Peninsula. Department of Conservation and Environment, Perth.

Trudgen, M.E. (1991). A flora and vegetation survey of the coast of the City of Mandurah. Department of Planning and Urban Development, Perth.

Wharton, P.H. (1980). The geology and hydrogeology of the Picton borehole line. Geological Survey of W.A. Annual Report, 1979.

Wilson, S.K. and D.G. Knowles (1988). Australia's Reptiles. Collins, Sydney.

PROPOSED STRUCTURE PLAN, REZONING AND SUBDIVISION FOR
BUNBURY ENDOWMENT LAND - PART LOT 670 GEOGRAPHE WAY,
WEST WITHERS, CITY OF BUNBURY

CONSULTATIVE ENVIRONMENTAL REVIEW
GUIDELINES

Overview

In Western Australia all environmental reviews are about protecting the environment. The fundamental requirement is for the proponent to describe what they propose to do, to discuss the potential environmental impacts of the proposal, and then to describe how those environmental impacts are going to be managed so that the environment is protected.

If the proponent can demonstrate that the environment will be protected then the proposal will be found environmentally acceptable; if the proponent cannot show that the environment would be protected then the Environmental Protection Authority (EPA) would recommend against the proposal.

Throughout the process it is the aim of the EPA to advise and assist the proponent to improve or modify the proposal in such a way that the environment is protected. Nonetheless, the environmental review in Western Australia is proponent driven, and it is up to the proponent to identify the potential environmental impacts and design and implement proposals which protect the environment.

For this proposal, protecting the environment means that the natural and social values associated with the System 6 recommendation for the 'South Bunbury Coastal Land' (Recommendation C70) are protected. Where they cannot be protected, proposals to mitigate the impacts are required.

Purpose of a Consultative Environmental Review

The primary function of a CER is to provide the basis for the EPA to provide advice to Government on protecting the environment. An additional function is to communicate clearly with the public so that the EPA can obtain informed public comment. As such, environmental impact assessment is quite deliberately a public process. The CER should set out the series of decisions taken to develop this proposal at this place and time and why.

Objectives of the review

The Consultative Environmental Review should have the following objectives:

- to place this project in the context of the regional environment and the progressive development of resources in the region, including the cumulative impact of this development;
- to explain the issues and decisions which led to the choice of this project at this place at this time;
- to set out the environmental impacts that the project may have; and
- for each impact, to describe any environmental management steps the proponent believes would avoid, mitigate or ameliorate that impact.

The CER should focus on the major issues for the area and anticipate the questions that members of the public will raise. Data describing the environment should be directly related to the discussion of the potential impacts of the proposal. Both should then relate directly to the

concerns are dealt with via other departments or procedures, outside the EPA process, these can be noted and referenced here.

Detailed list of environmental commitments

The commitments being made by the proponent to protect the environment should be clearly defined and separately listed. Where an environmental problem has the potential to occur, there should be a commitment to rectify it. They should be numbered and take the form of:

- a who will do the work;
 - b what the work is;
 - c when the work will be carried out; and
 - d to whose satisfaction the work will be carried out.
- All actionable and auditable commitments made in the body of the document should be numbered and summarised in this list.

Species	Common Name	Vegetation			
		1	2	3	4
NON FLOWERING VASCULAR PLANTS					
ZAMIACEAE					
Macrozamia riedlei	Zamia	+			
FLOWERING PLANTS					
AIZOACEAE					
Carpobrotus virescens	Coastal Pigface	+	+	+	+
Tetragonia decumbens	Sea Spinach				+
AMARANTHACEAE					
Ptilotus stirlingii		+			
ANTHERICACEAE					
Arnocrinum preissii		+			
Corynotheca micrantha		+	+		
Sowerbaea laxiflora	Purple Tassels	+			
Thysanotus arenarius	A Fringe Lily	+	+		
Tricoryne elatior	Yellow Autumn Lily	+	+	+	
APIACEAE <i>Trachymene pilosa</i> / <i>Homaloscradium homaloc</i> /					
Eryngium rostratum	Blue Devil	+	+		
APOCYNACEAE					
Alyxia buxifolia	Camel Bush		+	+	
ASPHODELACEAE					
*Trachyandra divaricata	Onion Weed		+	+	
ASTERACEAE					
*Arctotheca populifolia	Dune Capeweed				+
Asteridea pulverulenta	Common Bristle Daisy	+	+	+	
*Carduus tenuiflorus	Slender thistle	+			
Helichrysum cordatum	Tangle Daisy	+			
*Hypochaeris glabra	Smooth Catsear	+	+		
Olearia axillaris	Coastal Daisybush	+	+	+	+
Senecio lautus	Coastal Groundsel		+	+	
*Sonchus oleracea	Common Sowthistle	+	+		
BRASSICACEAE					
*Cakile maritima	Sea Rocket				+
CARYOPHYLLACEAE					
*Petrorhagia velutina	Velvet Pink	+	+		

Species	Common Name	Vegetation			
		1	2	3	4
GERANIACEAE					
Geranium solanderi		+	+		
*Pelargonium capitatum	Rose Pelargonium	+		+	+
Pelargonium littorale		+		+	
GOODENIACEAE					
Scaevola anchusifolia			+	+	
Scaevola crassifolia		+		+	+
Scaevola nitida		+		+	
HAEMODORACEAE					
Conostylis aculeata	Prickly Conostylis	+	+	+	
IRIDACEA					
*Romulea rosea	Guildford Grass		+		
LAMIACEAE					
Hemiandra pungens	Snake Bush		+	+	+
LAURACEAE					
Cassytha racemosa	Dodder Laurel	+	+	+	+
LOBELIACEAE					
Lobelia tenuior	Slender Lobelia	+	+		
LOGANIACEAE					
Logania vaginalis	White Spray		+		
LORANTHACEAE					
Nuytsia floribunda	Christmas Tree		+		
MIMOSACEAE					
Acacia cochlearis	Rigid Wattle	+	+	+	+
Acacia lasiocarpa	Panjang		+		
Acacia pulchella	Prickly Moses	+			
Acacia saligna	Orange Wattle	+	+	+	
Acacia willdenowiana	Grass Wattle	+			
MYOPORACEAE					
Eremophila glabra	Tar Bush	+			
Myoporum caprarioides	Slender Myoporum		+		
MYRTACEAE					
Agonis flexuosa	Peppermint	+	+	+	+
Eucalyptus gomphocephala	Tuart	+	+		
Eucalyptus marginata	Jarra	+			

Species	Common Name	Vegetation			
		1	2	3	4
RESTIONACEAE					
<i>Loxocarya flexuosa</i>			+		
RHAMNACEAE					
<i>Spyridium globulosum</i>		+	+	+	+
RUBIACEAE					
<i>Opercularia hispidula</i>	Hispid Stinkweed		+		
<i>Opercularia vaginata</i>	Dog Weed	+	+	+	
RUTACEAE					
<i>Diplolaena dampieri</i>	Beach Rose	+	+	+	+
SANTALACEAE					
<i>Exocarpos sparteus</i>	Broom Ballart	+	+	+	+
<i>Santalum acuminatum</i>	Quandong	+		+	+
SAPINDACEAE					
<i>Dodonaea aptera</i>			+		
SCROPHULARIACEAE					
* <i>Bellardia trixago</i>	Bellardia		+		
* <i>Dischisma arenarium</i>			+		
SOLANACEAE					
<i>Anthocercis littorea</i>	Yellow Tailflower		+		
STERCULIACEAE					
<i>Lasiopetalum membranaceum</i>		+			
<i>Thomasia cognata</i>		+	+		
STYLIDIACEAE					
<i>Stylidium junceum</i>	Reed Triggerplant	+			
VIOLACEAE					
<i>Hybanthus calycinus</i>	Native Violet	+	+		
XANTHORRHOEACEAE					
<i>Xanthorrhoea preissii</i>	Blackboy	+			
<i>Xanthorrhoea brunonis</i>		+			

HABITATS	1	2	3	4
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AMPHIBIAN SPECIES

LEPTODACTYLIDAE-Frogs				
<i>Crinia georgiana</i>	X	X	X	
<i>C. glauerti</i>		X		
<i>C. insignifera</i>	X	X	X	
<i>Heleioporus eyrei</i>	X	X	X	
<i>H. psammophilus</i>	X	X	X	
<i>Limnodynastes dorsalis</i>	X	X	X	X
<i>Pseudophryne guentheri</i>	X	X	X	
HYLIDAE				
<i>Litoria adelaidensis</i>	X	X	X	X
<i>L. moorei</i>	X	X	X	X

REPTILE SPECIES

GEKKONIDAE-Geckos				
<i>Phyllodactylus marmoratus</i>	X	F	F	
PYGOPODIDAE-Legless Lizards				
<i>Aprasia repens</i>	X	X	X	X
<i>Lialis burtonis</i>	X	X	F	X
<i>Pygopus lepidopodus</i>	X	X	X	X
AGAMIDAE-Dragon Lizards				
<i>Pogona m. minor</i>	X	X	X	X
SCINCIDAE-Skinks				
<i>Bassiana trilineata</i>	X	F	X	
<i>Cryptoblepharus plagiocephalus</i>	X	F	F	
<i>Ctenotus fallens</i>	X	F	F	X
<i>C. impar</i>	X	X	X	
<i>Egernia kingii</i>	X	X	X	
<i>E. napoleonis</i>	X	X	X	
<i>Hemiernis quadrilineata</i>	X	F	F	X
<i>Lerista distinguenda/elegans</i>	F	F	X	X
<i>Menetia greyii</i>	X	X	X	X
<i>Morethia lineocellata</i>	F	F	F	X
<i>M. obscura</i>	X	X	X	X
<i>Sphenomorphus australis</i>	X	X		
<i>Tiliqua r. rugosa</i>	X	X	F	X

HABITATS	1	2	3	4
BIRD SPECIES				
ACCIPITRIDAE				
Elanus notatus, Black-shouldered Kite		X	X	X
Lophoictinia isura, Square-tailed Kite	X	X	X	X
Haliastur sphenurus, Whistling Kite	X	X	X	X
Accipiter fasciatus, Brown Goshawk	X	X	X	X
A. cirrhocephalus, Collared Sparrowhawk	X	X	X	X
Aquila audax, Wedge-tailed Eagle	X	X	X	X
Hieraetus morphnoides, Little Eagle	X	X	X	X
Circus assimilis, Spotted Harrier	X	X	X	X
C. aeruginosus, Marsh Harrier	X	X	X	X
FALCONIDAE				
Falco peregrinus, Peregrine Falcon	X	X	X	X
F. longipennis, Australian Hobby	X	X	X	X
F. berigora, Brown Falcon	X	X	X	X
F. cenchroides, Australian Kestrel		X	X	X
PHASIANIDAE				
Coturnix novaezealandiae, Stubble Quail		X	X	X
TURNICIDAE				
Turnix varia, Painted Button-quail	X	X		
COLUMBIDAE				
Streptopelia senegalensis, Laughing Turtle-Dove*		X	X	
Phaps chalcoptera, Common Bronzewing*	X	X	X	
CACATUIDAE				
Calyptorhynchus baudinii, Baudin's Black-Cockatoo	X	X		
C. latirostris, Carnaby's Black-Cockatoo	X	X		
Cacatua roseicapilla, Galah		X	X	
LORIIDAE				
Glossopsitta porphyrocephala, Purple-crowned Lorikeet	X	X		

HABITATS		1	2	3	4
ALCEDINIDAE					
Dacelo novaeguineae,					
	Laughing Kookaburra*	X	X	X	
Halcyon sancta,	Sacred Kingfisher	X	X		
MEROPIDAE					
Merops ornatus,	Rainbow Bee-eater	X	X	X	
HIRUNDINIDAE					
Hirundo neoxena,	Welcome Swallow	X	X	X	X
Cecropis nigricans,	Tree Martin	X	X		
MOTACILLIDAE					
Anthus novaeseelandiae,	Richard's Pipit		X	X	X
CAMPEPHAGIDAE					
Coracina novaehollandiae,	Black-faced Cuckoo-shrike	X	X	X	
Lalage sueurii,	White-winged Triller	X	X		
MUSCICAPIDAE					
Petroica multicolor,	Scarlet Robin	X	X		
Eopsaltria georgiana,	White-breasted Robin		X		
E. griseogularis,	Western Yellow Robin	X	X		
Pachycephala pectoralis,	Golden Whistler	X	X	X	
P. rufiventris,	Rufous Whistler	X	X	X	
Colluricincla harmonica,	Grey Shrike-thrush	X	X		
Rhipidura fuliginosa,	Grey Fantail	X	X		
R. leucophrys,	Willie Wagtail	X	X	X	X
SYLVIIDAE					
Cinclorhamphus mathewsi,	Rufous Songlark	X	X		

HABITATS		1	2	3	4
VESPERTILIONIDAE-Bats					
Nyctophilus major,	Greater Long-eared Bat	X	X	X	X
N. gouldi,	Gould's Long-eared Bat	X	X	X	X
N. geoffroyi,	Lesser Long-eared Bat	X	X	X	X
Chalinolobus gouldii,	Gould's Wattled Bat	X	X	X	X
C. morio,	Chocolate Wattled Bat	X	X	X	X
Falsistrellus mackenziei,	Great Pipistrelle	X	X	X	X
Eptesicus regulus,	King River Eptesicus	X	X	X	X
MURIDAE-Native Rodents					
Rattus fuscipes,	Bush Rat	X	X	X	
INTRODUCTED MAMMALS					
MURIDAE					
R. rattus,	Black Rat*		X		
Mus musculus,	House Mouse*	X	X	X	X
LEPORIDAE					
Oryctolagus cuniculus,	Rabbit*	X	X	X	X
CANIDAE					
Vulpes vulpes,	Fox*	X	X	X	X
FELIDAE					
Felis catus,	Feral Cat*	X	X	X	X

HABITATS	1	2	3	4
DICAEIDAE				
Dicaeum hirundinaceum, Mistletoebird	X	X		
PARDALOTIDAE				
Pardalotus punctatus, Spotted Pardalote	X	X	X	
P. striatus, Striated Pardalote	X	X	X	
ZOSTEROPIDAE				
Zosterops lateralis, Silvereye	X	X	X	X
GRALLINIDAE				
Grallina cyanoleuca, Australian Magpie-lark	X	X	X	
ARTAMIDAE				
Artamus personatus, Masked Woodswallow	X	X	X	X
A. cinereus, Black-faced Woodswallow	X	X	X	X
A. cyanopterus, Dusky Woodswallow	X	X	X	X
CRACTICIDAE				
Cracticus torquatus, Grey Butcherbird	X	X	X	
Gymnorhina tibicen, Australian Magpie	X	X	X	
Strepera versicolor, Grey Currawong	X	X		
CORVIDAE				
Corvus coronoides, Australian Raven	X	X	X	X



C70 SOUTH BUNBURY COASTAL LAND



C70 SOUTH BUNBURY COASTAL LAND



C70

C70

SOUTH BUNBURY
COASTAL LAND
'The Maidens'



C70

**Development of part of System Six C70 south of
the Maidens. Bunbury endowment land Part of Lot
626, and Parts of Lots 301 - 4**

**City of Bunbury
Homeswest**

**Report and recommendations
of the Environmental Protection Authority**

**Full document
available
on request**

**Environmental Protection Authority
Perth, Western Australia
Bulletin 789
September 1995**

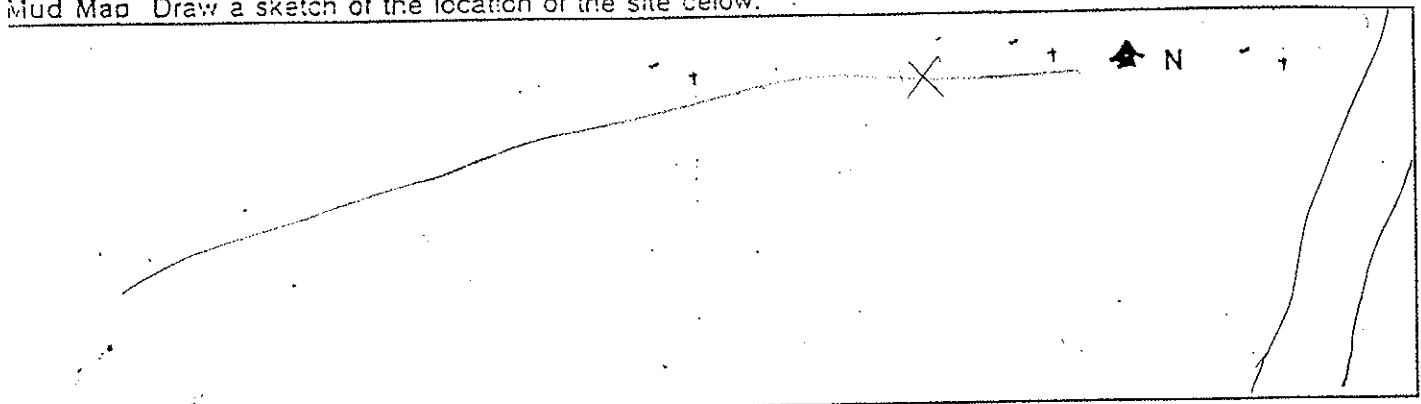
BUSHLAND PLANT SURVEY RECORDING SHEET 1- use pencil only

BUSHLAND AREA MAIDEN SITE NUMBER G No 1 = GMAID 01
 DATE TRIP 14/10/95 RECORDERS ALICE/BRAD/JENNIFER/JILL/CONSTANCE
 DATE TRIP _____ RECORDERS _____ GREG
 DATE TRIP _____ RECORDERS _____
 BOTANIST GREG

From 'Bushland Plant Survey' written by B. Keighery (1994) and published by the Wildflower Society of WA (Inc.), PO Box 2 Nedlands WA 6008.

1. LOCATION of the QUADRAT

Mud Map Draw a sketch of the location of the site below.

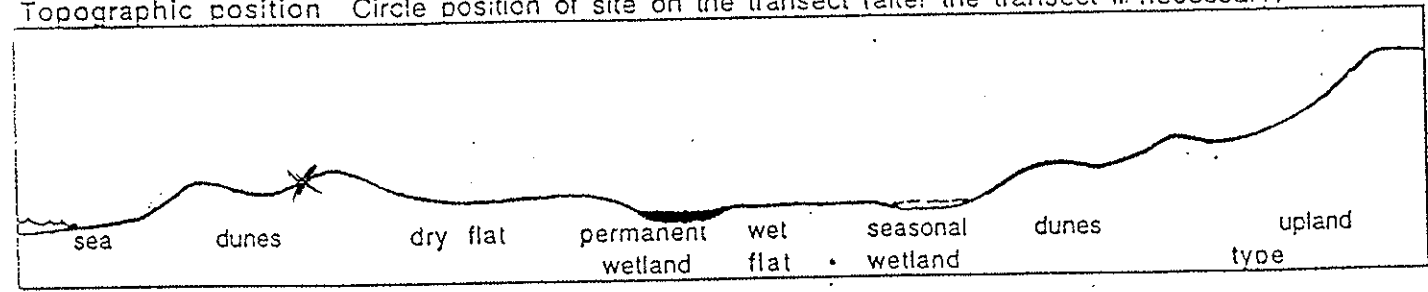


Road Location OCEAN DRIVE

Geographic Location Latitude _____ S Longitude _____ E Altitude _____
 Reference Map _____

Photograph _____ Photocraher's Name GREG Photo No _____

Topographic position Circle position of site on the transect (alter the transect if necessary)



2. SITE DATA Circle the correct response.

Slope flat gentle steep Aspect N NE E SE S SW W NW

Surface Soil SAND Colour RED/BROWN
 Exposed rock — type _____ % surface _____

Sub-surface Soil RED/BROWN SAND Colour _____
 Rock _____ type _____ depth to rock _____

Drainage well mod poor depth water _____ cm Wet all year winter/spring

Litter LOTS % cover > 70 Bare Ground % cover < 2
 Depth cm 3-5cm






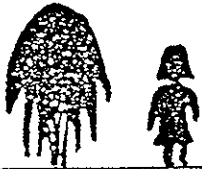







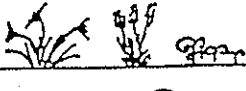
BUSHLAND PLANT SURVEY RECORDING SHEET 2 (Muir)- use pencil only

From 'Bushland Plant Survey' written by B. Keighery (1994) and published by the Wildflower Society of WA Inc., PO Box 64 Nedlands WA 6008.

3. VEGETATION STRUCTURE AND COVER

For each layer record - appropriate life form, cover class (see below), and dominant species in each layer.

Cover Class 2-10% 10-30% 30 - 70% over 70%

	TREES			MALLEES	
	over 30m	15 - 30m	5 - 15m under 5m	over 8m	under 8m
LIFE FORM		Woodland 	Low woodland B 		
COVER CLASS (%)		10-30	10-30		
DOMINANT SPECIES		Tuas ✓	Agonis flex		
	SHRUBS			SHRUBS	
	over 2m	2m - 1.5m	1.5 - 1m	1 - 0.5m	under 0.5m
LIFE FORM		Low scrub A 			Low Heath D 
COVER CLASS (%)		10-30			30-70
DOMINANT SPECIES		Spyridium globulosum			Synaphea sp H. Abbebia Hypericoides
	GRASSES	HERBS	SEDGES	over 0.5m	
				under 0.5m	
LIFE FORM	Open grass 	Herbs 		Open low sedges 	
COVER CLASS (%)	10-30	30-50		10-30	
DOMINANT SPECIES		Mixed		Lepido. species Sche. grand	

4. VEGETATION CONDITION

1	'PRISTINE'	COMMENTS
2	EXCELLENT	
3	VERY GOOD	
4	GOOD ✓	
5	DEGRADED	

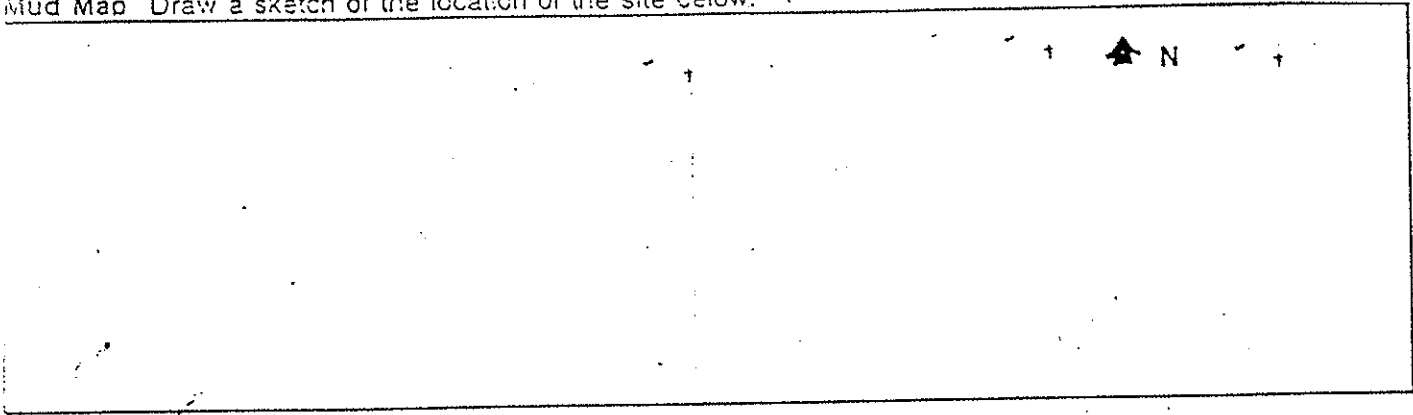
BUSHLAND PLANT SURVEY RECORDING SHEET 1- use pencil only

BUSHLAND AREA Maidens 2 SITE NUMBER [92] GMAID 02
 DATE TRIP 14/10/1995 RECORDERS GK/GP/AH/RG/Anne
 DATE TRIP _____ RECORDERS _____
 DATE TRIP _____ RECORDERS _____
 BOTANIST GREG

From 'Bushland Plant Survey' written by B. Keighery (1994) and published by the Wildflower Society of WA (Inc.), PO Box 2, Nedlands WA 6008.

1. LOCATION of the QUADRAT

Mud Map Draw a sketch of the location of the site below.



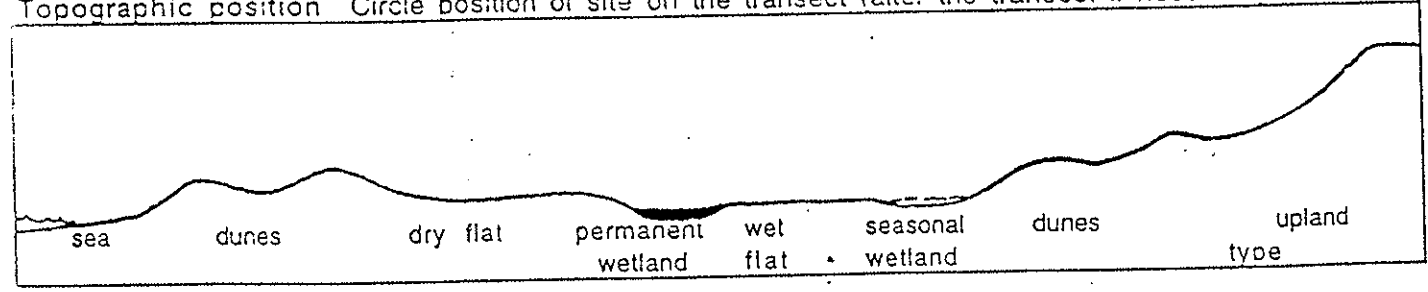
Road Location _____

Geographic Location Latitude _____ S Longitude _____ E Altitude _____

Reference Map _____

Photograph _____ Photographer's Name _____ Photo No _____

Topographic position Circle position of site on the transect (alter the transect if necessary)



2. SITE DATA Circle the correct response.

Slope flat gentle steep Aspect N NE E SE S SW W NW

Surface Soil SAND Colour DARK GREY ORGANIC
 Exposed rock type NO % surface _____

Sub-surface Soil STILL SAND Colour DARK ORGANIC
 Rock type - depth to rock ?

Drainage well mod poor depth water _____ cm Wet all year winter/spring

Litter 98% % cover _____ Bare Ground 2% % cover _____
 Depth 1-2 cm














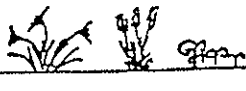
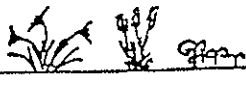
BUSHLAND PLANT SURVEY RECORDING SHEET 2 (Muir)- use pencil only

From 'Bushtand Plant Survey' written by B. Keighery (1994) and published by the Wildflower Society of WA Inc., PO Box 64 Nedlands WA 6008.

3. VEGETATION STRUCTURE AND COVER

For each layer record - appropriate life form, cover class (see below), and dominant species in each layer.

Cover Class 2-10% 10-30% 30 - 70% over 70%

LIFE FORM	TREES			MALLEES	
	over 30m	15 - 30m	5 - 15m under 5m	over 8m	under 8m
					
		2 - 10	10 - 30		
		TRART	AGONIS		
LIFE FORM	SHRUBS			SHRUBS	
	over 2m	2m - 1.5m	1.5 - 1m	1 - 0.5m	under 0.5m
					
	2 - 10	-			- 2%
	TEMPLETONIA RET				
	SPURIDIUM GLOB.				
LIFE FORM	GRASSES	HERBS	SEDGES	over 0.5m	under 0.5m
					
	2-10	10-30 mixed.	30-70 lepid glod.		

4. VEGETATION CONDITION

1	'PRISTINE'		COMMENTS Rabbit diggings ? bandicoots
2	EXCELLENT	✓	
3	VERY GOOD		
4	GOOD		
5	DEGRADED		

GMAID 9

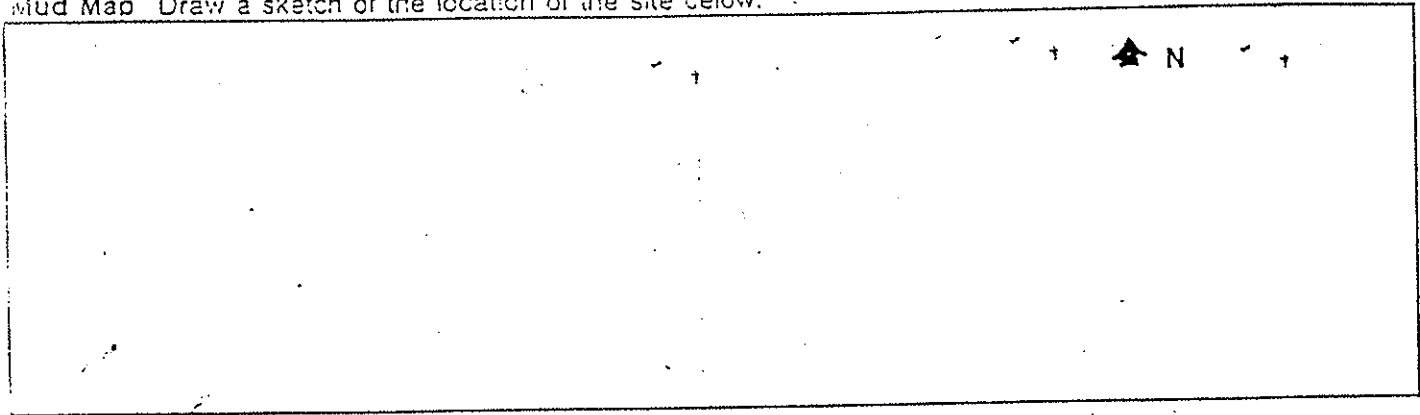
BUSHLAND PLANT SURVEY RECORDING SHEET 1- use pencil only

BUSHLAND AREA MAIDEN 3 SITE NUMBER G No 3
 DATE TRIP 14/10/95 RECORDERS JILL/JENNIFER/BRAD/ALICE/CONSTANCE
 DATE TRIP _____ RECORDERS _____
 DATE TRIP _____ RECORDERS _____
 BOTANIST ARIEG K

From 'Bushland Plant Survey' written by B. Keighery (1994) and published by the Wildflower Society of WA (Inc.), PO Box 2 Nedlands WA 6008.

1. LOCATION of the QUADRAT

Mud Map Draw a sketch of the location of the site below.

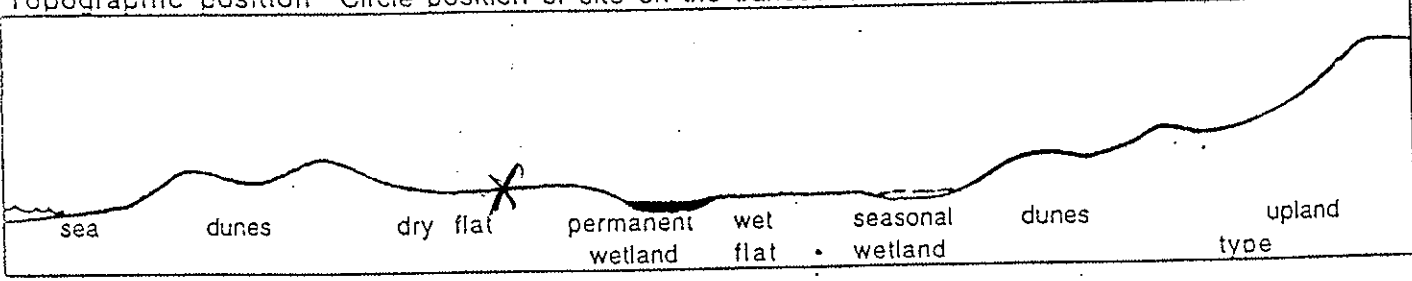


Road Location _____

Geographic Location Latitude _____ S Longitude _____ E Altitude _____
 Reference Map _____

Photograph _____ Photocracher's Name _____ Photo No _____

Topographic position Circle position of site on the transect (alter the transect if necessary)



2. SITE DATA Circle the correct response.

Slope flat gentle steep Aspect N NE E SE S SW W NW

Surface Soil SAND Colour RED/BROWN
 Exposed rock _____ type _____ % surface _____

Sub-surface Soil SAND Colour RED/BROWN
 Rock _____ type _____ depth to rock _____

Drainage well mod poor depth water _____ cm Wet all year winter/spring

Litter Over 70 % cover THICK Bare Ground NIL % cover _____
 Depth _____ cm

2-5cm















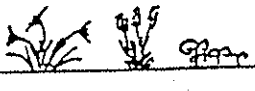
BUSHLAND PLANT SURVEY RECORDING SHEET 2 (Muir)- use pencil only

3. VEGETATION STRUCTURE AND COVER

From 'Bushtand Plant Survey' written by B. Keighery (1994) and published by the Wildflower Society of WA Inc., PO Box 64 Nedlands WA 6008.

For each layer record - appropriate life form, cover class (see below), and dominant species in each layer.

Cover Class 2-10% 10-30% 30-70% over 70%

LIFE FORM	TREES			MALEES	
	over 30m	15-30m	5-15m under 5m	over 8m	under 8m
					
COVER CLASS (%)		10-30	10-30		
DOMINANT SPECIES		JARRAH	AGONIS FLEX		
LIFE FORM	SHRUBS			SHRUBS	
	over 2m	2m-1.5m	1.5-1m	1-0.5m	under 0.5m
					
COVER CLASS (%)		10-30		30-70	
DOMINANT SPECIES		ACACIA ? COCCALIAS		HIBBETIA HYDOR ZAMIA	
LIFE FORM	GRASSES	HERBS	SEDGES	over 0.5m	
				under 0.5m	
					
COVER CLASS (%)	30-70	10-30		2-10	
DOMINANT SPECIES	BRIZA MAY	clover +		PATTERSONIA	

4. VEGETATION CONDITION

1	'PRISTINE'	COMMENTS
2	EXCELLENT	
3	VERY GOOD	
4	GOOD	
5	DEGRADED	

BUSHLAND PLANT SURVEY RECORDING SHEET 3 - use pencil only

5. SPECIES PRESENCE

Label each plant with plants number, site code, date and plant's name or working name if required

SITE No 93 MAIDENS
Date 14-10-95

Record on Sheet

- Column 1 plant name
- Column 2 plant number
- Column 3 flowering time- TICK if species flowering
- Column 4 identification check

From 'Bushland Plant Survey' written by B. Keighery (1994) and published by the Wildflower Society of WA (Inc.), PO Box 64 Nedlands WA 6008.

TREES	No	FI	ID	SHRUBS (cont.)	No	FI	ID	HERBS (cont.)	No	FI	ID
(JARRAH) Euc. marg.	1							Monarda moricans	31		✓
AGONIS FLEX	2							Orthocentris arenaria	32		✓ RH
								Conostylis aculeata	33		X
								Homaledia Rosoa	34		✓ RH
								Caesia parviflora	35	✓	✓ RH
								Orthrosanthus laxus	36	✓	✓ RH
MALLEES								Sonchus oleraceus	37		✓ RH
				GRASSES				Doxalis Poserina	43		✓ RH
				Styphna Stipa flavescens	18	✓	RH	Lagenaria huegelii	44		✓
				Microbera stipoides	41	✓	RH	Orthocentris (2) (See 37)	45		
SHRUBS				Poa poliformis	42	✓	RH	Orthocentris parviflora	46		✓ RH
(ZAMIA) Mac. riedtii	3			Briaza maxima	26	✓	RH	SEDGES			
ACACIA COCCLEARUS	4	✓	RH	Briaza minor	38	✓	RH	Lepidosperma Agrostoides	13	✓	✓ RH
PHILIPARIA CALYCINUS	5	✓	✓					Luzula meridionalis	16	✓	✓ RH
HIBBERTIA Adinopoda	6	✓	✓	H. hypericoides				Schoenus grandiflorus	17		✓ RH
DAVESIA DIVERGATA	7	✓	X RH								
PERSOONIA saccata	8	✓	✓ RH	HERBS							
Hybanthus Calycinus	10	✓	✓ RH	Eryngium Pinnatifidum	9	✓	✓	ssp pinnat RH			
Hardyera erata	11	✓	✓ RH	Caladonia pallidosa	12	✓	✓ RH				
Horea triskernaria	19			Arthropodium Capillipes	14		✓ RH				
Acacia pulchella	22			Petrophaca Velutina	15		✓ RH				
Synaphea spinulosa	23			Caladonia flava	20		✓ RH				
Rhabodia baccata	39			Arastracium Scabrum	21		✓ RH				
Bossia eriocarpa	40			Asteridia pulverulenta	24	✓	✓ RH				
				Dancoa glochidiatus	25		✓ RH				
				Sowerbaea laxiflora	27	✓	✓ RH				
				Geranium retrorsum	28		✓ RH				
				Pterostylis vittata	29		✓				
				Tricholium canpestre	30	✓	✓ RH				

Adjacent

- o (Frustr) Euc. gomp.
- o Petalarganum littoralis ✓ RH

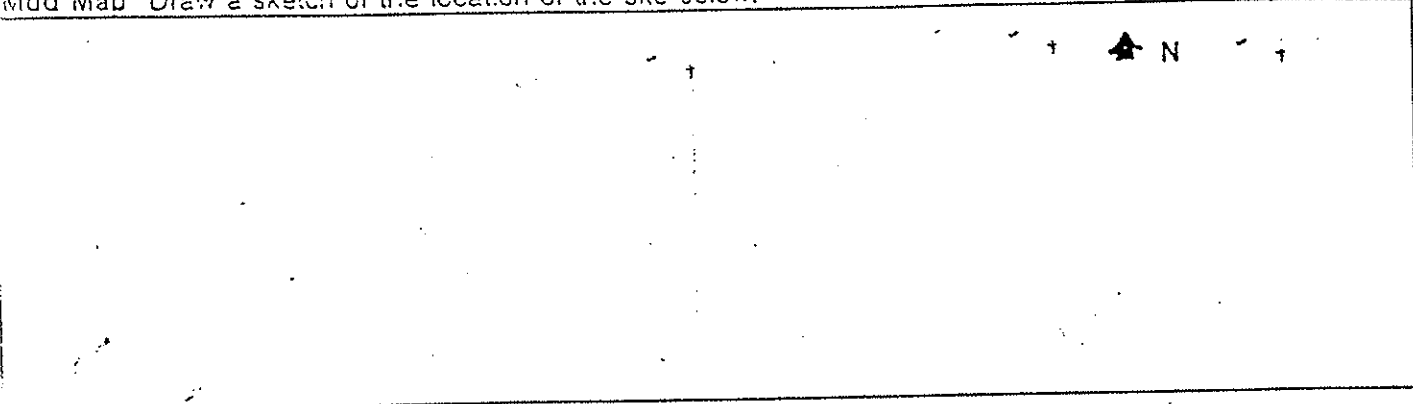
BUSHLAND PLANT SURVEY RECORDING SHEET 1- use pencil only

BUSHLAND AREA Maidens SITE NUMBER 94 = GMAID 04
 DATE TRIP 14.10.95 RECORDERS GK/GP/AH/RG/ANNE
 DATE TRIP _____ RECORDERS _____
 DATE TRIP _____ RECORDERS _____
 BOTANIST GREG

From 'Bushland Plant Survey' written by B. Keighery (1994) and published by the Wildflower Society of WA (Inc.), PO Box 2 Nedlands WA 6008.

1. LOCATION of the QUADRAT

Mud Map Draw a sketch of the location of the site below.

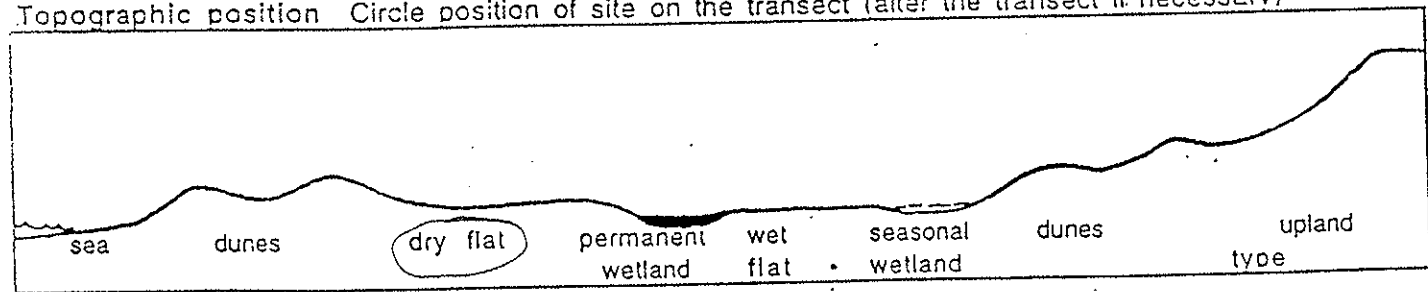


Road Location _____

Geographic Location Latitude _____ S Longitude _____ E Altitude _____
 Reference Map _____

Photograph _____ Photocracher's Name GREG Photo No _____

Topographic position Circle position of site on the transect (alter the transect if necessary)



2. SITE DATA Circle the correct response.

Slope	<input checked="" type="radio"/> flat	<input type="radio"/> gentle	<input type="radio"/> steep	Aspect	<input type="radio"/> N	<input type="radio"/> NE	<input type="radio"/> E	<input type="radio"/> SE	<input type="radio"/> S	<input checked="" type="radio"/> SW	<input type="radio"/> W	<input type="radio"/> NW	
Surface Soil	<u>Yellow sand</u>						Colour	<u>Yellow - darker</u>					
Exposed rock	type _____						% surface	_____					
Sub-surface Soil	<u>sand</u>						Colour	<u>Yellow</u>					
Rock	type _____						depth to rock	_____					
Drainage	<input checked="" type="radio"/> well	<input type="radio"/> mod	<input type="radio"/> poor	depth water	cm _____	Wet	<input type="radio"/> all year	<input type="radio"/> winter/spring	_____				
Litter	Depth	<u>90</u>	% cover	_____		Bare Ground	<u>5</u>	% cover	_____				
		<u>1</u>	cm	_____					_____				



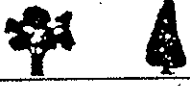



BUSHLAND PLANT SURVEY RECORDING SHEET 2 (Muir)- use pencil only







From 'Bushtand Plant Survey' written by B. Keighery (1994) and published by the Wildflower Society of WA Inc., PO Box 64 Nedlands WA 6008.




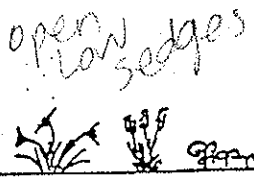
3. VEGETATION STRUCTURE AND COVER

For each layer record - appropriate life form, cover class (see below), and dominant species in each layer.

Cover Class 2-10% 10-30% 30 - 70% over 70%

LIFE FORM	TREES			MALLEES	
	over 30m	15 - 30m	5 - 15m under 5m	over 8m	under 8m
					
COVER CLASS (%)			10-30/2-10		
DOMINANT SPECIES			<i>Banksia attenuata</i>		
			" "		

LIFE FORM	SHRUBS			SHRUBS	
	over 2m	2m - 1.5m	1.5 - 1m	1 - 0.5m	under 0.5m
					
COVER CLASS (%)			10-30	[2-10]	10-30%
DOMINANT SPECIES			<i>Zamia palm</i>	<i>Hibbertia</i>	<i>Hibbertia hyp.</i>

LIFE FORM	GRASSES	HERBS	SEDGES	over 0.5m	under 0.5m
					
COVER CLASS (%)	2-10	30-70			10-30
DOMINANT SPECIES	<i>Ryegrass</i>				<i>Shoenus grand.</i>

4. VEGETATION CONDITION

1	'PRISTINE'	COMMENTS
2	EXCELLENT	
3	VERY GOOD ✓	
4	GOOD	
5	DEGRADED	

BUSHLAND PLANT SURVEY RECORDING SHEET 3 - use pencil only

5. SPECIES PRESENCE Label each plant with plant's number, site code, date and plant's name or working name if required

SITE No G.MAIDEN 4
 Date 16-10-95

Record on Sheet

- Column 1 plant name
- Column 2 plant number
- Column 3 flowering time- TICK if species flowering
- Column 4 identification check

From 'Buskland Plant Survey' written by B. Keighery (1994) and published by the Wildflower Society of WA (Inc.), PO Box 64 Nedlands WA 6108.

TREES	No	FI	ID	SHRUBS (cont.)	No	FI	ID	HERBS (cont.)	No	FI	ID
<i>Phanksia attenuata</i> (no specimen)	2		✓					<i>ERYNGIUM pinct</i> ssp. <i>pin.</i>	26	✓	✓
	8							<i>Labelia tenuior</i>	27	✓	✓
								<i>OLASIOPIETALUM MEMBRANACEAUM</i>	28	✓	✓
								<i>OCARZIA MILLEANTHA</i>	34	✓	✓
								<i>KURSIHIA ANTHEMIOIDES</i>	39	✓	✓
								<i>OPETROHAGIA VELUTINA</i>	40	✓	✓
MALLEES								(Small clover) <i>TRIFOLIUM DUBIA</i>	43	✓	✓
				GRASSES				<i>MASTRODIMA PADIUM</i>	44	✓	✓
				<i>PARA CARYOPHYLLAEA</i>	11	✓	✓	<i>PROMYLEA ROSA LOM. CAESPITOSA</i>	45	✓	✓
				<i>STIPA FLAVESCENS</i>	18	✓	✓	<i>PERIDIUM CICTARIUM</i>	46	✓	✓
				<i>BRIZZA MAXIMA</i>	21	✓	✓	<i>ODONATUS GLOCHIDIATUS</i>	47	✓	✓
				<i>HYPONDOERS GRASSA</i>	22	✓	✓	<i>BRACHYRACHIS IBERIDIFOLIA</i>	48	✓	✓
<i>Diavasia diversicata</i>	3	✓		<i>OPETROHAGIA VELUTINA</i>	23	✓	✓	<i>DANTHONIA OCCIDENT</i>	49	✓	✓
<i>Acacia COCHLEARIS</i> (Cross leaf)	4	✓		<i>POA POIFORM (STER)</i>	31	✓	✓	SEDGES			
<i>Zamia palm MACROZAMIA RIEDLE</i>	5	✓		<i>POA diamondiana</i>	32	✓	✓	<i>SCHONEUS GRANDIFLORA</i>	1	✓	✓
<i>Phyll. calycinus</i>	6	✓	✓	<i>STIPA CAMPTOCHNE Dichelocrinite</i>	33	✓	✓	<i>PHYSALOTIS OREARIUS</i>	15	✓	✓
<i>Hibbertia HYPERICOIDES</i>	7	✓	✓	<i>BROMUS diandrus</i>	35	✓	✓	<i>Dianella DIVARICATA</i>	16		
<i>Gompholobium TOMENTOSUM</i>	8	✓	✓	HERBS				<i>COMANDRA MARITIMA. SAME AS 29</i>	29		
<i>Synaloea SPINULOSITA</i>	9	✓	✓	<i>POA</i>				<i>SCHONEUS. LEPID. ANGUST</i>	30	✓	✓
<i>TRIFOLIUM CAMPESTRE</i>	10	✓	✓	<i>POA</i>				<i>COMANDRA MARITIMA = 29</i>	41		
<i>ASTERIDIA PULVERULENTA</i>	12	✓	✓	<i>PHILANTHUS CALYTHYMUS</i>	6						
<i>Hybanthus calycinus</i>	13	✓	✓	<i>Hibbertia (not seen)</i>	7	✓					
No obs.	#				8						
				<i>Synaloea spinulosa</i>	9	✓	✓				
				(Clover) <i>TRIFOLIUM campestre</i>	10	✓	✓				
				(Generalizing daisy) <i>ASTERID. pulv.</i>	12	✓	✓				
				<i>Hybanthus calycinus</i>	13	✓	✓				
				<i>MYLOTIA MYOSOTIDIFOLIA (CHECK WITH)</i>	17	✓	✓				
				<i>PODOTHECA ANGUSTIFOLIA</i>	19	✓	✓	<i>BROMUS ARENARIUS</i>	42	✓	✓
				<i>Homaloscardium homalacayram</i>	20	✓	✓	<i>PROMYLEA ROSA</i>	38	✓	✓
				<i>TRACHYMENE PILOSA</i>	24	✓	✓	<i>BRIZZA MINOR</i>	37	✓	✓
				<i>HYPONDOERS GRASSA</i>	25	✓	✓	<i>DANTHONIA OCCIDENTALIS</i>	36	✓	✓

ADJ *CONOSTYLIS ACUTATA*
BRACHOME ICEL RH.

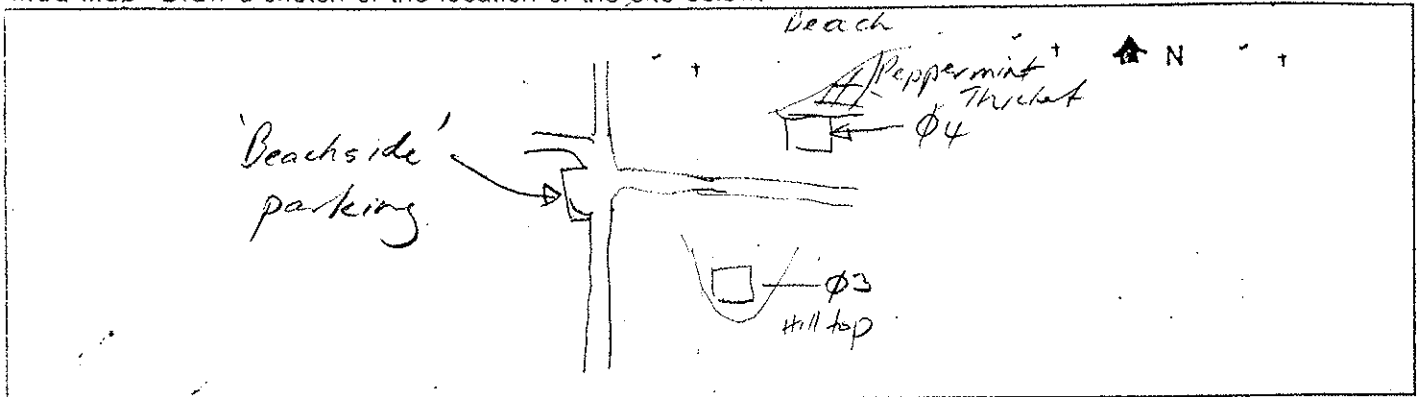
BUSHLAND PLANT SURVEY RECORDING SHEET 1: use pencil only

BUSHLAND AREA THE MAIDENS SITE NUMBER MAID-2
 DATE TRIP 14-10-95 RECORDERS BRONWEN K., ANDREW T. DLGA. DOROTHY JANSJE K.
 DATE TRIP _____ RECORDERS _____
 DATE TRIP _____ RECORDERS _____
 BOTANIST BRONWEN KEIGHERY

From 'Bushland Plant Survey' written by B. Keighery (1994) and published by the Wildflower Society of WA (Inc.), PO Box 4 Nedlands WA 6008.

1. LOCATION of the QUADRAT

Mud Map Draw a sketch of the location of the site below.

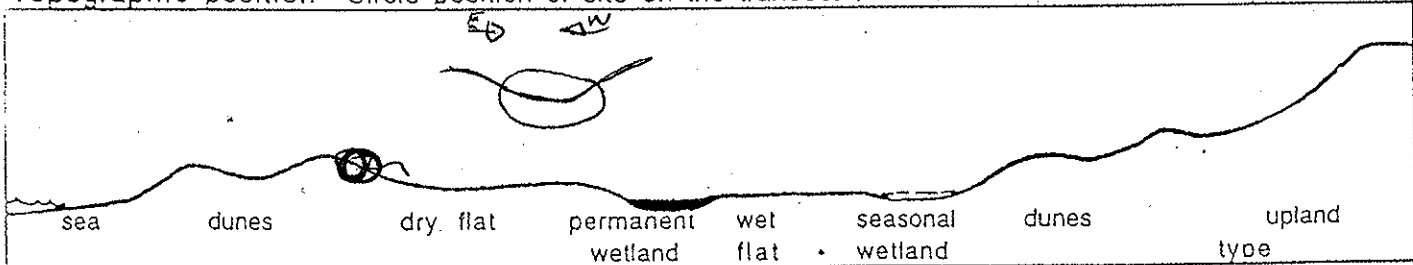


Road Location

Geographic Location Latitude 28° 22' 40.9 S Longitude 115° 36' 45.1 E Altitude
 Reference Map

Photograph Photographer's Name BJK Photo No

Topographic position Circle position of site on the transect (alter the transect if necessary)



see diagram above

2. SITE DATA Circle the correct response.

Slope flat gentle steep Aspect N NE E SE S SW W NW

Surface Soil type sand Colour grey/brown
 Exposed rock type NA % surface

Sub-surface Soil type sand Colour cream
 Rock type NA depth to rock

Drainage well mod poor depth water cm Wet all year winter/spring

Litter Depth 90 % cover > 1 cm Bare Ground 5-10 % cover

BUSHLAND PLANT SURVEY RECORDING SHEET 2 (Muir)- use pencil only

From 'Bushland Plant Survey' written by B. Keighery (1994) and published by the Wildflower Society of WA Inc., PO Box 64 Nedlands WA 6008.

3. VEGETATION STRUCTURE AND COVER

For each layer record - appropriate life form, cover class (see below), and dominant species in each layer.

Cover Class 2-10% 10-30% 30-70% over 70%

LIFE FORM	TREES			MALLEES	
	over 30m	15-30m	5-15m under 5m	over 8m	under 9m
					30m 10m
COVER CLASS (%)					2-10%
DOMINANT SPECIES					Agonis flex
LIFE FORM	SHRUBS			SHRUBS	
	over 2m	2m-1.5m	1.5-1m	1-0.5m	under 0.5m
		Some Dip Heath A only 1m on W slope 		Dwarf Scrub C 	
					2m 1m
COVER CLASS (%)		30%-70%		10-30	
DOMINANT SPECIES		spyrad. glob. Diplacn. Exocarpus		Jack. Acacia Heath pung	
LIFE FORM	GRASSES	HERBS	SEDGES	SEDGES	
	open grasses	Herbs	over 0.5m	under 0.5m	
					1m
COVER CLASS (%)	10-30%	30-70%	2-10%		
DOMINANT SPECIES	Calandrinia Pararteria	canostylis senecio. comocarpus.	Leptos. angust Leptos Gkd.		

4. VEGETATION CONDITION

1	'PRISTINE'	COMMENTS Some weed spp. (10) Native sp. seedlings Good cover of native annuals.
2	EXCELLENT	
3	VERY GOOD ✓	
4	GOOD	
5	DEGRADED	

NMA10Φ1

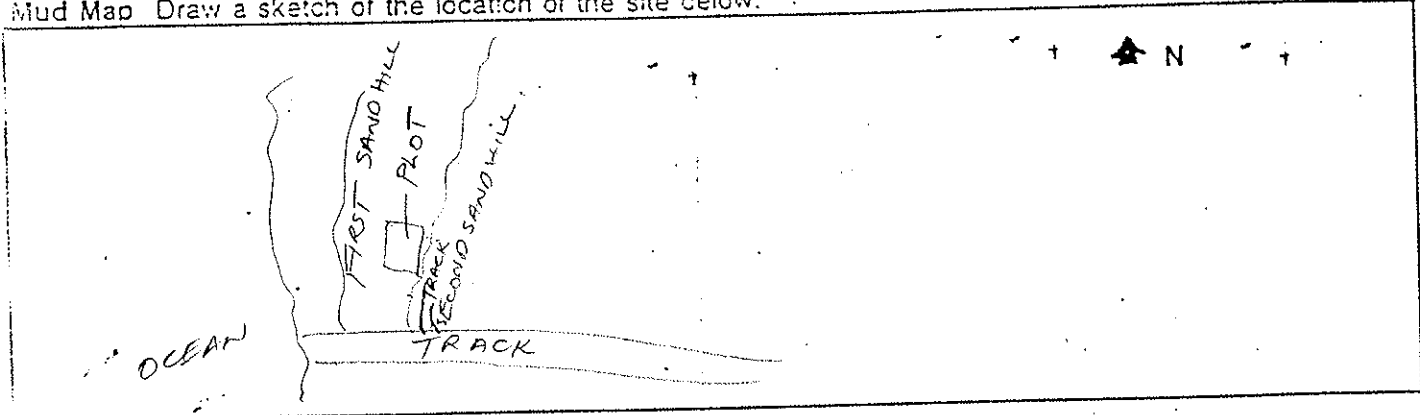
BUSHLAND PLANT SURVEY RECORDING SHEET 1- use pencil only

BUSHLAND AREA MAIDENS RESERVE SITE NUMBER NMA10 (N1)
 DATE TRIP 14/10/95 RECORDERS DIANE, CAROLYN, JOHN, GARY, MARGO, KATE & NEIL
 DATE TRIP _____ RECORDERS _____
 DATE TRIP _____ RECORDERS _____
 BOTANIST _____

From 'Bushland Plant Survey' written by B. Keighery (1994) and published by the Wildflower Society of WA (Inc.), PO Box 1 Nedlands WA 6008.

1. LOCATION of the QUADRAT

Mud Map Draw a sketch of the location of the site below.



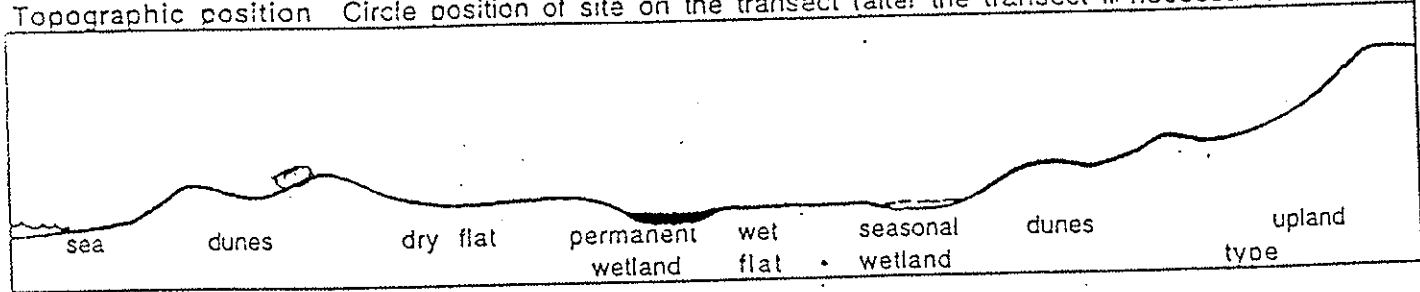
Road Location MAIDENS RESERVE NEAR BEACH

Geographic Location Latitude 33 22 45.0 S Longitude 115 36 39.6 E Altitude 20m

Reference Map ±100

Photograph _____ Photocracher's Name _____ Photo No NS-21

Topographic position Circle position of site on the transect (alter the transect if necessary)



2. SITE DATA Circle the correct response.

Slope flat gentle steep Aspect N NE E SE S SW W NW

Surface Soil SAND Colour WHITE/CREAM
Exposed rock _____ type _____ % surface

Sub-surface Soil SAND Colour WHITE
Rock _____ type _____ depth to rock

Drainage well mod poor depth water _____ cm Wet all year winter/spring

Litter	<u>20</u> 30 % cover	Bare Ground	<u>S</u> % cover
Depth	<u>1.5</u> cm		



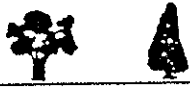




















BUSHLAND PLANT SURVEY RECORDING SHEET 2 (Muir)- use pencil only

From 'Bushland Plant Survey' written by B. Keighery (1994) and published by the Wildflower Society of WA Inc., PO Box 64 Nedlands WA 6008.

3. VEGETATION STRUCTURE AND COVER

For each layer record - appropriate life form, cover class (see below), and dominant species in each layer.

Cover Class 2-10% 10-30% 30 - 70% over 70%

LIFE FORM	TREES			MALLEES	
	over 30m	15 - 30m	5 - 15m under 5m	over 8m	under 8m
					
COVER CLASS (%)					
DOMINANT SPECIES					
LIFE FORM	SHRUBS			SHRUBS	
	over 2m	2m - 1.5m	1.5 - 1m	1 - 0.5m	under 0.5m
	 			Dense Low Heath 	
COVER CLASS (%)				90%	
DOMINANT SPECIES				AGONIS FLEX. SCAEVOLA SPHRIDNUM	ANEMUS GLOB.
LIFE FORM	GRASSES	HERBS	SEDGES	SEDGES	
				over 0.5m	under 0.5m
	 	Very open Herbs   	  	 	 
COVER CLASS (%)	2-10%	2-10% SENECIO LAURIS CONYSTYLIS AC.			
DOMINANT SPECIES					

4. VEGETATION CONDITION

1	'PRISTINE'		COMMENTS
2	EXCELLENT	✓	
3	VERY GOOD		
4	GOOD		
5	DEGRADED		

BUSHLAND PLANT SURVEY RECORDING SHEET 1- use pencil only

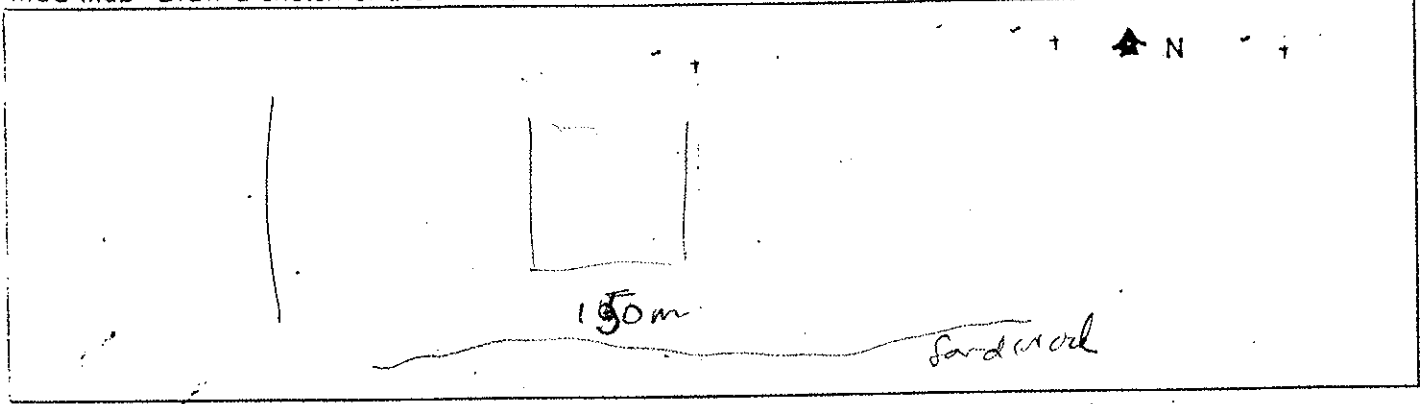
NMA1003

BUSHLAND AREA Maudens SITE NUMBER Maudens 3
 DATE TRIP 7/4/10 RECORDERS Brian Shirley, Bernard, Mary, Geoff Fran
 DATE TRIP _____ RECORDERS _____
 DATE TRIP _____ RECORDERS _____
 BOTANIST _____

From 'Bushland Plant Survey' written by B. Keighery (1994) and published by the Wildflower Society of WA (Inc.), PO Box 21 Nedlands WA 6008.

1. LOCATION of the QUADRAT

Mud Map Draw a sketch of the location of the site below.

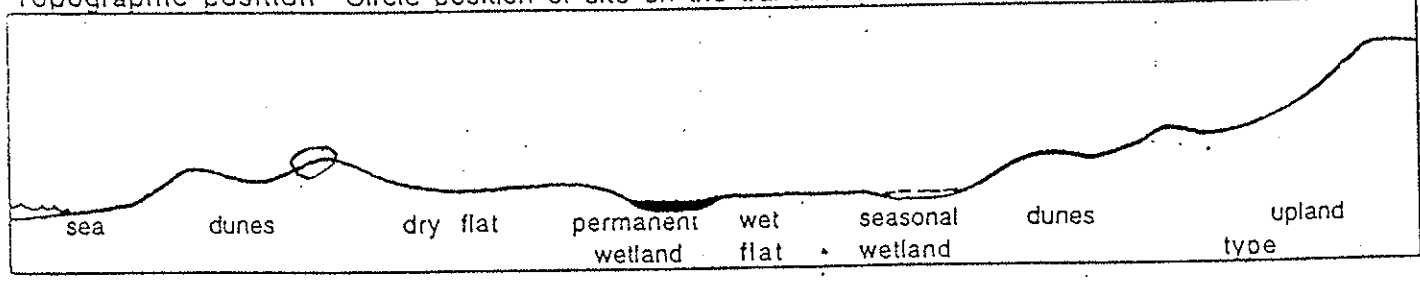


Road Location _____

Geographic Location Latitude 33 22 41.0 S Longitude 115 36 46.3 E Altitude _____
 Reference Map ± 100m

Photograph _____ Photographer's Name _____ Photo No _____

Topographic position Circle position of site on the transect (alter the transect if necessary)



2. SITE DATA Circle the correct response.

Slope flat gentle steep Aspect N NE E SE S SW W NW

Surface Soil sand Colour grey/brown
 Exposed rock type - % surface _____

Sub-surface Soil sand Colour grey brown
 Rock type - depth to rock _____

Drainage well mod poor depth water _____ cm Wet all year winter/spring

Litter 5-10 % cover _____
 Depth 1 cm Bare Ground 20-25 % cover _____













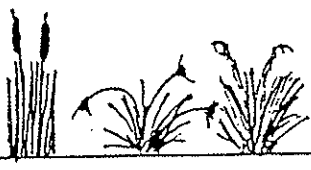
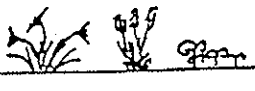
BUSHLAND PLANT SURVEY RECORDING SHEET 2 (Muir)- use pencil only

3. VEGETATION STRUCTURE AND COVER

From 'Bushtand Plant Survey' written by B. Keighery (1994) and published by the Wildflower Society of WA Inc., PO Box 64 Nedlands WA 6008.

For each layer record - appropriate life form, cover class (see below), and dominant species in each layer.

Cover Class 2-10% 10-30% 30 - 70% over 70%

LIFE FORM	TREES			MALLEES	
	over 30m	15 - 30m	5 - 15m under 5m	over 8m	under 8m
					
COVER CLASS (%)					
DOMINANT SPECIES					
LIFE FORM	SHRUBS			SHRUBS	
	over 2m	2m - 1.5m	1.5 - 1m Low Scrub B	1-0.5m Low Heath C	under 0.5m Low Heath D
					
COVER CLASS (%)			70-80	30-70	30-70
DOMINANT SPECIES			Torresiana Acacia	Acacia	Acacia Hemionda
LIFE FORM	GRASSES	HERBS	SEDGES	SEDGES	
		Dense Herbs		over 0.5m	under 0.5m
					
COVER CLASS (%)	2-10	70-70			2
DOMINANT SPECIES		Conostylis daunifera			

4. VEGETATION CONDITION

1 'PRISTINE'		COMMENTS very few weeds
2 EXCELLENT	✓	
3 VERY GOOD		
4 GOOD		
5 DEGRADED		

NMAD 03

M3 on labels

BUSHLAND PLANT SURVEY RECORDING SHEET 3 - use pencil only

5. SPECIES PRESENCE

Label each plant with plants number, site code, date and plant's name or working name if required

SITE No	Mardens 3
Date	14/10/95

Record on Sheet

- Column 1 plant name-
- Column 2 plant number
- Column 3 flowering time- TICK if species flowering
- Column 4 identification check

From 'Bushland Plant Survey' written by B. Keighery (1994) and published by the Wildflower Society of WA (Inc.), PO Box 64 Nedlands WA 6008.

TREES	No	FI	ID	SHRUBS (cont.)	No	FI	ID	HERBS (cont.)	No	FI	ID
								<input checked="" type="checkbox"/> <i>Senecio lantus</i> ssp <i>marit</i>	26	✓	✓
								<input checked="" type="checkbox"/> <i>Opercularia vaginalis</i>	27		✓
								<input checked="" type="checkbox"/> <i>Thlaspi Sonchus</i> s <i>obovatus</i>	30		✓
								<input checked="" type="checkbox"/> <i>Crocosypha collarata</i>	31		✓
								<input type="checkbox"/> Weed (indet)	32		✓
								<input checked="" type="checkbox"/> <i>Zygophyllum apiculatum</i>	33		✓
MALLEES											
				GRASSES							
				<input checked="" type="checkbox"/> <i>Stipa flavescens</i>	28		✓				
				<input checked="" type="checkbox"/> <i>Romulea rosea</i>	29		✓				
				<input checked="" type="checkbox"/> <i>Paraphrodos</i>	76		✓				
				<input checked="" type="checkbox"/> <i>Bromus arenarius</i>	27		✓				
SHRUBS											
<input checked="" type="checkbox"/> <i>Sarcobatus acuminatum</i>	1		✓								
<input checked="" type="checkbox"/> <i>Jacksonia furcellata</i>	2		✓								
<input checked="" type="checkbox"/> <i>Acacia corbaris</i>	3		✓								
<input checked="" type="checkbox"/> <i>Diploleena Dampieri</i>	4	✓	✓								
<input checked="" type="checkbox"/> <i>Exocarpos Sparteus</i>	5		✓								
<input checked="" type="checkbox"/> <i>Hemionda pungens</i>	6	✓	✓								
<input checked="" type="checkbox"/> <i>Phyllanthus calycinus</i>	7		✓								
<input checked="" type="checkbox"/> <i>Olearia axillaris</i>	11		✓								
<input checked="" type="checkbox"/> <i>Comptolopum tomentosum</i>	20	✓	✓								
<input checked="" type="checkbox"/> <i>Sphindium globulosum</i>	28		✓								
<input checked="" type="checkbox"/> <i>Rhagodia baccata</i>	35		✓								
				HERBS							
				<input checked="" type="checkbox"/> <i>Kernedia prostrata</i>	8		✓				
				<input checked="" type="checkbox"/> <i>Doranthera microphylla</i>	9		✓				
				<input checked="" type="checkbox"/> <i>Carpentaria virescens</i>	10		✓				
				<input checked="" type="checkbox"/> <i>Conostylus setigera</i>	12	✓	✓				
				<input checked="" type="checkbox"/> <i>Calandrinia liniflora</i>	13	✓	✓				
				<input checked="" type="checkbox"/> <i>Asteridea ruberulenta</i>	15	✓	✓				
				(yellow) <i>dam</i> ? No spec)	16	✓	✓				
				<input checked="" type="checkbox"/> <i>Dischisma arenarium</i>	17		✓				
				(weed) <i>Logurus orckus</i>	18		✓				
				<input checked="" type="checkbox"/> <i>Trochymene pilosa</i>	19		✓				
				(Broom) = <i>Olearia axil</i>	21		✓				
				<input checked="" type="checkbox"/> <i>Scariosa holosericea</i>	22	✓	✓				
				<input checked="" type="checkbox"/> <i>Trochymene pilosa</i>	23		✓				
								SEDGES			
								<input checked="" type="checkbox"/> <i>Alepidosperma angustatum</i>	14		✓
								<input checked="" type="checkbox"/> <i>Schoenus grandiflorus</i>	24		✓
								<input checked="" type="checkbox"/> <i>Pisolepis marginalis</i>	34		✓
								APDs			
								<input checked="" type="checkbox"/> <i>Agonis flexuosa</i>			
								<input checked="" type="checkbox"/> <i>Limnium flexuiflorum</i>			
								<input checked="" type="checkbox"/> <i>Hambozia</i>			
								<i>Hib. canei</i>			
								= <i>Archusitolia</i>			



























BUSHLAND PLANT SURVEY RECORDING SHEET 2 - use pencil only

From 'Bushland Plant Survey' written by B. Keighery (1994) and published by the Wildflower Society of WA (Inc.), PO Box 64 Nedlands WA 6008.

3. VEGETATION STRUCTURE AND COVER

For each layer record - appropriate life form, cover class (see below) and dominant species in each layer.

Cover Class 2-10% 10-30% 30-70% over 70%

		TREES			MALLEES	
		over 30m	10-30m	under 10m	over 8m	under 8m
LIFE FORM	30m			 		
	10m					
COVER CLASS (%)						
DOMINANT SPECIES						
		SHRUBS			SHRUBS	
		over 2m	2m - 1m	under 1m		
LIFE FORM	2m	  	  	   		
	1m					
COVER CLASS (%)						
DOMINANT SPECIES						
		GRASSES	HERBS	SEDGES		OTHER
LIFE FORM	1m	 	   	   		
COVER CLASS (%)						
DOMINANT SPECIES						

4. VEGETATION CONDITION

1 'PRISTINE'	COMMENTS
2 EXCELLENT	
3 VERY GOOD	
4 GOOD	
5 DEGRADED	

NMAID 04

BUSHLAND PLANT SURVEY RECORDING SHEET 1- use pencil only

BUSHLAND AREA MAIDENS BUNBURY SITE NUMBER MAID 4

DATE TRIP 14/10/95 RECORDERS KATE TAUSS

DATE TRIP _____ RECORDERS _____

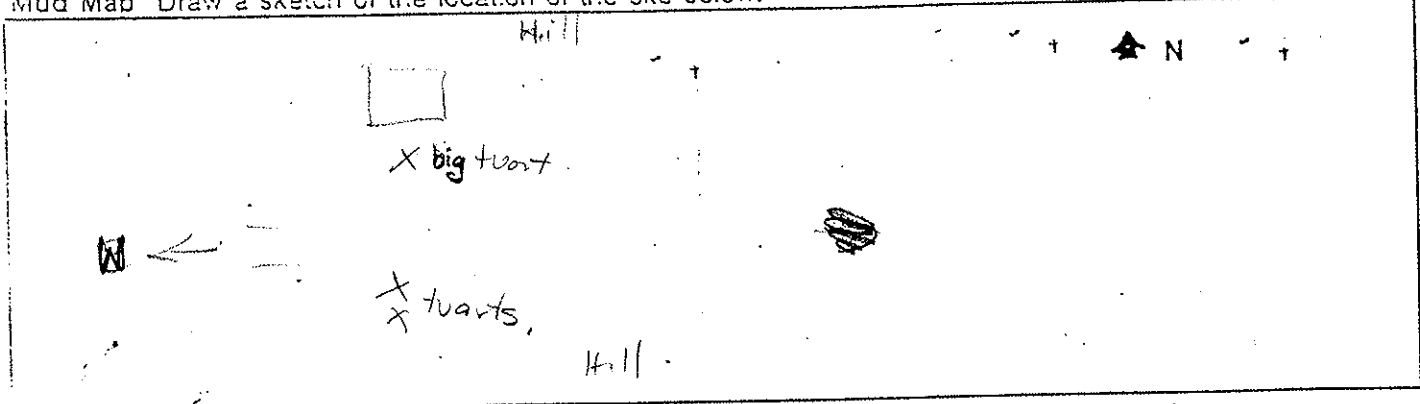
DATE TRIP _____ RECORDERS _____

BOTANIST _____

From 'Bushland Plant Survey' written by B. Keighery (1994) and published by the Wildflower Society of WA (Inc.), PO Box 21 Nedlands WA 6008.

1. LOCATION of the QUADRAT

Mud Map Draw a sketch of the location of the site below.



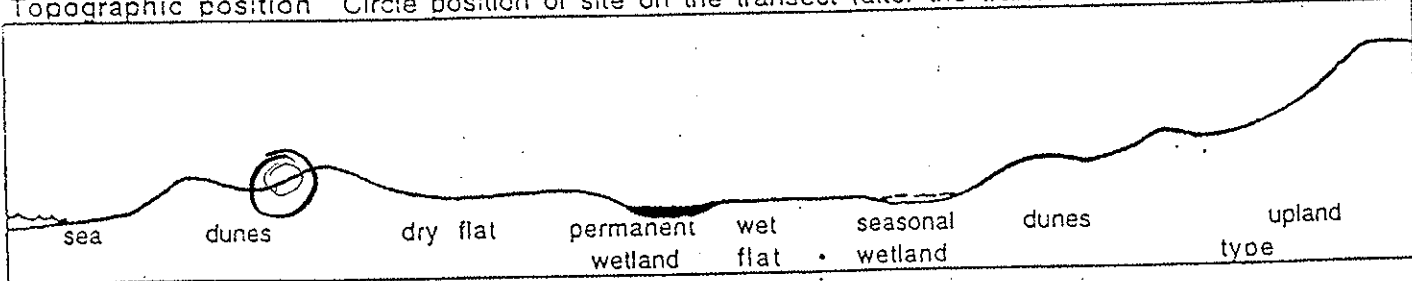
Road Location

Geographic Location Latitude 33/22/42. WS Longitude 115/37/08.6 E Altitude 50 M

Reference Map _____ acc t300

Photograph _____ Photographer's Name _____ Photo No N622

Topographic position Circle position of site on the transect (alter the transect if necessary)



2. SITE DATA Circle the correct response.

Slope	flat	gentle	<u>steep</u>	Aspect	N	NE	E	SE	<u>(S)</u>	SW	W	NW
Surface Soil	<u>brown sand</u>							Colour	<u>brown</u>			
Exposed rock	type _____			% surface	_____							
Sub-surface Soil	<u>brown sand</u>							Colour	<u>brown</u>			
Rock	type _____			depth to rock	_____							
Drainage	<u>well</u>	mod	poor	depth water	cm	Wet	all year	winter/spring				
Litter	Depth	<u>30</u>	% cover					Bare Ground	<u>0% cover</u>			
		<u>7-8</u>	cm									













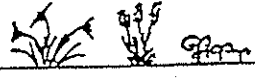
BUSHLAND PLANT SURVEY RECORDING SHEET 2 (Muir)- use pencil only

From 'Bushland Plant Survey' written by B. Keighery (1994) and published by the Wildflower Society of WA Inc., PO Box 64 Nedlands WA 6008.

3. VEGETATION STRUCTURE AND COVER

For each layer record - appropriate life form, cover class (see below), and dominant species in each layer.

Cover Class 2-10% 10-30% 30-70% over 70%

TREES			MALLEES		
over 30m	15-30m	5-15m under 5m	over 8m	under 8m	
LIFE FORM	Woodland 	 7 6			
COVER CLASS (%)	10-30%	10-30%			
DOMINANT SPECIES	Tuart	Agonis flexuosa Tuart			
SHRUBS			SHRUBS		
over 2m	2m-1.5m	1.5-1m	1-0.5m	under 0.5m	
LIFE FORM			Low Scrub B 		
COVER CLASS (%)		10-30%			
DOMINANT SPECIES		Ternstroemia retusa Anthracopus preissii Rhaprodia hacc.			
GRASSES		HERBS	SEDGES	under 0.5m	
over 0.5m			over 0.5m		
LIFE FORM			Dense Tall Sedges 		
COVER CLASS (%)			30-70%		
DOMINANT SPECIES			Lepidosperma gladiatum		

4. VEGETATION CONDITION

1	'PRISTINE'	COMMENTS
2	EXCELLENT 21	
3	VERY GOOD	
4	GOOD	
5	DEGRADED	

NMA10 05

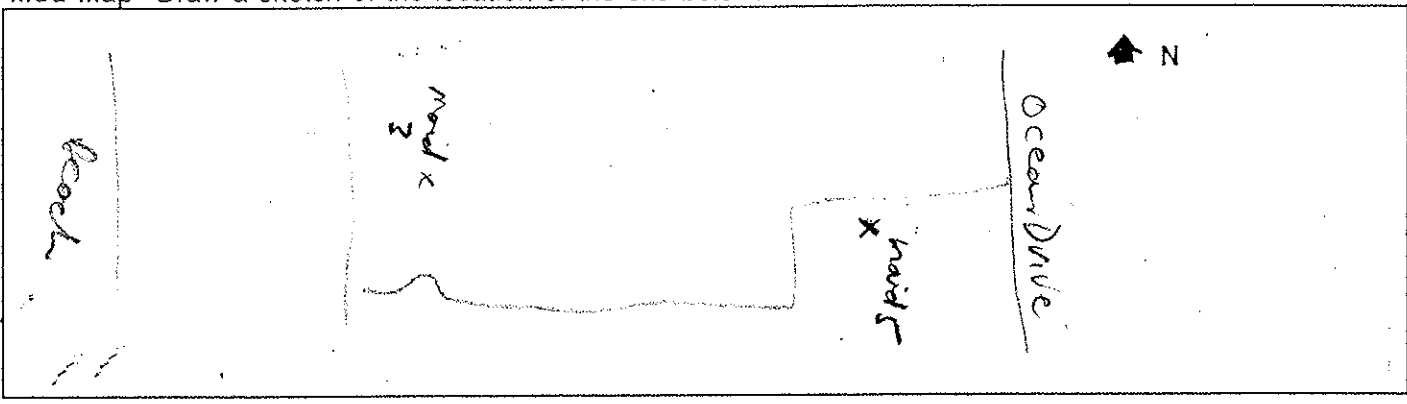
BUSHLAND PLANT SURVEY RECORDING SHEET 1- use pencil only

BUSHLAND AREA Bunbury SITE NUMBER Maid 5
 DATE TRIP 14/10/95 RECORDERS Bruce, Fran, Geoff, Shirley Bernard
 DATE TRIP _____ RECORDERS _____
 DATE TRIP _____ RECORDERS _____
 BOTANIST Brunson

From 'Bushland Plant Survey' written by B. Keighery (1994) and published by the Wildflower Society of WA (Inc.), PO Box 64 Nedlands WA 6008.

1. LOCATION of the QUADRAT

Mud Map Draw a sketch of the location of the site below.

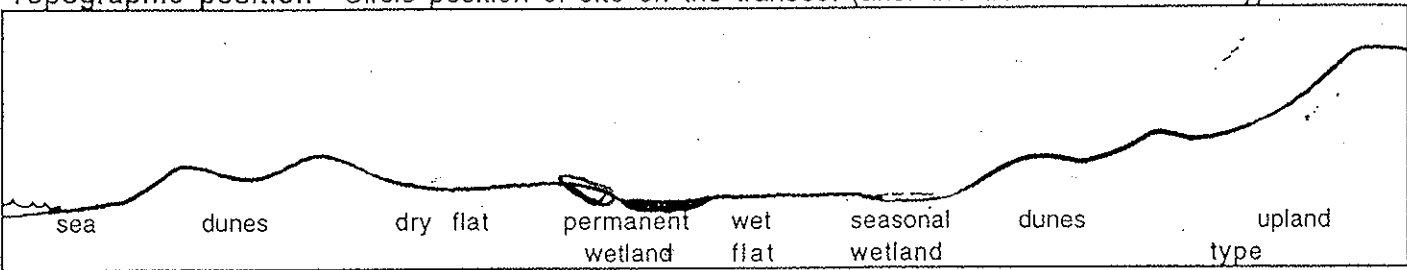


Road Location

Geographic Location Latitude 23 22 44.3 S Longitude 115 37 10.5 E Altitude
 Reference Map ± 300m

Photograph Photographer's Name Photo No

Topographic position Circle position of site on the transect (alter the transect if necessary)



2. SITE DATA Circle the correct response.

Slope flat gentle steep Aspect N NE E SE S SW W NW

Surface Soil Sand. coarse Colour brown
 Exposed rock type — % surface

Sub-surface Soil yellow/orange coarse sand Colour yellow/orange
 Rock type — depth to rock

Drainage well mod poor depth water cm Wet all year winter/spring

Litter Depth 50 % cover Bare Ground 0 % cover
 Depth 10 cm







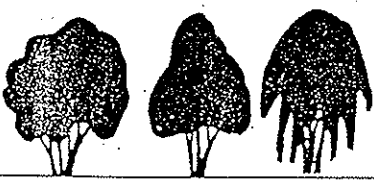





BUSHLAND PLANT SURVEY RECORDING SHEET 2 - use pencil only

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3. VEGETATION STRUCTURE AND COVER

For each layer record - appropriate life form, cover class (see below) and dominant species in each layer.

Cover Class 2-10% 10-30% 30-70% over 70%

		TREES			MALLEES	
		over 30m	10-30m	under 10m	over 8m	under 8m
LIFE FORM		Tall forest 		Low forest A  		
		30-70		30-70		
COVER CLASS (%)						
DOMINANT SPECIES		Tuart		Banksia attenuata A genus.		
		SHRUBS over 2m		2m-1m	SHRUBS under 1m	
LIFE FORM		Scrub 	Open low scrub B 	Dwarf scrub C 		
		10-30	2-10	10-30		
COVER CLASS (%)						
DOMINANT SPECIES		Rohrer Protea	Jacksonia fusc. Kulberrha caa.	Zinnia Syrphocarpus sp.		
		GRASSES	HERBS	SEDGES	OTHER	
LIFE FORM		Dense grasses 	Open herbs 			
		>70	10-30	<10		
COVER CLASS (%)						
DOMINANT SPECIES		Herbs.				

4. VEGETATION CONDITION

1	'PRISTINE'	COMMENTS herb and grass impacted by Griza and clear between G and V good
2	EXCELLENT	
3	VERY GOOD	
4	GOOD	
5	DEGRADED	



- 1 = N MAID ϕ 1
- 2 = B MAID ϕ 2
- G1 = G MAID ϕ 1
- G2 = G MAID ϕ 2
- 3 = G MAID ϕ 3
- 4 = G MAID ϕ 4
- (3) = N MAID ϕ 3

- N4 = N MAID ϕ 4
- 5 = N MAID ϕ 5