BROWNMAN SWAMP, MT BROWN LAKE AND ADJACENT BUSHLAND, HENDERSON/NAVAL BASE

Boundary Definition: protected area/bushland (part taken to cadastre)/conservation wetland boundary (Areas of bushland within the boundaries of the Site are not accurately mapped. The boundary has been drawn to include any unmapped bushland.)

SECTION 1: LOCATION INFORMATION

Bush Forever Site no. 346
Area (ha): bushland 558.3 (Site also includes open water.)
Map no. 57, 58, 63, 64
Map sheet series ref. no. 2033–I SW
Other Names: Henderson Regional Open Space, Lake Mt Brown and Brownman Swamp part of Beeliar Regional Park
Local Authorities (Suburb): City of Cockburn (Henderson), Town of Kwinana (Naval Base)
System 6 (1983): M91 and part M92 Part System area bushland and part scattered native plants (canopy), all vegetation described

SECTION 2: REGIONAL INFORMATION

LANDFORMS AND SOILS

Spearwood Dunes
Sands derived from Tamala Limestone (Qts: S7)
Tamala Limestone (Qtl: LS1)
Quindalup Dunes (Holocene dunes)
Safety Bay Sands (Qhs: S13)
Wetlands (within the Spearwood Dunes)
Holocene Swamp Deposits (Qhw: M6)

VEGETATION AND FLORA

Vegetation Complexes
Spearwood Dunes
Cottesloe Complex — Central and South
Quindalup Dunes
Becher (Qu.2)
Floristic Community Types
Supergroup 2: Seasonal Wetlands
16 Highly saline seasonal wetlands (Open Low Heath dominated by *Grevillea vestita*, *Frankenia pauciflora* or *Acanthocarpus preissii* on Coastal Limestone Cliff)
17 *Melaleuca rhaphiophylla — Gahnia trifida* seasonal wetlands (in area of most northerly occurrence)
Supergroup 4: Uplands centred on Spearwood and Quindalup Dunes
24 Northern Spearwood shrublands and woodlands
29a Coastal shrublands on shallow sands

WETLANDS

Wetland Types: sumpland
Natural Wetland Groups
Spearwood Dunes
Coogee (S.3)
Stakehill (S.4)
Wetland Management Objectives: Conservation (95ha)
Swan Coastal Plain Lakes EPP: 26.6ha + 17.5ha + 17.4ha = 61.5 (total)

THREATENED ECOLOGICAL COMMUNITIES

Not assessed

SECTION 3: SPECIFIC SITE DETAIL

Landscape Features: limestone ridge, tall dune, open water, vegetated wetland, vegetated uplands, ocean — limestone cliff
Vegetation and Flora: limited survey (part Site — Cockburn Wetlands Committee 1976, EPA and WAWA 1990, Gibson *et al.* 1994 (MTB 01–05) (Navb 01–04), Semeniuk, V&C Research Group 1997b); detailed survey (part Site — Keighery, GJ, and Keighery 1993c (M91))
Structural Units: mapping (part Site — EPA and WAWA 1990, Semeniuk, V&C Research Group 1997b)
Uplands — Sands derived from Tamala Limestone: Mixed Open Woodland of *Eucalyptus gomphocephala, E. marginata* and *E. calophylla*; *E. marginata* Low Woodland over *Banksia attenuata* Low Open Woodland; *Banksia attenuata, B. menziesii* and *B. grandis* Low Woodland to Low Open Forest; *Acacia pulchella* and *Jacksonia furcellata* Open Shrubland to Tall Open Scrub

Uplands — Tamala Limestone: Tree Mallee dominated by *Eucalyptus foecunda* or *E. decipiens*; Shrublands dominated by *Acacia rostellifera* or *A. cyclops*; Tall Open Scrub to Closed Tall Scrub dominated by *Melaleuca huegelii* and/or *Dryandra sessilis* var. *cygnorum; Melaleuca systena, Hibbertia hypericoides* and *Acacia cochlearis* Open Heath; Mixed Closed Low Heath; Open Low Heath dominated by *Grevillea vestita, Frankenia pauciflora* or *Acanthocarpus preissii*; *Lepidosperma gladiatum* Sedgeland
Wetlands: *Melaleuca rhaphiophylla* Low Woodland to Low Closed Forest; *Melaleuca teretifolia* Low Open Forest; *Frankenia pauciflora* and *Sarcocornia quinqueflora* Closed Low Heath; Sedgelands dominated by *Gahnia trifida* or *Baumea juncea*

Scattered Native Plants: *Eucalyptus gomphocephala* Open Woodland

Vegetation Condition: >80% Very Good, <20% Good to Degraded, with areas of severe localised disturbance (Weston 1993)

Total Flora: 145 native taxa, 74 weed taxa (compiled Keighery, GJ, and Keighery 1993c, Semeniuk, V&C Research Group 1997b) (estimated >75% of expected flora)

Significant Flora: Keighery, GJ and Keighery 1993c— *Wilsonia backhousei* and *Lawrencia spicata* (normally associated with saline wetlands), *Lavatera plebeia* var. *tomentosa* and *Wilsonia humilis* (normally confined to offshore islands; *Lavatera plebeia* var. *tomentosa* is the only mainland record), *Kennedia coccinea* (becoming increasingly uncommon on the western margins of the Plain), *Hemigenia barbata* (uncommon on the Plain, associated with Tamala Limestones, most southern population known); typical Tamala Limestone taxa — *Melaleuca huegelii, Grevillea preissii, Eucalyptus foecunda, Pimelea calcicola, Trymalium ledifolium* subsp. *ledifolium, Hibbertia spicata* subsp. *leptotheca*

Fauna: limited survey for birds (AHC 2000 D) including species of trans-equatorial wading birds protected under JAMBA/ CAMBA treaties. Significant mammal species: Quenda (Friend 1996 D)

Linkage: adjacent bushland to the south, east (across road) and west; part of Greenways 74, 87 (Tingay Alan & Associates, 1998a); part of a regionally significant contiguous bushland/wetland linkage (Part A, Map 7)

Other Special Attributes: majority included in Beeliar Regional Park Proposal (DPUD 1992a); BJ Keighery (1996) in an assessment of the Beeliar Wetlands recognised the importance of the Site in containing landscape, vegetation, flora and wetlands typical of the Spearwood Dunes in a contiguous sequence from the coast inland to the wetlands, the presence of vegetated limestone cliffs in this sequence being unique in the PMR; V&C Semeniuk Research Group (1997b) in a study of 22 bushland reserves in the City of Cockburn found in relation to this Site that the value of the four reserves (Coastal Reserve M91, Henderson Regional Open Space, Brownman Swamps, Lake Mt Brown) outweighed the value of the other separate reserves. Together the four reserves stand as an uncommon example of diversity of landforms and vegetation in the Spearwood Dunes — they illustrate the graduation of habitats in the Spearwood System from swale to ridge crest and from hinterland to coast, they provide a viable fauna refuge, the upland areas provide a buffer to the wetlands, and the two wetlands remain hydrologically linked; Brownman Swamp and Mt Brown Lake contain significant invertebrate fauna, Mt Brown Lake being the best example of its type (J. Davis pers. comm.)

SECTION 4: INTERNATIONAL AND NATIONAL SIGNIFICANCE

Entered in the Interim List of the Register of the National Estate; location for JAMBA/CAMBA species; subject to protection under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*

SECTION 5: SELECTION CRITERIA AND RECOMMENDATIONS

Criteria: Representation of ecological communities, Diversity, Scientific or evolutionary importance, General criteria for the protection of wetland, streamline and estuarine fringing and coastal vegetation, Criteria not relevant to determination of regional significance, but which may be applied when evaluating areas having similar values

Recommendation: Part A: Site with Some Existing Protection; the care, control and management of this portion of this Site for conservation purposes within Beeliar Regional Park is endorsed. Part B: Proposed Parks and Recreation Reservation (see Table 3, Volume 1).


Beeliar Regional Park
M91 Res A24309 Coogee
M92 Cockburn Wetlands - W Cham
NAVB 1-4
MTB 1-3, 4 & 5
Photos 7.5147, 7.514
meSh
5
htW
4
meSh
meSh
htW
3
4
Ht
3
4
bLOW
4
3
bLW
Ht
Ht
Ht/Sh
meLW
Ht
jbW
1
jbW
baLW
Ht
bLW

- SURVEY RECORDING SHEET Please use pencil

QUADRAT No. MTR 01 VEGETATION TYPE Eucalypt woodland

DATE FIRST TRIP 21/9/92 VOLUNTEERS _____

DATE SECOND TRIP _____ VOLUNTEERS _____

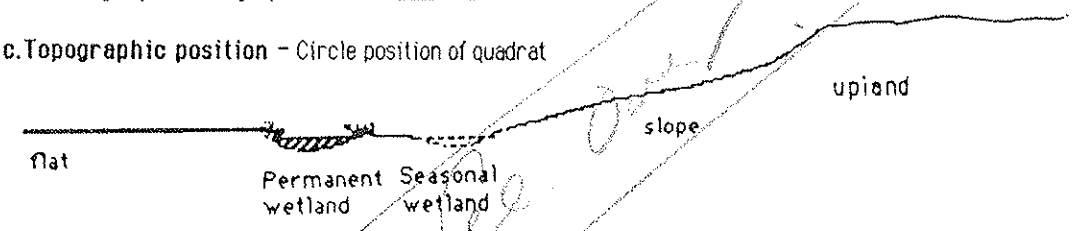
BOTANIST _____

1. LOCATION of the QUADRAT

a. Mud Map Draw a sketch of the location of the quadrat the back of this sheet →

b. Photograph Photographer's name _____

c. Topographic position – Circle position of quadrat



Keighery and Keighery, 1990
Adapted from Griffin and Keighery, 1989
MOORE RIVER to JURIEN SANDPLAIN
SURVEY. WILDFLOWER SOCIETY of WA

2. SITE DATA – Circle the correct response

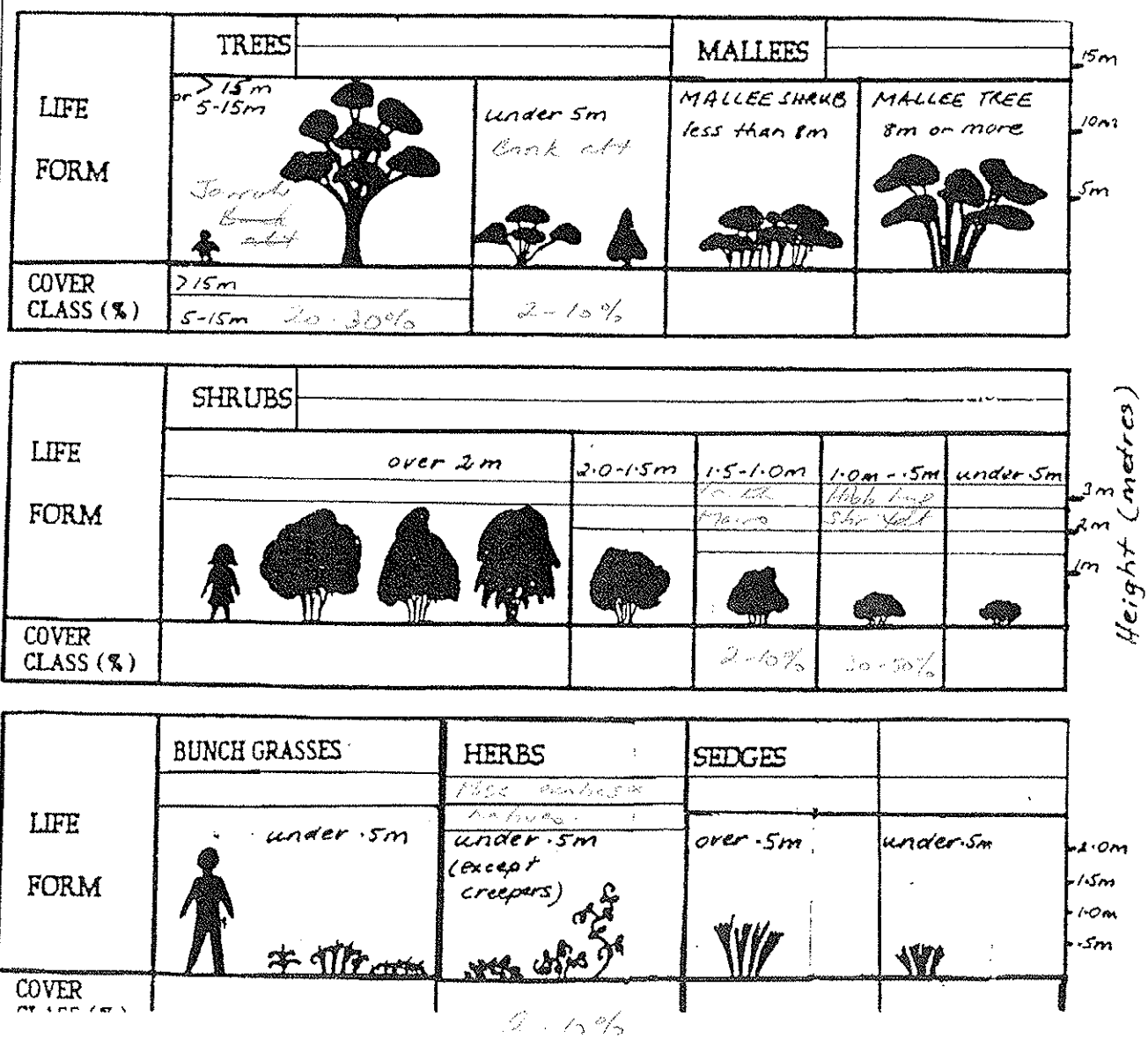
Slope flat gentle steep Aspect N NE E SE S SW W NW

% Bare ground____ Drainage well mod poor Wet All year winter/spring

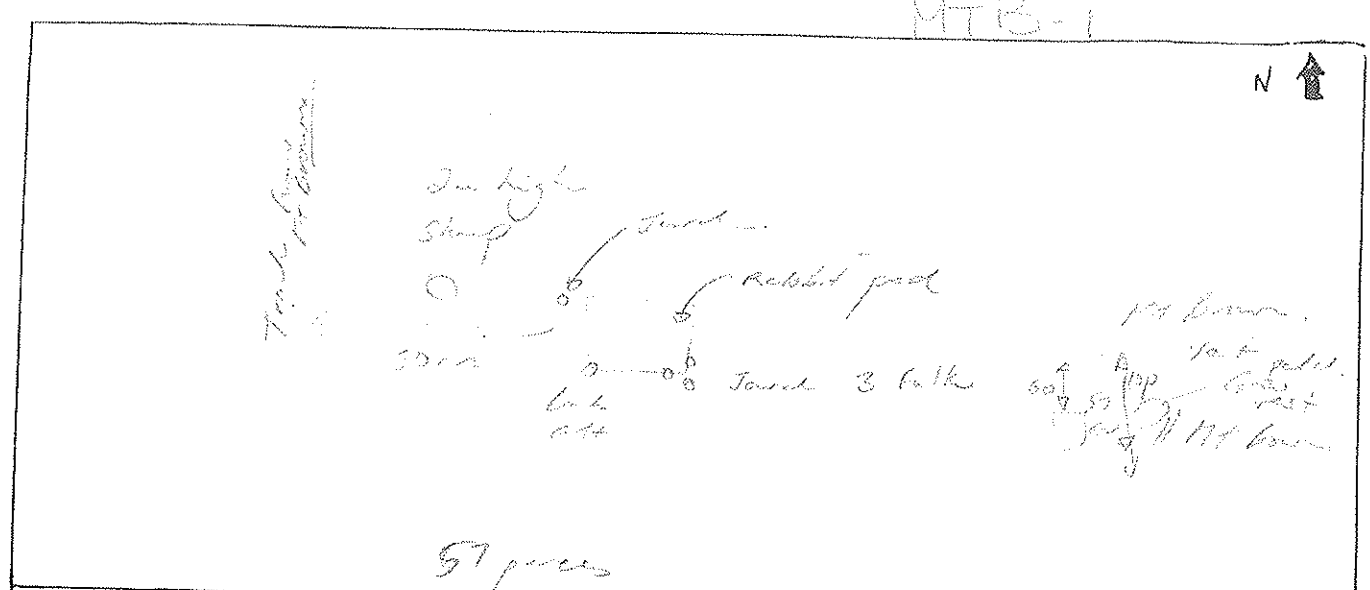
Litter (% cover)____ Surface soil_____ Sub-surface soil _____

3. VEGETATION STRUCTURE AND COVER Record appropriate cover class

Cover Class – percentage classes: 0% | under 2% | 2–10% | 10–20% | 20–30% | 30–50% | 50–70% | over 70%



MTC-1

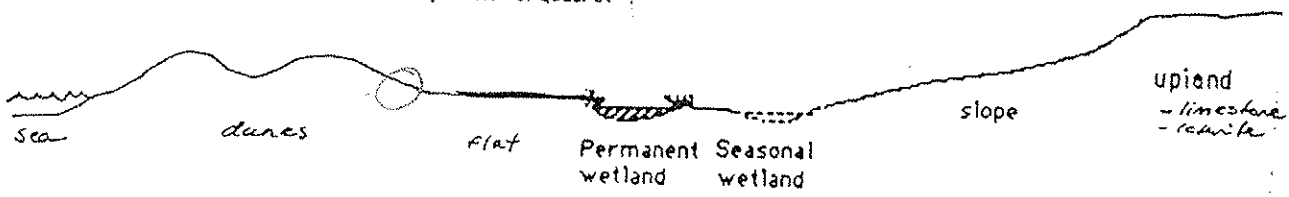


57 pines

b Road Location	c. Latitude	Longitude
	32° 10' 18.0"	115° 47' 12.6"

d. Photograph Photographer's name _____ Photo No _____ Altitude

e. Topographic position – Circle position of quadrat



2. SITE DATA – Circle the correct response

Slope flat gentle steep

Aspect N NE E SE S SW W NW

Surface soil Humus | reddish brown sand

Sub-surface soil yellow sand Environmental code S7

Drainage well mod poor

Wet All year winter/spring

Litter (% cover) 40%

% Bare ground 2%

4. VEGETATION CONDITION

		Comments
EXCELLENT		rabbit grazing - pest trees
VERY GOOD		[illegible]
GOOD	↓	[illegible]
POOR	↓	[illegible]
VERY POOR		Rabbit pest [illegible]

MTC 11

4. SPECIES PRESENCE

7/9/92

- work systematically through the vegetation, start with the tallest stratum, i.e. trees
- within each stratum try to record the **most common species first** and the most uncommon last.
- as each species is collected **label** it with a numbered tag and use this number on your recording sheet
- indicate if the species is in **flower**

QUADRAT No.
MZB01

Keighery and Keighery, 1990
Adapted from Griffin and Keighery, 1989
MOORE RIVER to JURIEN SANDPLAIN SURVEY. WILDFLOWER SOCIETY of WA

Trees	No	ID
Jarrah		
Bank. ant		
Mallees		
SHRUBS		
Hovea sp.		
Xanth. prae.		
Hybb. hyp.		
Stylid. stat.		
Petrophile linearis		
Banksia ??		
Bos. ??		
Dryandra ??		
Hemiandra ?? cuspidata	X	

SHRUBS	No	ID
X Hovea dis.		
X Persoonia ??		
X Acacia pulch.		
X Conostylis ??		
X Calothamnus ??		
X Grevillea ??	/	
X Lambertia ??		
X Trymalium ??		
X Hakea ??		
X Adenanthos ??		
X Velleia ophytum ??		
X Melaleuca sp. ??	X	
X Scaevola ??		
Bunch Grasses		
X Xanthorrhoea ??	X	
X Vulpia ??		
X Ehrharta ??	X	
X Lepi. ??	X	
Herbs		
X Conost. ??		
X Hypo. ??	/	
X Stylid. ??		
X Drosera ??		
X Trachy. ??		
X Hyp. ??		
X ?		
X Stypandra ??		
X Wachendorfia ??		
X Tetr. ??		
X Conost. ??	/	
X Lomandra ??		
X Patersonia ??		
X Haemodorum ??	/	

Herbs	No	ID
X Centaurium ??		
X Wahlenbergia ??		
X Senecio ??		
X Convolvulus ??	X	
X Trach. ??		
X Convolv. ??	/	
X Convolv. ??		
X ? Trifolium ??	X	
X ? Gaillardia ??	/	
X ? Arctotheca ??		
X Anthropodium ??	/	
X ? Agapanthus ??	X	
X ? Sefanotus ??	/	
Sedges		
X Isol. ??		
X Lepi. ??		
X ? Tetraria ??		
X Centrolepis ??	X	
X Evandra ??		

- SURVEY RECORDING SHEET Please use pencil

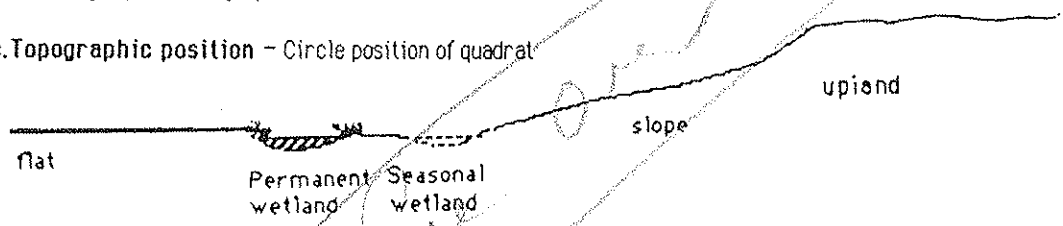
QUADRAT No. MTR 67 VEGETATION TYPE _____
DATE FIRST TRIP 2/9/92 VOLUNTEERS _____
DATE SECOND TRIP _____ VOLUNTEERS _____
BOTANIST HG, EJT

1. LOCATION of the QUADRAT

a. Mud Map Draw a sketch of the location of the quadrat the back of this sheet →

b. Photograph Photographer's name _____

c. Topographic position – Circle position of quadrat



Keighery and Keighery, 1990
Adapted from Griffin and Keighery, 1989
MOORE RIVER to JURIEN SANDPLAIN
SURVEY. WILDFLOWER SOCIETY of WA

2. SITE DATA – Circle the correct response

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

% Bare ground____ **Drainage** well mod poor **Wet** All year winter/spring

Litter (% cover)____ Surface soil_____ Sub-surface soil _____

3. VEGETATION STRUCTURE AND COVER. Record appropriate cover class

Cover Class – percentage classes: 0% | under 2% | 2–10% | 10–20% | 20–30% | 30–50% | 50–70% | over 70%

LIFE FORM	TREES		MALLEES	
	>15m or 5–15m	under 5m	MALLEE SHRUB less than 8m	MALLEE TREE 8m or more
COVER CLASS (%)	>15m 5–15m			

15m
10m
5m

LIFE FORM	SHRUBS				
	over 2m	2.0–1.5m	1.5–1.0m	1.0m – .5m	under .5m
COVER CLASS (%)					50–70%

3m
2m
1m

Height (metres)

LIFE FORM	BUNCH GRASSES	HERBS	SEDGES	
	Stipa under .5m	Misc or under .5m (except creepers)	over .5m	under .5m
COVER	<2%	30–50%		<2%

2.0m
1.5m
1.0m
.5m

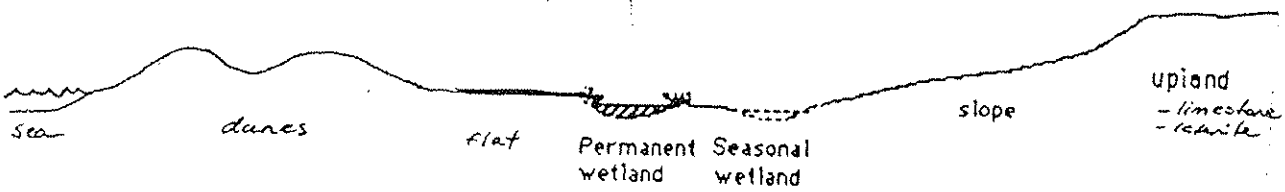
MTB-2

N

b Road Location	c. Latitude	Longitude
	32° 10' 46"	115° 46' 04"

d. **Photograph** Photographer's name _____ Photo No _____ Altitude

e. **Topographic position** – Circle position of quadrat



2. SITE DATA – Circle the correct response

Slope flat gentle steep

Aspect N NE E SE S SW W NW

Surface soil _____

Sub-surface soil _____

Drainage well mod poor

Wet All year winter/spring

Litter (% cover) _____

% Bare ground _____

4. VEGETATION CONDITION

EXCELLENT	
VERY GOOD	
GOOD	
POOR	✓
VERY POOR	

Comments

1. SPECIES PRESENCE

- **work systematically through the vegetation**, start with the tallest stratum, i.e. trees
- within each stratum try to record the **most common species first** and the most uncommon last.
- as each species is collected **label** it with a numbered tag and use this number on your recording sheet
- indicate if the species is in **flower**

QUADRAT No.
MTB 02

Keighery and Keighery, 1990
Adapted from Griffin and Keighery, 1989
MOORE RIVER to JURIEN SANDPLAIN
SURVEY. WILDFLOWER SOCIETY of WA

Trees

No	ID

Mallees

No	ID

SHRUBS

No	ID

SHRUBS

No	ID

Bunch Grasses

No	ID

Herbs

No	ID

Herbs

No	ID

Sedges

No	ID

- SURVEY RECORDING SHEET Please use pencil

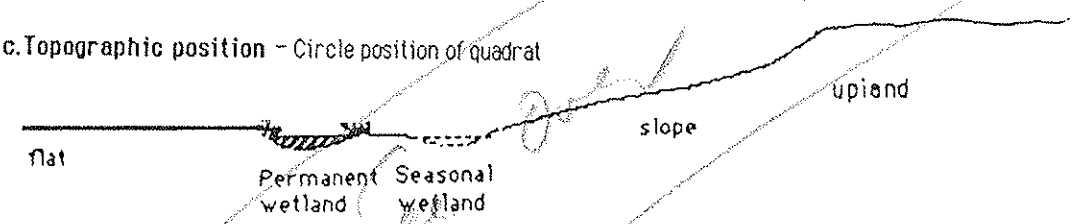
QUADRAT No. MTB 03 VEGETATION TYPE _____
DATE FIRST TRIP 7/7/92 VOLUNTEERS _____
DATE SECOND TRIP _____ VOLUNTEERS _____
BOTANIST _____

1. LOCATION of the QUADRAT

a. **Mud Map** Draw a sketch of the location of the quadrat the back of this sheet →

b. **Photograph** Photographer's name _____

c. **Topographic position** – Circle position of quadrat



Keighery and Keighery, 1990
Adapted from Griffin and Keighery, 1989
MOORE RIVER to JURIEN SANDPLAIN
SURVEY. WILDFLOWER SOCIETY of WA

2. SITE DATA – Circle the correct response

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

% Bare ground____ Drainage well mod poor Wet All year winter/spring

Litter (% cover)____ Surface soil_____ Sub-surface soil _____

3. VEGETATION STRUCTURE AND COVER Record appropriate cover class

Cover Class – percentage classes: 0% | under 2% | 2-10% | 10-20% | 20-30% | 30-50% | 50-70% | over 70%

	TREES		MALLEES	
LIFE FORM	>15m or 5-15m	under 5m	MALLEE SHRUB less than 8m	MALLEE TREE 8m or more
COVER CLASS (%)	>15m 5-15m		10-20%	

15m
10m
5m

	SHRUBS				
LIFE FORM	over 2m	2.0-1.5m	1.5-1.0m	1.0m - .5m	under .5m
COVER CLASS (%)			50-70%		

3m
2m
1m

Height (metres)

	BUNCH GRASSES	HERBS	SEDGES	
LIFE FORM	under .5m	under .5m (except creepers)	over .5m	under .5m
COVER				

1.0m
.5m
1.0m
.5m

30 - 50%

MTB-3

1. LOCATION of the QUADRAT

a. Mud Map Draw a sketch of the location of the quadrat :

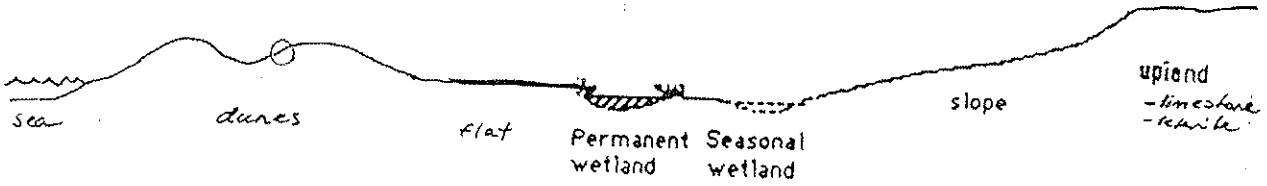
Just to E of Gate track

Mallee woodland

b Road Location	c. Latitude	Longitude
	32° 10' 16.3"	115 46 37.6

d. Photograph Photographer's name LC Photo # No Altitude

e. Topographic position – Circle position of quadrat



2. SITE DATA – Circle the correct response

Slope flat (gentle) steep

Aspect (N) NE E SE S SW W NW

Surface soil brown sand – small amount of limestone

Sub-surface soil limestone + bright orange-yel sand

Drainage (well) mod poor

Environ Creek LS 1

Wet All year winter/spring

Litter (% cover) 20-30%

% Bare ground 2-10%

4. VEGETATION CONDITION

EXCELLANT	
VERY GOOD	
GOOD	
POOR	
VERY POOR	

Comments

tracks + rabbit burrows rabbits droppings, rabbit feed

4. SPECIES PRESENCE

- **work systematically through the vegetation**, start with the tallest stratum, i.e. trees
- within each stratum try to record the **most common species first** and the most uncommon last.
- as each species is collected **label** it with a numbered tag and use this number on your recording sheet
- indicate if the species is in **flower**

QUADRAT No. MRD 3

Keighery and Keighery, 1990
Adapted from Griffin and Keighery, 1989
MOORE RIVER to JURIEN SANDPLAIN SURVEY. WILDFLOWER SOCIETY of WA

Trees

	No	ID

Mallees

	No	ID

SHRUBS

	No	ID

SHRUBS

	No	ID

Bunch Grasses

	No	ID

Herbs

	No	ID

Herbs

	No	ID

Sedges

	No	ID

SURVEY RECORDING SHEET Please use pencil

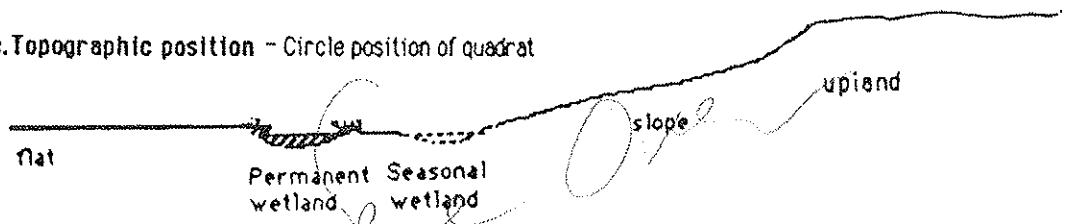
QUADRAT No. MTR 94 VEGETATION TYPE
DATE FIRST TRIP 29/10/92 VOLUNTEERS
DATE SECOND TRIP VOLUNTEERS
BOTANIST Tim Nooks & NC Dick

1. LOCATION of the QUADRAT

a. Mud Map Draw a sketch of the location of the quadrat the back of this sheet →

b. Photograph Photographer's name

c. Topographic position – Circle position of quadrat



Keighery and Keighery, 1990
Adapted from Griffin and Keighery, 1989
MOORE RIVER to JURIEN SANDPLAIN
SURVEY. WILDFLOWER SOCIETY of WA

2. SITE DATA – Circle the correct response

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

% Bare ground **Drainage** well mod poor **Wet** All year winter/spring

Litter (% cover) **Surface soil** **Sub-surface soil**

3. VEGETATION STRUCTURE AND COVER Record appropriate cover class

Cover Class – percentage classes: 0% | under 2% | 2–10% | 10–20% | 20–30% | 30–50% | 50–70% | over 70%

	TREES	MALLEES		
LIFE FORM	>15m or 5–15m	under 5m	MALLEE SHRUB less than 8m	MALLEE TREE 8m or more
COVER CLASS (%)	>15m 10–20 5–15m	20–30%		

	SHRUBS					
LIFE FORM	Xanth. over 2m	2.0–1.5m	1.5–1.0m	1.0m – .5m	under .5m	
COVER CLASS (%)	>70%		2–10%		2–10%	

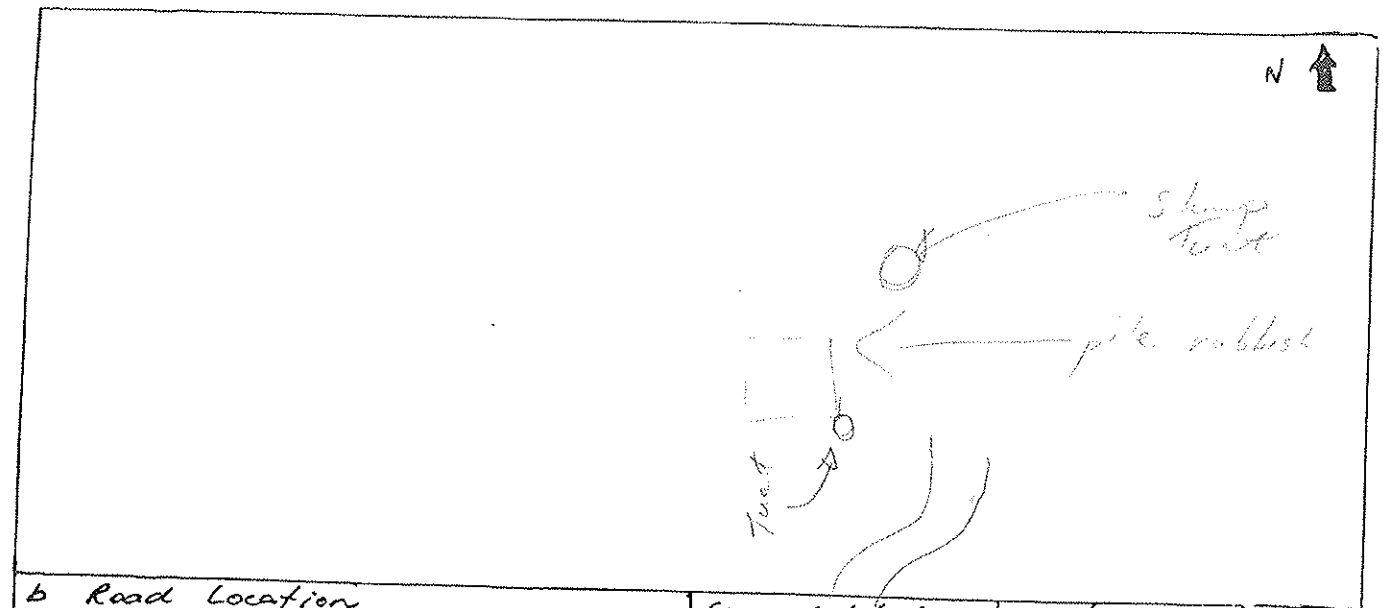
Height (metres): 3m, 2m, 1m

	BUNCH GRASSES	HERBS	SEDGES	
LIFE FORM	under .5m	under .5m (except creepers)	over .5m	under .5m
COVER	2–10%	2–10%		

2.0m, 1.5m, 1.0m, .5m

a. Mud Map Draw a sketch of the location of the quadrat

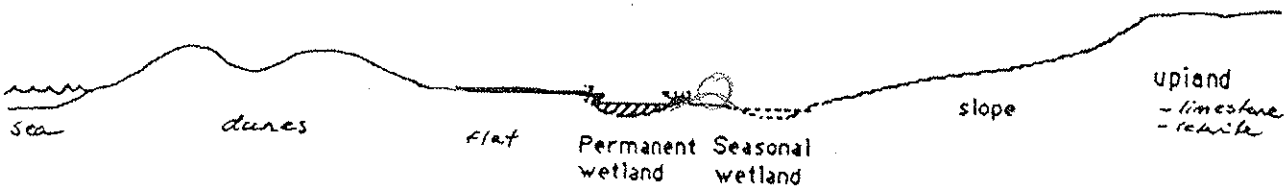
MTB-4



b Road Location	c. Latitude	Longitude 52.0
-	32° 09' 35"	115° 66'

d. Photograph Photographer's name NG Photo No ± 300m Altitude 20m

e. Topographic position - Circle position of quadrat



2. SITE DATA - Circle the correct response

Slope flat gentle steep

Aspect N NE E SE S SW W NW

Surface soil grey | sand

Sub-surface soil grey sand, limestone exposure in patches

Drainage well mod poor

Wet All year winter/spring

Litter (% cover) 90%

% Bare ground 10%

4. VEGETATION CONDITION

EXCELLENT	
VERY GOOD	
GOOD	✓
POOR	
VERY POOR	

Comments

Banksia = woody.

SPECIES PRESENCE

QUADRAT No.
MTB 04

- **work systematically through the vegetation**, start with the tallest stratum, i.e. trees
- within each stratum try to record **most common species first** and the most uncommon last.
- as each species is collected **label** it with a numbered tag and use this number on your recording sheet
- indicate if the species is in **flower**

Keighery and Keighery, 1990
Adapted from Griffin and Keighery, 1989
MOORE RIVER to JURIEN SANDPLAIN SURVEY. WILDFLOWER SOCIETY of WA

Trees

	No	ID
Eucalyptus gomphocephala		
Eucalyptus [illegible]		

Mallees

	No	ID

SHRUBS

	No	ID
Xanthorrhoea [illegible]		
Xanthorrhoea [illegible]		
Calothamnus rosaceus		
Leucopogon [illegible]		
Conostylis setigera subsp. setigera = RBDK		
RBDJ		
Stirlingia [illegible]		
Conostylis [illegible]		

SHRUBS

	No	ID
24/10/92		
* Pentaschistis [illegible]		
* Ursinia [illegible]		
* Conostylis [illegible]		
* Anthocercis [illegible]		
Hibbertia [illegible]		
* Arctotheca [illegible]		
* Hypochaeris [illegible]		
Vulpia [illegible]		

Bunch Grasses

	No	ID
Stipa [illegible]		
Poa [illegible]		

Herbs

	No	ID
* Trachyandra [illegible]		
* Gnephosis [illegible]		
* Borya [illegible]		
* Wahlenbergia [illegible]		
* Lechenaultia [illegible]		
* Schoenia [illegible]		
Stylidium [illegible]		
Hemiandra [illegible]		
Petrophile [illegible]		
Calytrix [illegible]		
* Caladenia [illegible]		
* Drosera [illegible]		

Herbs

	No	ID
RBDJ Hydrocotyle [illegible]		

Sedges

	No	ID
Hypolaena [illegible]		

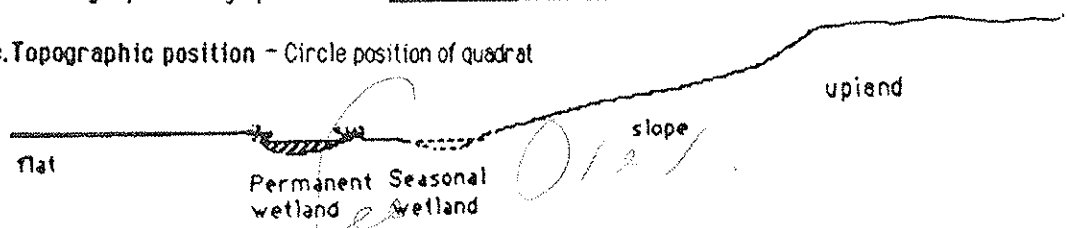
QUADRAT No. MTB 85 VEGETATION TYPE Mel mal
DATE FIRST TRIP 22/10/90 VOLUNTEERS
DATE SECOND TRIP VOLUNTEERS
BOTANIST BJK, AC

1. LOCATION of the QUADRAT

a. **Mud Map** Draw a sketch of the location of the quadrat the back of this sheet →

b. **Photograph** Photographer's name

c. **Topographic position** – Circle position of quadrat



Keighery and Keighery, 1990
Adapted from Griffin and Keighery, 1989
MOORE RIVER to JURIEN SANDPLAIN SURVEY. WILDFLOWER SOCIETY of WA

2. SITE DATA – Circle the correct response

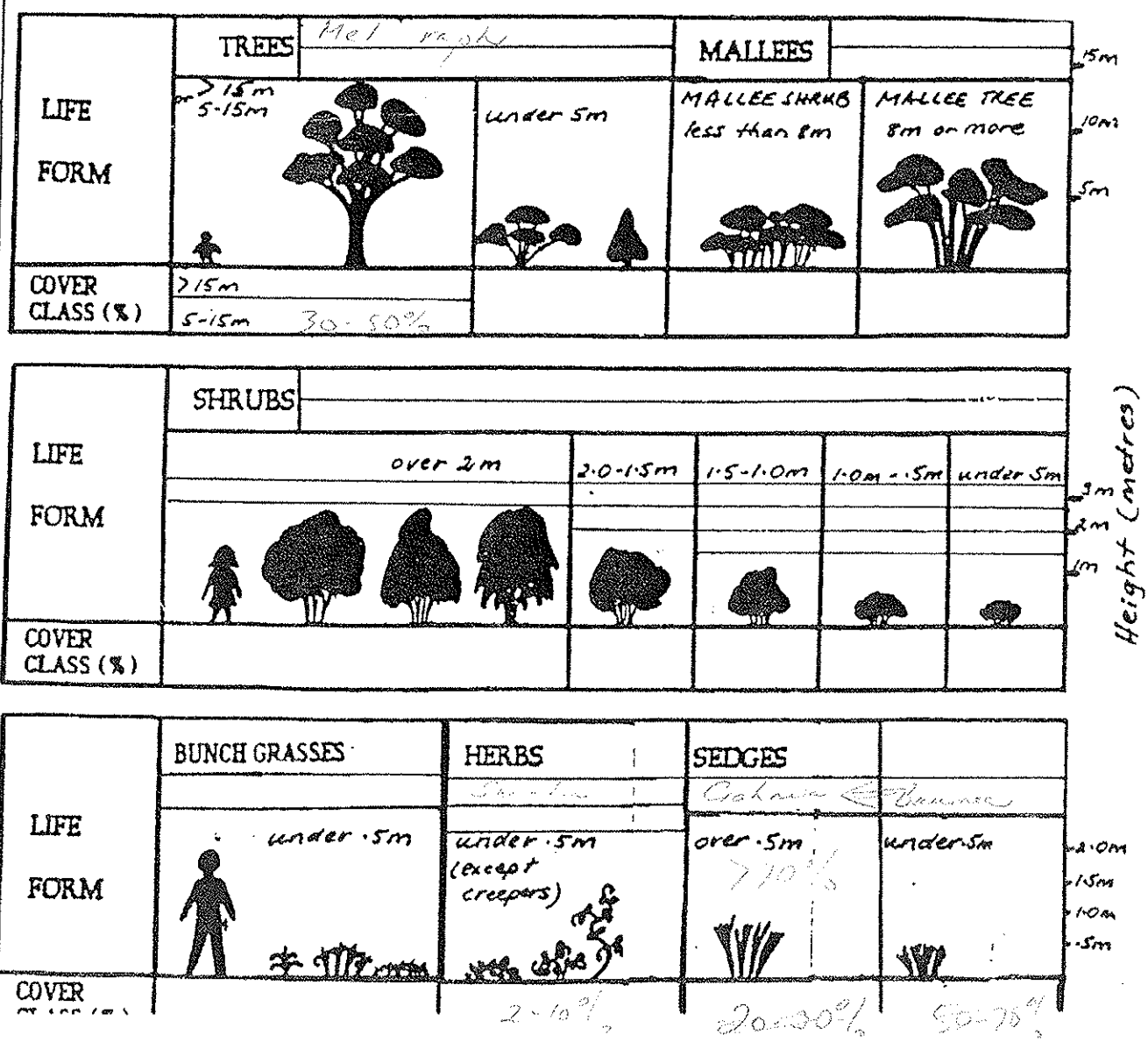
Slope flat gentle steep **Aspect** N NE E SE S SW W NW

% Bare ground Drainage well mod poor **Wet** All year winter/spring

Litter (% cover) Surface soil Sub-surface soil

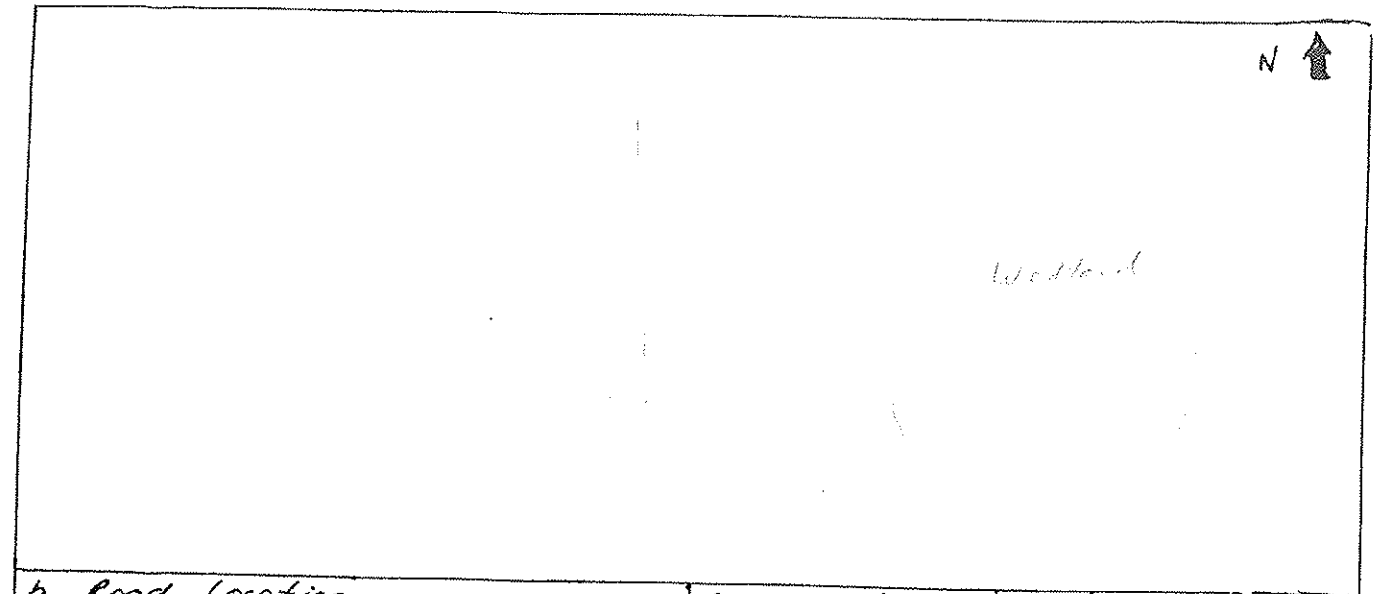
3. VEGETATION STRUCTURE AND COVER Record appropriate cover class

Cover Class – percentage classes: 0% under 2% | 2-10% | 10-20% | 20-30% | 30-50% | 50-70% | over 70%



a. **Mud Map** Draw a sketch of the location of the quadrat

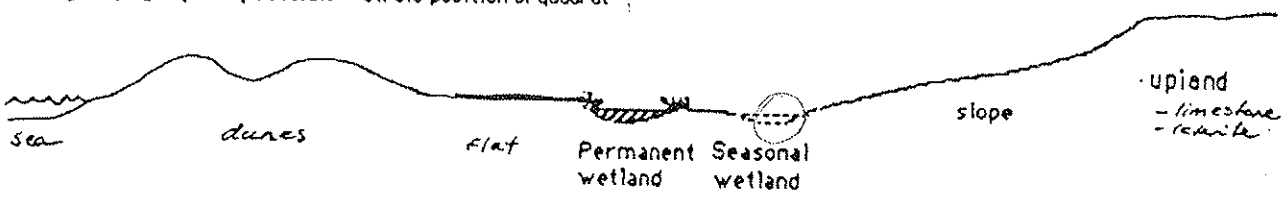
MTB-5



b Road Location	c. Latitude	Longitude
Brown mon Swamp	32° 09' 31.0"	115° 46' 58.5"

d. **Photograph** Photographer's name NG Photo No 1 100mm Altitude 70m

e. **Topographic position** – Circle position of quadrat



2. SITE DATA – Circle the correct response

Slope (flat) gentle steep

Aspect (N) NE E SE S SW W NW

Surface soil Brown Clayey Sand

Sub-surface soil Clay Environ Geol MS

Drainage well mod (poor)

Wet All year (winter/spring)

Litter (% cover) 50%

% Bare ground 10-20%

4. VEGETATION CONDITION

		Comments
EXCELLENT		Undisturbed with no opportunities available. Frequently burnt, jarrahdale block.
VERY GOOD	✓	
GOOD		
POOR		
VERY POOR		

SPECIES PRESENCE

- **work systematically through the vegetation**, start with the tallest stratum, i.e. trees
- within each stratum try to record **most common species first** and the most uncommon last.
- as each species is collected **label** it with a numbered tag and use this number on your recording sheet
- indicate if the species is in **flower**

QUADRAT No. MRB 65

Keighery and Keighery, 1990
Adapted from Griffin and Keighery, 1989
MOORE RIVER to JURIEN SANDPLAIN SURVEY. WILDFLOWER SOCIETY of WA

MRB 65

Trees	No	ID
Eucalyptus rudis		
Mallees		
SHRUBS		
Melaleuca huegelii		

SHRUBS	No	ID
Bunch Grasses		
Herbs		
Conostylis juncea		
Algae		

Herbs	No	ID
Sedges		
Baloskion tetraphyllum		
Kunzea glabrescens		
Leptocarpus coangustatus		
Lepidosperma squamatum		

- SURVEY RECORDING SHEET **Please use pencil**

QUADRAT No. mrb6 01 VEGETATION TYPE _____

DATE FIRST TRIP 2/7/97 VOLUNTEERS _____

DATE SECOND TRIP _____ VOLUNTEERS _____

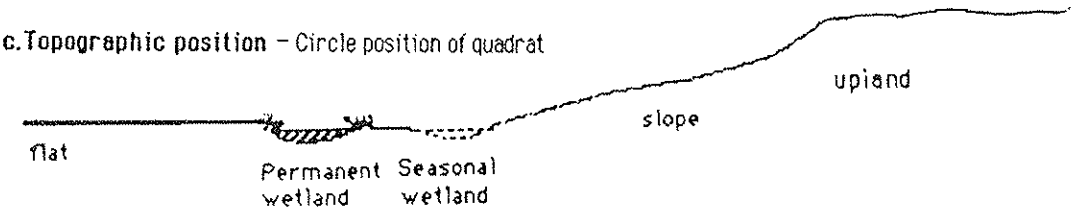
BOTANIST MC DOK

1. LOCATION of the QUADRAT

a. Mud Map Draw a sketch of the location of the quadrat the back of this sheet →

b. Photograph Photographer's name _____

c. Topographic position – Circle position of quadrat



Keighery and Keighery, 1990
Adapted from Griffin and Keighery, 1989
MOORE RIVER to JURIEN SANDPLAIN
SURVEY. WILDFLOWER SOCIETY of WA

2. SITE DATA – Circle the correct response

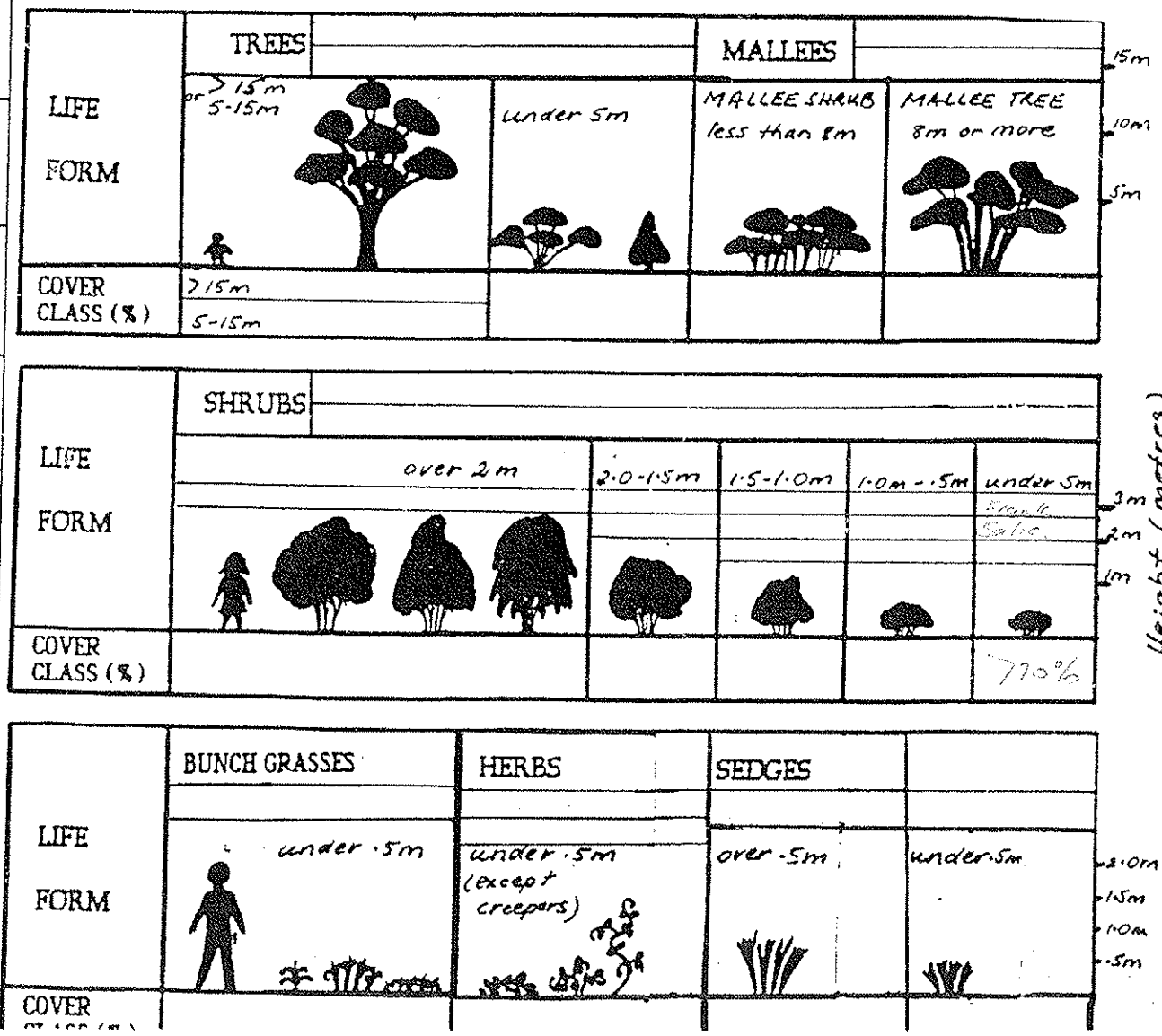
Slope flat gentle steep **Aspect** N NE E SE S SW W NW

% Bare ground____ **Drainage** well mod poor **Wet** All year winter/spring

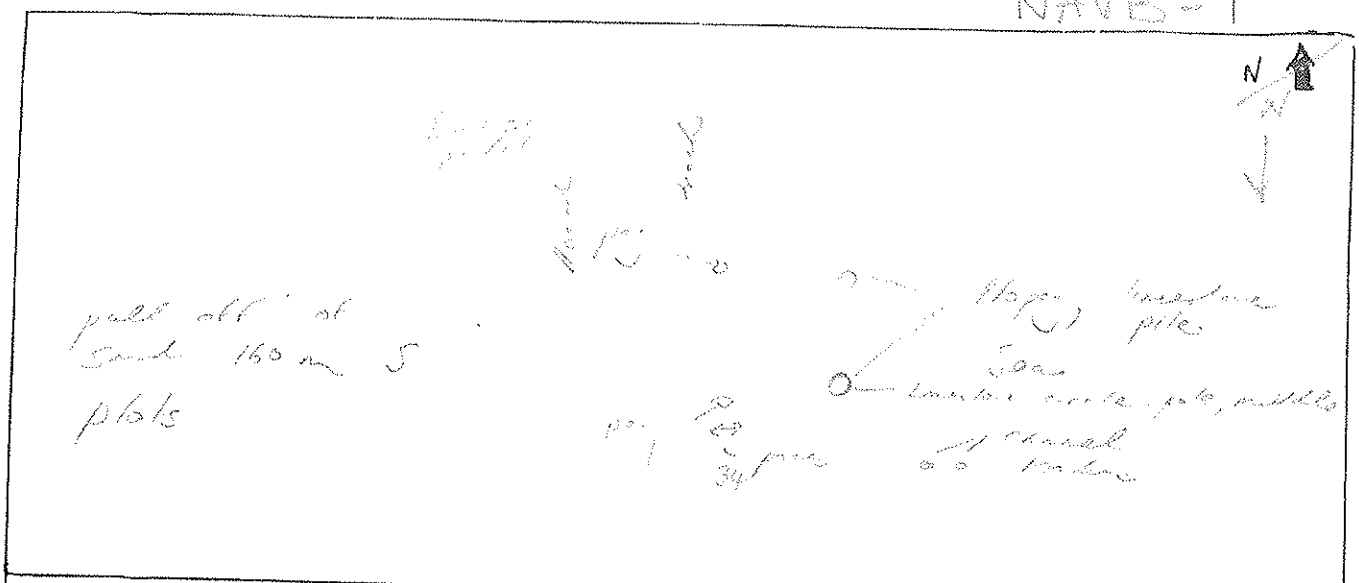
Litter (% cover)____ **Surface soil**_____ **Sub-surface soil** _____

3. VEGETATION STRUCTURE AND COVER Record appropriate cover class

Cover Class – percentage classes: 0% | under 2% | 2–10% | 10–20% | 20–30% | 30–50% | 50–70% | over 70%



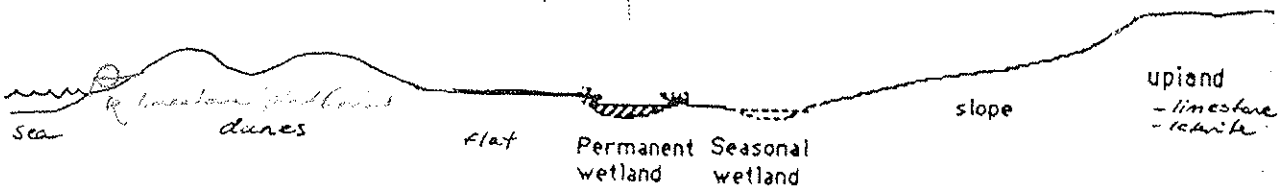
NAVB-1



b Road Location	c. Latitude	Longitude
	32° 09' 52.2"	115° 66' 04.3"

d. Photograph Photographer's name NG Photo # N, ± 30m Altitude

e. Topographic position – Circle position of quadrat



2. SITE DATA – Circle the correct response

Slope flat (gentle) steep

Aspect N NE E SE S SW W NW

Surface soil grey sand, shell grit & underlying limestone

Sub-surface soil limestone Environ Geol LS 1

Drainage (well) mod poor

Wet All year winter/spring

Litter (% cover) 5%

% Bare ground 5 - 10%

4. VEGETATION CONDITION

		Comments
EXCELLENT		Rabbits known on site
VERY GOOD	✓	? Thrush nest
GOOD		
POOR		
VERY POOR		

1. SPECIES PRESENCE

- **work systematically through the vegetation**, start with the tallest stratum, i.e. trees
- within each stratum try to record the **most common species first** and the most uncommon last.
- as each species is collected **label** it with a numbered tag and use this number on your recording sheet
- indicate if the species is in **flower**

QUADRAT No.
NAVC 1

Keighery and Keighery, 1990
Adapted from Griffin and Keighery, 1989
MOORE RIVER to JURIEN SANDPLAIN
SURVEY. WILDFLOWER SOCIETY of WA

Trees

No	ID

Mallees

No	ID

SHRUBS

No	ID
1 Eucalyptus rameli	
1 Sarcocornia quinqueflora	X
1 Thryptomene d. Rhizo	
1 Astrotricha decumbens	
1 Xanthos rugosa	
1 Melaleuca cheeseana	X

SHRUBS

No	ID

Bunch Grasses

No	ID
2 Poa annua	✓
2 Ehrharta virgata	X

Herbs

No	ID
1 Cardamine no Emu Swamp	
~~1 Lotus~~	~~X~~
1 Centaurium erythraea	X
1 Medicago indica	X
(= Medicago minima?)	

Herbs

No	ID

Sedges

No	ID

- SURVEY RECORDING SHEET Please use pencil

QUADRAT No. NAVB 02 VEGETATION TYPE _____

DATE FIRST TRIP 7/7/22 VOLUNTEERS _____

DATE SECOND TRIP _____ VOLUNTEERS _____

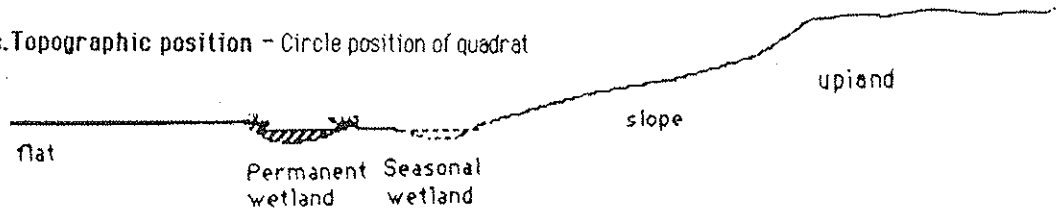
BOTANIST HC BJC

1. LOCATION of the QUADRAT

a. Mud Map Draw a sketch of the location of the quadrat the back of this sheet →

b. Photograph Photographer's name _____

c. Topographic position – Circle position of quadrat



Keighery and Keighery, 1990
Adapted from Griffin and Keighery, 1989
MOORE RIVER to JURIEN SANDPLAIN
SURVEY. WILDFLOWER SOCIETY of WA

2. SITE DATA – Circle the correct response

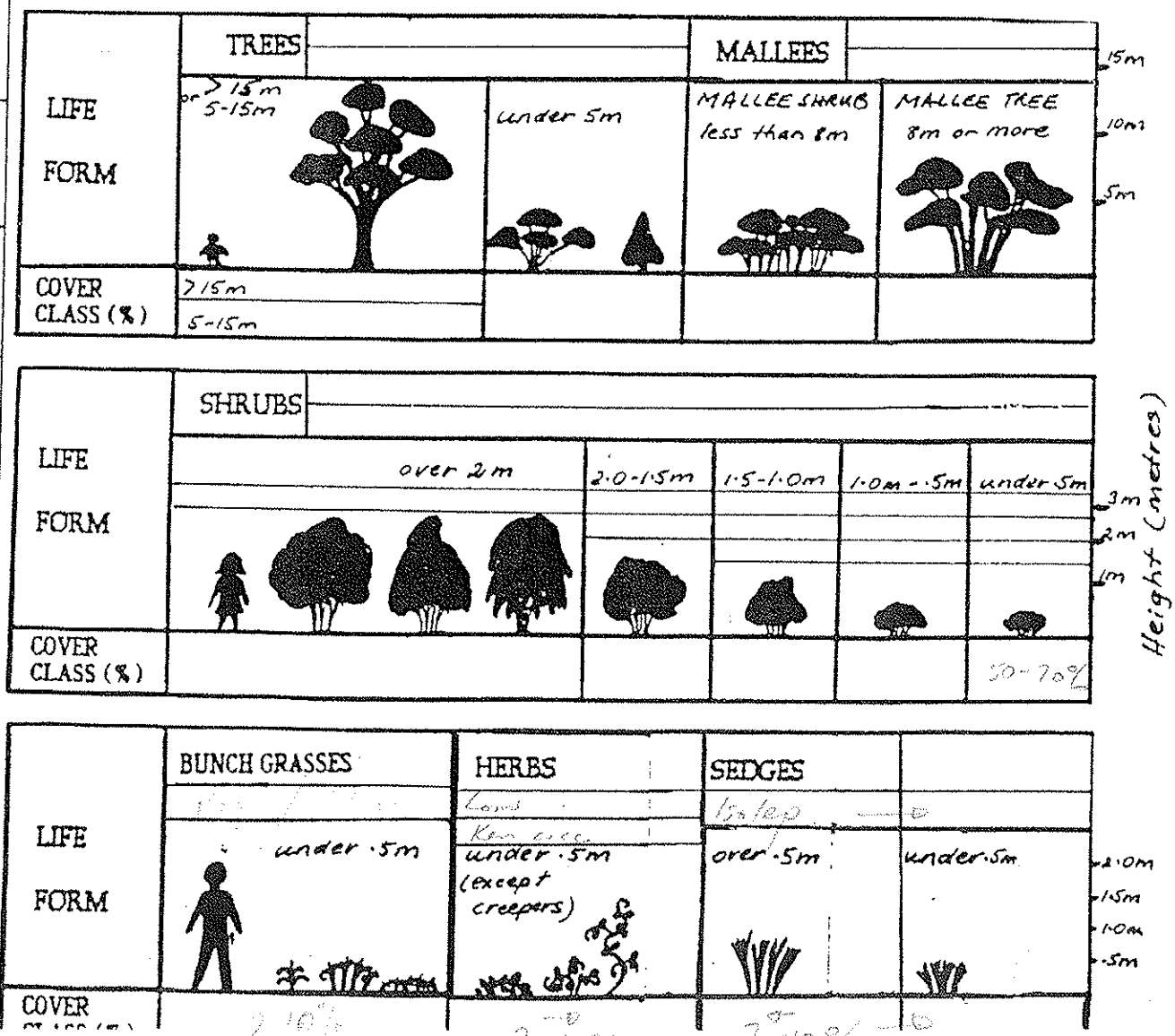
Slope flat gentle steep Aspect N NE E SE S SW W NW

% Bare ground____ Drainage well mod poor Wet All year winter/spring

Litter (% cover)____ Surface soil_____ Sub-surface soil _____

3. VEGETATION STRUCTURE AND COVER Record appropriate cover class

Cover Class – percentage classes: 0% | under 2% | 2–10% | 10–20% | 20–30% | 30–50% | 50–70% | over 70%



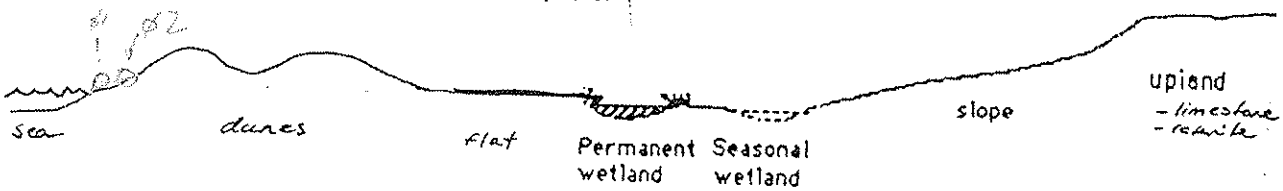
NAME 2

N

b Road Location	c. Latitude	Longitude
Sea NAME Ø1	Sea Ø1	Altitude

d. Photograph Photographer's name NG Photo No

e. Topographic position – Circle position of quadrat



2. SITE DATA – Circle the correct response

Slope flat gentle steep

Aspect N NE E SE S SW W NW

Surface soil

Sub-surface soil limestone

Drainage well mod poor

Wet All year winter/spring

Litter (% cover)

% Bare ground

4. VEGETATION CONDITION

		Comments
EXCELLENT		
VERY GOOD		
GOOD	✓	
POOR		
VERY POOR		

4. SPECIES PRESENCE

- **work systematically through the vegetation**, start with the tallest stratum, i.e. trees
- within each stratum try to record the **most common species first** and the most uncommon last.
- as each species is collected **label** it with a numbered tag and use this number on your recording sheet
- indicate if the species is in **flower**

QUADRAT No.
NRLB D2

Keighery and Keighery, 1990
Adapted from Griffin and Keighery, 1989
MOORE RIVER to JURIEN SANDPLAIN
SURVEY. WILDFLOWER SOCIETY of WA

Trees

	No	ID

Mallees

	No	ID

SHRUBS

	No	ID
Hemiandra pungens		
Dryandra nivea		
Petrophile serruriae	X	
Kingia australis		
Hakea prostrata		
Isopogon sphaerocephalus		
Leucopogon parviflorus		
Hibbertia hypericoides		
Verticordia plumosa var. plumosa		
Thryptomene australis		

SHRUBS

	No	ID
Banksia sessilis var. cygnorum		
Calothamnus quadrifidus		
Conostylis setosa		
Hakea ruscifolia		
Hibbertia hypericoides		
Jacksonia furcellata		
Leucopogon australis		
Leucopogon parviflorus		
Melaleuca acerosa		
Melaleuca cuticularis		
Melaleuca huegelii		
Melaleuca systena		
Melaleuca thymoides		
Petrophile linearis		
Phyllanthus calycinus		
Scholtzia involucrata		
Stirlingia latifolia		
Verticordia densiflora var. densiflora		
Verticordia plumosa var. plumosa		

Bunch Grasses

	No	ID
Ehrharta calycina		
Lepidosperma gladiatum		
Lepidosperma squamatum		
Schoenus curvifolius		
Schoenus grandiflorus		
Schoenus nanus		
Schoenus pleiostemoneus		
Tetraria octandra		
Xanthorrhoea preissii		

Herbs

	No	ID
Actinotus leucocephalus		
Arctotheca calendula		
Arctotheca populifolia		
Briza maxima		
Briza minor		
Bromus diandrus		
Bromus hordeaceus		
Centaurium erythraea		
Cheilanthes austrotenuifolia		
Conostylis aculeata		
Conostylis candicans		
Conostylis setigera		
Cotula coronopifolia		
Cotula vulgaris		
Crassula colorata		
Crassula decumbens var. decumbens		
Crassula exserta		
Crassula glomerata		
Crassula natans var. natans		
Dampiera linearis		
Daucus glochidiatus		
Desmocladus flexuosus		
Drosera erythrorhiza		
Drosera glanduligera		
Drosera macrantha subsp. macrantha		
Drosera menziesii subsp. menziesii		
Drosera pallida		
Drosera stolonifera		
Ehrharta longiflora		
Erodium botrys		
Erodium cicutarium		
Eryngium pinnatifidum		
Euphorbia peplus		
Gastrolobium capitatum		
Gastrolobium spinosum		
Gompholobium tomentosum		
Gonocarpus pithyoides		
Gonocarpus scabridus		
Gonocarpus tetragynus		
Hakea varia		
Hemiandra pungens		
Hibbertia commutata		
Hibbertia hypericoides		
Hibbertia racemosa		
Hypochaeris glabra		
Hypochaeris radicata		
Isolepis cernua		
Isolepis marginata		
Isolepis nodosa		
Jacksonia furcellata		
Lagenifera huegelii		
Lagenifera stipitata		
Lasiopetalum floribundum		
Lavatera plebeia		
Leucopogon australis		
Leucopogon parviflorus		
Lobelia rhytidosperma		
Logfia gallica		
Lotus angustissimus		
Lysimachia arvensis		
Macarthuria keigheryi		
Macrozamia fraseri		
Mesembryanthemum crystallinum		
Mesembryanthemum nodiflorum		
Microtis media subsp. media		
Moraea flaccida		
Neurachne alopecuroidea		
Opercularia vaginata		
Orthrosanthus laxus		
Patersonia occidentalis		
Petrorhagia dubia		
Petrorhagia velutina		
Phyllangium paradoxum		
Pimelea angustifolia subsp. angustifolia		
Pimelea calcicola		
Pimelea ciliata		
Pimelea rosea		
Pimelea suaveolens subsp. suaveolens		
Pimelea sulcata		
Podolepis canescens		
Podotheca angustifolia		
Polygala barbata		
Polygala pungens		
Ptilotus drummondii var. drummondii		
Ptilotus manglesii		
Ptilotus polystachyus		
Ptilotus sessilifolius		
Ptilotus spathulatus		
Ptilotus spathulatus var. spathulatus		
Ptilotus spathulatus var. velutinus		
Ptilotus stirlingii		
Ptilotus subspinescens		
Ptilotus supplicatus		
Ptilotus velutinus		
Rhodanthe citrina		
Rhodanthe floribunda		
Rhodanthe manglesii		
Rhodanthe pyrethrifolia		
Rhodanthe stricta		
Rumex acetosella		
Schoenus curvifolius		
Schoenus grandiflorus		
Schoenus nanus		
Schoenus pleiostemoneus		
Senecio glomeratus		
Senecio hyssopifolius		
Senecio pinnatifolius		
Silene gallica		
Solanum nigrum		
Solenogyne bellioides		
Sonchus asper		
Sonchus oleraceus		
Stackhousia monogyna		
Stylidium affine		
Stylidium brunonianum		
Stylidium calcaratum		
Stylidium crossocephalum		
Stylidium diuris		
Stylidium ecorne		
Stylidium glandulosum		
Stylidium hispidum		
Stylidium junceum		
Stylidium piliferum		
Stylidium repens		
Stylidium scandens		
Stylidium schoenoides		
Stylidium tenuifolium		
Thelymitra antennifera		
Thelymitra crinita		
Thelymitra flexuosa		
Thelymitra macrophylla		
Thelymitra nuda		
Trachymene pilosa		
Trachymene pilosa var. pilosa		
Trachymene pilosa var. glabrata		
Trachymene pilosa var. multifida		
Trachymene pilosa var. pilosa		
Trachymene pilosa var. subtilis		
Trachymene pilosa var. trichocarpa		
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- SURVEY RECORDING SHEET Please use pencil

QUADRAT No. NMB 03 VEGETATION TYPE _____

DATE FIRST TRIP 2/9/92 VOLUNTEERS _____

DATE SECOND TRIP _____ VOLUNTEERS _____

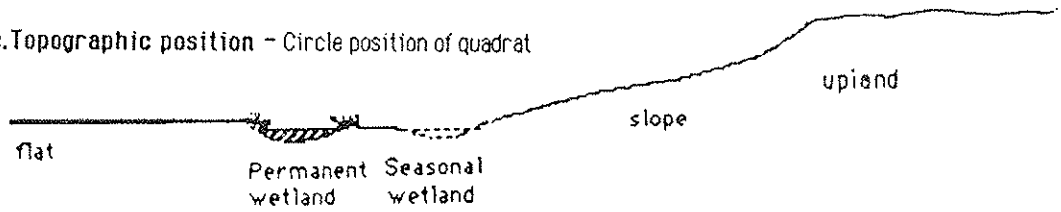
BOTANIST NG, ASK

1. LOCATION of the QUADRAT

a. **Mud Map** Draw a sketch of the location of the quadrat the back of this sheet →

b. **Photograph** Photographer's name _____

c. **Topographic position** – Circle position of quadrat



Keighery and Keighery, 1990
Adapted from Griffin and Keighery, 1989
MOORE RIVER to JURIEN SANDPLAIN SURVEY. WILDFLOWER SOCIETY of WA

2. SITE DATA – Circle the correct response

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

% Bare ground____ Drainage well mod poor **Wet** All year winter/spring

Litter (% cover)____ Surface soil_____ Sub-surface soil _____

3. VEGETATION STRUCTURE AND COVER Record appropriate cover class

Cover Class – percentage classes: 0% | under 2% | 2-10% | 10-20% | 20-30% | 30-50% | 50-70% | over 70%

LIFE FORM					COVER CLASS (%)
TREES		MALLEES			
>15m or 5-15m	under 5m	MALLEE SHRUB less than 8m	MALLEE TREE 8m or more	15m / 10m / 5m	>15m 5-15m
SHRUBS					
over 2m	2.0-1.5m	1.5-1.0m	1.0m-.5m	under .5m	<2% 5-70%
BUNCH GRASSES	HERBS	SEDGES			
under .5m	under .5m (except creepers)	over .5m	under .5m	2.0m / 1.5m / 1.0m / .5m	2-10% 2-10%

Height (metres)

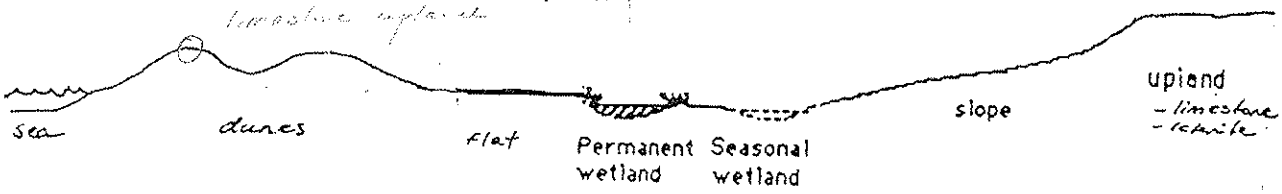
NAVB-3

N

b Road Location	c. Latitude	Longitude
	32° 10' 17.3".	115° 46' 15.1"

d. Photograph Photographer's name _____ Photo No _____ ± 30m Altitude 5m

e. Topographic position – Circle position of quadrat



2. SITE DATA – Circle the correct response

Slope flat gentle steep

Aspect N NE E SE S SW W NW

Surface soil brown sand

Sub-surface soil limestone

Drainage well mod poor

Wet All year winter/spring

Litter (% cover) 10%

% Bare ground

4. VEGETATION CONDITION

		Comments
EXCELLENT		
VERY GOOD		
GOOD		
POOR		
VERY POOR		

4. SPECIES PRESENCE

- **work systematically through the vegetation**, start with the tallest stratum, i.e. trees
- within each stratum try to record the **most common species first** and the most uncommon last.
- as each species is collected **label** it with a numbered tag and use this number on your recording sheet
- indicate if the species is in **flower**

QUADRAT No. WAK 53

Keighery and Keighery, 1990
Adapted from Griffin and Keighery, 1989
MOORE RIVER to JURIEN SANDPLAIN
SURVEY. WILDFLOWER SOCIETY of WA

Trees	No	ID

Mallees	No	ID

SHRUBS	No	ID
Thy. sp. aff.		
Lichen root		
Melo. huegeli		
Leuc. gelida		
Dry. lasiocarpa		
Conos. linoides		
Hakea sp. aff. lissosperma		
Phebalium sp.		
Hak. scoparia (mucr.)		
Thomasia (Cala. tax.) (Picognata)	X	
Pteridium esculentum		
Acrotriche cuneata	✓	
Pultenaea pinifolia		
very depauperate		

SHRUBS	No	ID
[illegible]		
[illegible]		
✓ Centaurium erythraea		
✓ [illegible]		
[illegible] a conferta = PB		
[illegible]	✓	
[illegible]	✓	
[illegible] ✓ cicola	✓	
[illegible]		
[illegible]		
[illegible]	✓	
✓ Cantharinum violaceum		
✓ Trifolium campestre		

Bunch Grasses	No	ID
✓ Stipa flavescens		
✓ Lagurus ovatus	X	

Herbs	No	ID
X Hypochoeris glabra		
✓ Trachyandra divaricata		
✓ Briza minor		
✓ Brassica sp.		
✓ Lysimachia arvensis		
✓ Romulea rosea		
✓ Cotula coronopifolia		
✓ Centaurium spicatum		
✓ Euphorb. peplus		
✓ Galium aparine		
✓ Convolvulus sp.	X	
[illegible]		
✓ Petrorhagia dubia	X	
✓ Trifolium arvense		
✓ Plantago sp. (slender)	VSP	
✓ Erodium cicutarium	X	
✓ Arctotheca calendula		

Herbs	No	ID
✓ Lotus angustissimus		

Sedges	No	ID
Isolepis [illegible]		
Isolepis cernua complex		

- SURVEY RECORDING SHEET Please use pencil

QUADRAT No. NAKE 04 VEGETATION TYPE _____

DATE FIRST TRIP 7/7/92 VOLUNTEERS _____

DATE SECOND TRIP _____ VOLUNTEERS _____

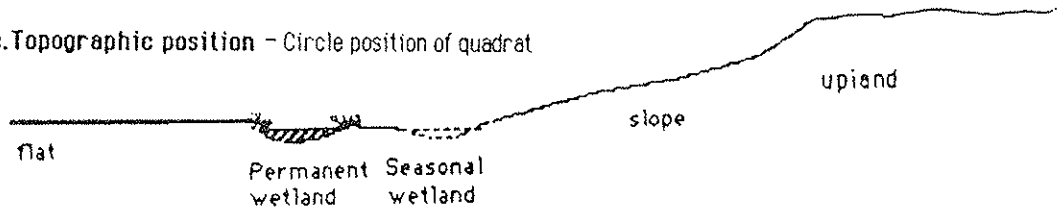
BOTANIST NG, BJK

1. LOCATION of the QUADRAT

a. Mud Map Draw a sketch of the location of the quadrat the back of this sheet →

b. Photograph Photographer's name _____

c. Topographic position – Circle position of quadrat



Keighery and Keighery, 1990
Adapted from Griffin and Keighery, 1989
MOORE RIVER to JURIEN SANDPLAIN
SURVEY. WILDFLOWER SOCIETY of WA

2. SITE DATA – Circle the correct response

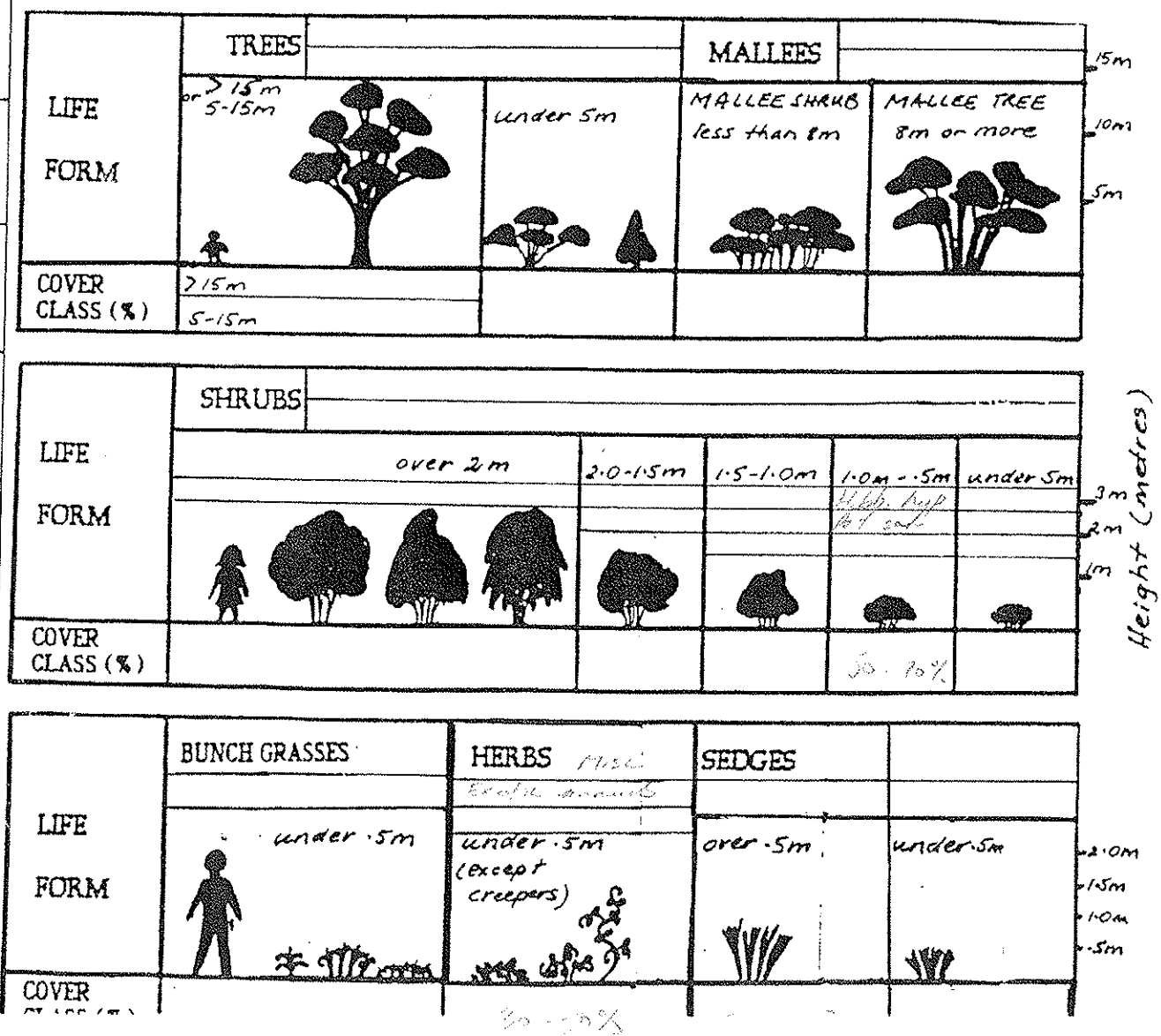
Slope flat gentle steep Aspect N NE E SE S SW W NW

% Bare ground____ Drainage well mod poor Wet All year winter/spring

Litter (% cover)____ Surface soil_____ Sub-surface soil _____

3. VEGETATION STRUCTURE AND COVER Record appropriate cover class

Cover Class – percentage classes: 0% | under 2% | 2–10% | 10–20% | 20–30% | 30–50% | 50–70% | over 70%



NAV 6-4

N

P3 - Ridge

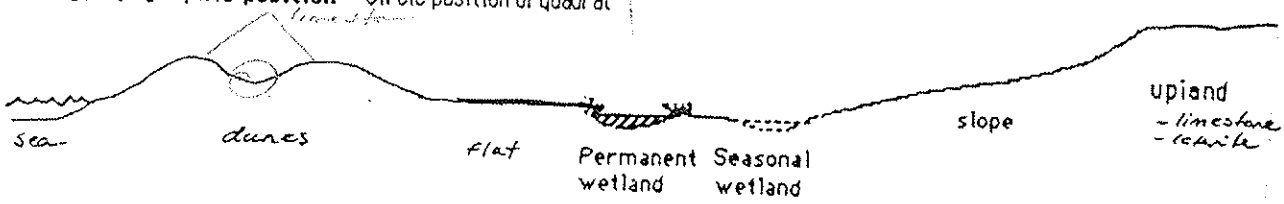
Q4 | Swale

Passenger Sign

b Road location	c. Latitude	Longitude
	32° 10' 19.2"	115° 46' 15.6"

d. Photograph Photographer's name _____ Photo No 230 Altitude 5m

e. Topographic position – Circle position of quadrat



2. SITE DATA – Circle the correct response

Slope flat gentle steep

Aspect N NE E SE S SW W NW

Surface soil orange | brown sand

Sub-surface soil limestone

Environ Geol 45 I

Drainage well mod poor

Some pools =

Wet All year winter/spring

Litter (% cover) 30-70 %

% Bare ground 2-10%

4. VEGETATION CONDITION

EXCELLANT	
VERY GOOD	
GOOD	
POOR	✓
VERY POOR	

Comments

All weed layer = exotic herbs
Low native
Rabbits, patchy disturbance

4. SPECIES PRESENCE

- **work systematically through the vegetation**; start with the tallest stratum, i.e. trees
- within each stratum try to record the **most common species first** and the most uncommon last.
- as each species is collected **label** it with a numbered tag and use this number on your recording sheet
- indicate if the species is in **flower**

QUADRAT No. plot 04

Keighery and Keighery, 1990
Adapted from Griffin and Keighery, 1989
MOORE RIVER to JURIEN SANDPLAIN SURVEY. WILDFLOWER SOCIETY of WA

Trees

	No	ID

Mallees

	No	ID

SHRUBS

	No	ID
Hibb. type		
Hak. teeth pink		
Solanum. Spinosum	X	
Hak. dact		
Lep. trine		
Hibb. linea		
Hak. crassa		
Cres. scab.		
Hak. salic.		
Hak. polyanthema cap		

SHRUBS

	No	ID
Myrsine		
Thomasiana		
" coriacea		
" N.g		
+ Eucalyptus		
Avena barbata.		
ok Sonchus		
Tagetes - garnered		
NOT ABLE TO GET most		

Bunch Grasses

	No	ID
*Ehrharta long		
Cyp. tenuif (N)		
Cyp. abortiporchata	X	

Herbs

	No	ID
Thys. pat form		
Conostylis candicans		
Hak. corn		
* Romulea rosea		
* Trifolium arv.	X	
* Vicia sativa	X	
* Stell		
* Romulea rosea		
Opercularia diomorpha	X	
Lomandra maritima		
Utricularia bicolor		
* Gnaphalium spicatum	X	
* Sonchus asper	X	
* Solanum nigrum		
* Arctotheca calendula		

Herbs

	No	ID
Crassula colorata		
Solanum nigrum		
? Brassicaceae - fr. like		
? Plantago = 02		
* Petrorhagia = 10 mm		
* Convolvulus glom.		
29/10		
* Arctotheca calendula		
S. hydrophilum.		

Sedges

	No	ID
Isolepis cernua		
Isopogon ? coarse		

Natural Reserves Management Study

Report to:

Environmental Division
City of Cockburn

Report by:

V & C Semeniuk Research Group

JUNE 1997

3.0 DESCRIPTION OF NATURAL FEATURES

The natural features of the reserves are described under categories of uplands and wetlands.

3.1 Uplands

Upland reserves are listed in an order corresponding to numbers assigned to them for this study. They are described in the following manner:

- location - in geographic terms
- geometrically in terms of size and shape;
- setting - in geomorphic terms;
- natural features in terms of landform, soils and vegetation.
- condition of vegetation
- functions

RESERVE #1 - M91 COASTAL RESERVE

The area of reserved remnant vegetation is located south of the Henderson Industrial Estate and west of Cockburn Road. It is a microscale area, linear in shape, approximately 200 m wide. This coastal reserve incorporates part of the western coastal edge of one of the Spearwood ridges. It is an undulating terrain incorporating several small scale geomorphic units: limestone pavements, low mounds, hollows and cliff tops. It is underlain by Tamala limestone and shallow brown soils. The vegetation cover forms a mosaic composed of five different assemblages and three different structures (Figure 3). They are: low closed heath (*Melaleuca acerosa, Grevillea thelemanniana, Hibbertia hypericoides, and Dryandra lindleyana*), closed scrub (*Acacia rostellifera, Spyridium globulosum),* sedgeland *(Lepidosperma gladiatum, Isolepis nodosa*), and two open low heaths (*Acanthocarpus preissii)* and *(Frankenia pauciflora*). Refer to Table 1 for a species list. The condition of the vegetation is good.

From information collected during this study, the functions of this reserve are mainly ecological, cultural (pertaining to heritage), and scientific. They are:

1. to preserve coastal heaths which function as important food sources to avifauna, especially honey eaters and wrens.

2. to maintain biodiversity by preserving the range of natural features and habitats described above

3. to maintain undisturbed representative examples of uncommon and poorly reserved remnant vegetation types particularly the low closed heath

4. to preserve this example of a now uncommon type of ecosystem (the coastal expression of a Spearwood Dune ridge), which is largely in its natural state

5. to preserve part of a linked system (the coastal expression of a Spearwood Dune ridge) which continues inland and incorporates wetlands

6. to preserve relationships evident here between landform/vegetation response and salt spray/species competition which are important to the study of natural ecology and the advancement of our understanding of ecological processes.

RESERVE #4 - HENDERSON REGIONAL OPEN SPACE

The area of reserved remnant vegetation is located south of the Cockburn International Raceway and east of Cockburn Road. It is a macroscale area, rectangular in shape, approximately 1 km wide. Henderson Regional Open Space incorporates part of the Spearwood ridges. It is an area of undulating hills incorporating several smallscale geomorphic units: interdune depressions, dunes, limestone hills (cemented Pleistocene parabolic dunes). It is underlain by Tamala limestone and shallow brown soils. The natural vegetation cover forms a mosaic comprising seven different assemblages and four different structures (Figure 4). These are: open woodland (*Eucalyptus.gomphocephala*), low woodland (*Banksia.attenuata*), low woodland (*E. decipiens*), closed heath (*Melaleuca acerosa, Grevillea thelemanniana, Hibbertia hypericoides*), closed scrub (*Acacia rostellifera*), closed scrub (*Dryandra sessilis*) and scrub (*Melaleuca huegelii, Dryandra sessilis*). A species list for the reserve is in Table 2. The vegetation is in good condition except for an area in the south west of the reserve where exotic species have been planted.

From information collected during this study, the functions of this reserve are mainly ecological, cultural (pertaining to heritage), and scientific. They are:

1. to preserve important habitats for avifauna (coastal heaths and *Banksia* woodlands), especially honey eaters and wrens, and to preserve marsupial populations.

2. to preserve biodiversity by maintaining habitat diversity.

3. to maintain undisturbed representative examples of uncommon and poorly reserved types of remnant vegetation such as the low closed heath and low woodland (*Eucalyptus. decipiens).*

4. to preserve the central and the best developed portion of a Spearwood Dune ridge in the City of Cockburn, including the isolated limestone hills and the dune topography formed by the blanketing of the ridge with yellow aeolian sand.

5. to preserve the clear relationship between the vegetation response and environmental factors such as the different geomorphic units, their different elevations and concomitant water availability, exposure to sea breezes, and insolation gradients.

RESERVE #2 - BROWNMAN SWAMPS RESERVE

Brownman Swamps is the local name given to a reserve which includes part of a chain of five wetlands and their surrounds. This chain of wetlands is located south of Russell Road and west of Rockingham Road. The wetlands are shallow leptoscale to mesoscale fresh water to hyposaline sumplands. They are recharged by rainfall which is ponded by the limestone, and by lateral groundwater flow. Water is discharged through evaporation and probable downward leakage into the limestone. The wetlands contain shallow muds and muddy sands (comprising peat and carbonate muds) and are underlain by quartz sand and limestone. The carbonate muds in the chain of wetlands of the Coogee Suite, to which this wetland belongs, are of calcitic and dolomitic mineralogy. The vegetation is maculiform and consists of forest to woodland (*Melaleuca rhaphiophylla*), open shrubland (*M. teretifolia*), sedgeland (*Gahnia trifida*), and sedgeland (*Baumea juncea*) (Figure 4). The low ridges between the sumplands are colonnised by forest dominated by *Eucalyptus gomphocephala*, which is gradually replaced by low forest dominated by species of *Banksia* nearer the coast. The condition of the wetland vegetation and its buffer zone is good.

The functions of this reserve are mainly ecological and cultural (pertaining to heritage). They are:

1. to maintain representative examples of this type of vegetated wetland (Semeniuk 1988), in an undisturbed state

2. to preserve this example of a rare type of ecosystem (i.e. vegetated by forest and two types of sedge communities which are largely in their natural state)

3. to preserve this wetland and swale portion of the Spearwood Dune ridge complex thus maintaining the ecological (faunal use and vegetation communities), geomorphological (dune/swale) and hydrological (water movement between dune and swale) linkages

4. the Brownman Swamps appear to be linked hydrologically to Lake Mt Brown in that they are a possible source of some of its groundwater input

5. to maintain a source of water to fauna, especially mammals, and amphibia.

6. to maintain protection and nesting sites for avifauna

7. to preserve the potentially globally significant scientific heritage of dolomite occurrence

RESERVE #3 - LAKE MOUNT BROWN RESERVE

Lake Mt. Brown is the name given to a reserve which includes one wetland and its surrounds. This reserve is located adjacent to the southern boundary of the Brownman Swamps Reserve, and west of Rockingham Road. The wetland is a shallow leptoscale fresh water to mesosaline sumpland (not a lake). It is recharged by rainfall which is ponded by the limestone and later discharged through evaporation. The wetland contains shallow muddy sands (peat, carbonate mud, and quartz) underlain by

limestone. Carbonate muds in the chain of wetlands of the Coogee Suite, to which this wetland belongs, are of calcitic and dolomitic mineralogy. The vegetation is concentriform and consists of low forest (*Melaleuca rhaphiophylla*), and sedgeland (*Gahnia trifida, Juncus kraussii, Baumea juncea*), with some invasion by the aggressive wetland weed Pampas Grass (**Cortaderia selloana)*). Also present are: *Acacia saligna, Apium prostratum, *Aster subulatus, Banksia litoralis, Centella cordifolia, *Cirsium vulgare, Lepidosperma longitudinale, Logania vaginalis, *Pennisetum clandestinum, Samolus repens, Sarcocornia quinqueflora, Sonchus hydrophilus, Sporobolus virginicus, *Stenotaphrum secundatum.* A vegetated buffer zone surrounds the northern, eastern and western side of the wetland. These surrounding ridges are vegetated by forest dominated by *Eucalyptus gomphocephala*, which is gradually replaced by scrub dominated by *Melaleuca huegelii* at higher relief and where limestone is exposed. The condition of the wetland vegetation is good (Figure 4).

The wetland Lake Mt Brown belongs to the same suite as the Brownman Swamps (Semeniuk 1988). Lake Mt Brown is part of a linked system, hydrologically and ecologically. The wetland changes from having permanent open water to seasonal open water in response to cyclic rainfall conditions but in either state it compliments the completely vegetated wetlands to the north.

The important functions of this reserve are mainly ecological, hydrological, and cultural (pertaining to heritage). They are:

1. as a waterfowl habitat; this more open wetland provides feeding and loafing sites complimenting the vegetated wetlands to the north which provide protection and cover for avifauna

2. as a receiving basin for groundwater from the north, effecting its hydroperiod and depth.

3. as an extension of wetland habitat types in the area; Lake Mt Brown is the wetter and more saline part of the suite of wetlands

4. as a site to preserve a potentially globally significant scientific heritage (dolomite)

RESERVE #8 - BUCKINGHAM RESERVE

Buckingham reserve includes portion of a wetland and no buffer zone. This reserve is located south of Gibbs Road and between Beenyup and Liddelow Roads. The wetland is a leptoscale fresh water sumpland. It is recharged by rainfall and groundwater rise and discharged through evaporation and local drawdown. The wetland contains shallow humic and iron oxide coated quartz sands and is underlain by Bassendean Sand. The vegetation is maculiform and consists of low forest and scrubland (*Melaleuca rhaphiophylla*), low woodland (*M.preissiana*), two types of scrubland (*M. viminea*) and (*M.rhaphiophylla, M.viminea, M.polygaloides*). The wetland vegetation is in good condition (Figure 7).

From on-site investigation, the most important functions are ecological and cultural (pertaining to heritage). They are:

6.0 MANAGEMENT RECOMMENDATIONS

In the management recommendations made here, there has been a concerted effort to consider long term management objectives over short term management constraints, cost effective over cost prohibitive mechanisms and, most importantly, preservation of wetland values and functions where warranted, given the importance of remnant vegetation in the study area in a regional context.

6.1 Uplands

The upland areas are grouped in descending order of importance as follows:

- Group 1 - M91 Coastal Reserve and Henderson Regional open space;
- Group 2 - Reserve 1820 - which was the focus of an independent and more detailed study, and although those results are not repeated herein, the current study concurs with the earlier conclusions and recommendations in Meney 1996;
- Group 3 - Sherbrooke Gardens, Holdsworth Park, Frankland Reserve, Cocos Park Reserve, and Manning Lake upland; and
- Group 4 - Hammond Road Reserve, Torgoyle Road Reserve, Redemptora Road Reserve, Fancote Reserve, and Coogee Beach Reserve.

Group 1

The most important functions of the M91Coastal Reserve and Henderson Regional open space are ecological and therefore are dependent on habitat preservation. Management of these areas and their values requires the following concepts to be incorporated into the management strategy:

1. Although the upland areas may be separately managed, the value of the area covered by the four reserves (Coastal Reserve M91, Henderson Regional open space, Brownman swamps, Lake Mt Brown) outweighs the values of the separate reserves. Together, the four reserves stand as an uncommon example of diversity of landforms and vegetation in the Spearwood Dunes, they illustrate the gradation of habitats in the Spearwood system from swale to ridge crest and from hinterland to coast, they provide a viable fauna refuge, the upland areas provide a buffer to the wetlands, and the two wetland reserves remain hydrologically linked.
2. Vegetation plays an important role in the ecological functions of the system.
3. Vegetation is vulnerable to disturbance such as fire, local clearing, and trampling.
4. Native fauna are vulnerable to fire and to feral species of animals.
5. The upland habitats provide an example of ecosystems and natural features which are only duplicated (and only to a limited extent), in the Burns Beach and Quinns Rocks regions in the Perth Metropolitan area.

Management of the four reserves as one entity with the objective of conservation of ecological values is a strategy which satisfies the criteria outlined above for best management practices in that it is viable in the long term, cost effective, and preserves recogniseable values. With this as the objective, it is now possible to formulate tasks appropriate to this strategy.

- The Authority responsible for fire management should be informed about the values of the reserve so that it is perceived to be a **valuable property** with a **high priority** for fire control.

- Some rehabilitation of vegetation is required in local patches in order to close the vegetation cover particularly in the Coastal Reserve M91. Open areas are vulnerable to weed invasion and to wind deflation.

- Some immediate weed control is recommended for both the M91 Coastal Reserve, because several alien species which have only begun to invade the area are known to be extremely virulent and resistant to removal once established. In addition, certain species directly cause the demise of the native vegetation. The most important species to eradicate is "bridal creeper" *Asparagus asparagoides* because it kills its support plant.

- Signs should be erected informing the community about what activities **are permitted** in the reserve.

- It is recommended that the area encompassing the four reserves be fenced to prevent random access and rubbish dumping.

Group 2

Reserve 1820 is ecologically part of a linked system in that it adjoins a much larger area of vegetated Bassendean Dunes and a wetland ecosystem to the north. These links enhance the importance of the reserve with regard to habitat diversity and faunal use. Both of these functions are important. For long term viability of fauna populations, two options are presented. The first option is that dividing fences be removed so that Reserve 1820 can incorporate the surrounding wetland and vegetated upland. The total area should then be vested in an appropriate Authority to be managed as a reserve. The second option is to modify the boundaries of Reserve 1820 so that it includes vegetated upland areas presently in the reserve and vegetated wetland areas to the north. This option would depend on the outcome of an enquiry into the feasibility of a land exchange, with the objective of reserving vegetated areas and releasing cleared areas for potential development (Figure 5b).

For other recommendations referring specifically to Reserve 1820 refer Meney (1996).

Group 3

The most important functions of the third group of upland areas (Sherbrooke Gardens, Holdsworth Park, Frankland Reserve, Cocos Park Reserve, and Manning Lake upland) are ecological and again are dependent on habitat preservation. Management of these

- Torgoyle Road Reserve and Hammond Road Reserve have been the sites for a series of activities such as clearing of vegetation, excavation, track development and infrastructure development. Both reserves would require extensive re-vegetation to try to restore ecological values. Hammond Road Reserve would be the preferred site for such an extensive programme because there is already a groundcover, the landform and soils are undisturbed, and wetland vegetation adjacent is relatively undisturbed.

- Torgoyle Road Reserve management depends on the type of uses to which it is assigned by the City of Cockburn. As these are variable, the general recommendation for the reserve is that these uses be compatible with the limestone terrain and the remaining endemic vegetation.

- The Coogee Beach Reserve is susceptible to aeolian and marine erosion, therefore the best way to preserve its integrity is to encourage the type of use which decreases the effect of erosion. Areas should be clearly marked where access is restricted. Pathways through Coogee Beach Reserve should be wooden to prevent sand mobilisation through these artificial wind corridors. Dune cliffs and wind scours should be covered with branches to restrict further removal of sand, and re-vegetation of endemic species should be undertaken.

- The major management issue for Redemptora Road and Fancote Road Reserves is currently the frequency of fire. The Authority responsible for fire management should be informed about the values of the reserve so that it is perceived to be a **valuable property** with a **high priority** for fire control. The Authority should also be encouraged to lengthen the period between fire episodes as the major result of the present fire regime is to diminish the biodiversity of the reserve.

6.2 Wetlands

The wetland areas are grouped in descending order of importance as follows:

- Group 1 - the Brownman Swamps and Lake Mt Brown which belong to the same suite;

- Group 2 - Buckingham Reserve and Bosworth Reserve;

- Group 3 - Bibra Lake and Manning Lake; and

- Group 4 - Gil Chalwell Reserve, Mather Reserve, Kraemer Reserve, and Emma Treeby Reserve.

Group 1

There are three important functions for the Brownman Swamps and Lake Mt Brown wetlands; these are: 1. their ecological role, which depends on habitat preservation; 2. their regional scientific significance as the predominantly freshwater end of the spectrum of a chain of wetlands that belong to the Coogee Suite of consanguineous

wetlands; and 3. their potentially globally significant heritage value in the occurrence of dolomite mud within the Coogee Suite of wetlands. The aspect of their ecological role requires maintenance of the hydrological and sedimentological mechanisms which induce the range of biological responses. The aspect of their representing the freshwater end of the Coogee Suite relates to the fact that the chain of Coogee Suite of consanguineious wetlands, located only in the seaward part of the Swan Coastal Plain between Fremantle and Leda, is saline to the north, grading to freshwater/brackish to the south. The Brownman Swamps and Lake Mount Brown uniquely represent the freshwater end of the spectrum of this suite in the City of Cockburn.

The aspect of the global significance of dolomite is amplified further here. Calcitic mud is a common mineral of freshwater wetlands in Western Australia and in general globally. Dolomite, however, is not so common, and in terms of geological heritage, its occurrence in modern near coastal wetland sediments is significant since it has been documented as a sedimentary deposit in modern wetlands only in a few locations globally, the best known occurrence being The Coorong, South Australia. Dolomite has been documented as a mud-sized mineral component in the carbonate muds of the Coogee Suite of wetlands in this region. Once the information on dolomite has been published and the hydrology and hydrochemistry underlying its occurrence are documented, it is likely that the wetlands of the Coogee Suite that contain this mineral will become classic examples of this type of mineral occurrence. If studies, currently underway, confirm their importance to science in the context of precipitation of carbonate minerals in the spectrum from saline to freshwater/brackish environments, these wetlands in the near future may assume ***international significance***. In this context, their hydrology, their buffer zones and their upland relationships cannot be compromised.

Management of these wetlands and their values, in the light of the information above, requires the following concepts to be understood and incorporated into the management strategy:

1. the wetlands behave as a hydrological and ecological linked system.
2. the wetland recharge and discharge processes extend into, are derived from and are linked to the surrounding upland areas
3. vegetation plays an important role in the ecological functions of the system
4. the system is vulnerable to water level alteration, water quality alteration, fire, vegetation clearing, and alienation
5. the wetlands and upland habitats combined, provide an example of ecosystems and natural features which are not duplicated in the Perth Metropolitan area
6. the hydrologic and hydrochemical environment of the wetlands and the terrain around the wetlands must not be compromised because this will alter the precipitation and maintenance of carbonate mud formation

The best way to preserve the integrity of each of the wetland components (Brownman swamps, and Lake Mt Brown)) is to preserve the system covered by the three reserves (Henderson Regional open space, Brownman swamps, and Lake Mt Brown). In this way hydrological processes are maintained, and the wetlands are surrounded by vegetated buffer zones. Decisions regarding any one of the reserves should be made in the best interest of maintaining the values of the integrated system

This strategy satisfies the criteria outlined above for best management practices in that it is viable in the long term, cost effective, and preserves recogniseable values. With this as the objective, it is now possible to formulate tasks appropriate to this strategy.

- The Authority responsible for fire management should be informed about the values of the reserve so that it is perceived to be a **valuable property** with a **high priority** for fire control.
- The community require information regarding reserve values. A community group may be initiated for purposes connected with reserve management and dissemination of information.

- Some immediate weed control is required at Lake Mt Brown because several virulent alien species have become established e.g., Pampas Grass - *Cortaderia selloana*.

- Vehicle access should be directed rather than unrestricted.

- Signs should be erected informing the community about what activities **are permitted** in the reserve.

- Directions to alternate localities should be circulated to residents for activities outside the scope of this reserve, so that people become aware of facilities suited to their recreational or other activities.

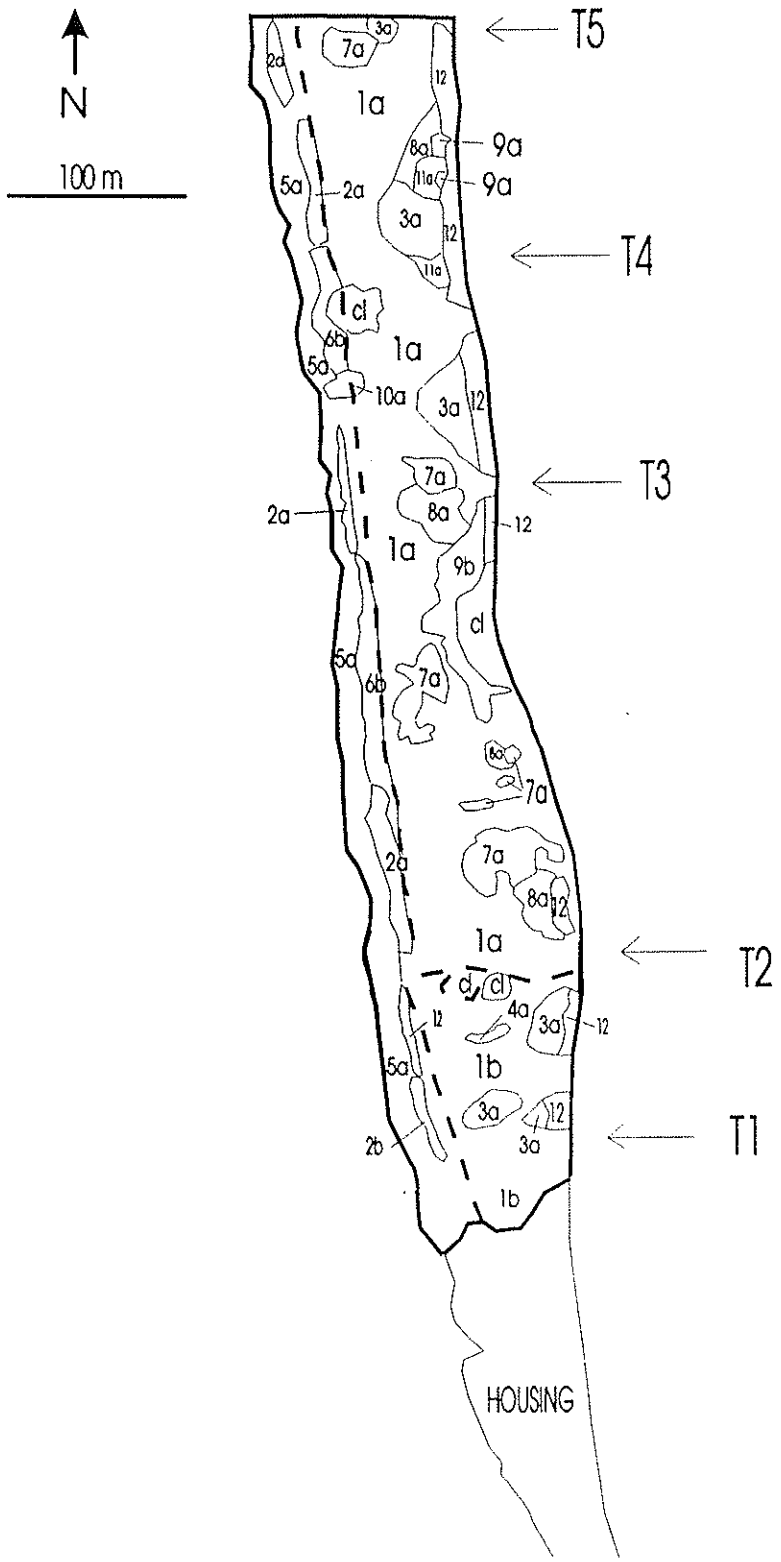
- Liaison with other planning and land management authorities should take place to ensure consistent management goals for wetlands which extend outside the City's reserve boundary and to decide on appropriate and beneficial future developments on the periphery of the reserve.

- Continual liaison with other Authorities should be undertaken to review and if necessary enter into negotiation on any planned development that may potentially contravene the documented and established purpose of the reserve, or degrade its ecological values. Such a development would be the proposed partitioning of the area by transport routes.

Group 2

The most important functions of the Buckingham and Bosworth Reserves are ecological and depend on habitat preservation. This requires maintenance of the mechanisms which induce the range of biological responses. Management of these wetlands and their values requires the following concepts to be understood and incorporated into the management strategy.

1. The wetlands in the reserves are only a portion of the natural wetland. The wetland recharge and discharge processes extend into, are derived from and are linked to the surrounding areas which are on land under freehold title.
2. Vegetation plays an important role in the ecological functions of the system.
3. The system is vulnerable to water level alteration, water quality alteration, fire, vegetation clearing, and alienation.



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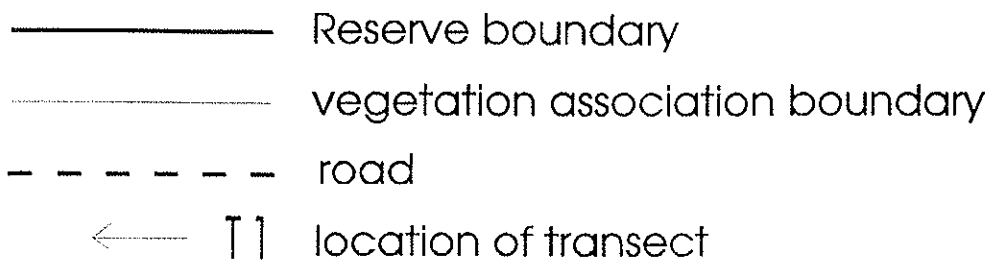
Map of Coastal Reserve M91

Figure 3



VEGETATION ASSEMBLAGES

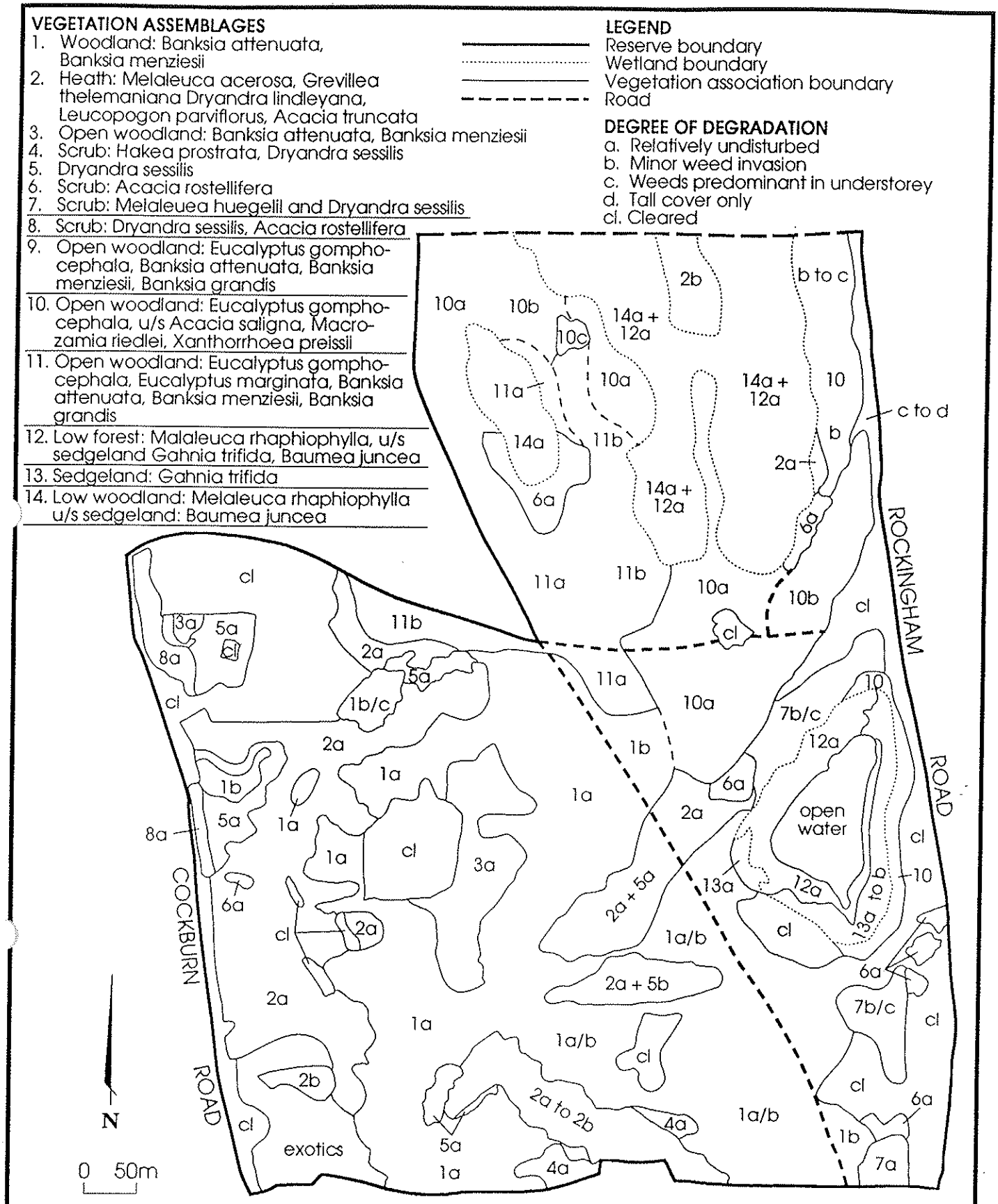
1. Low closed mixed heath: Grevillea thelemanniana; Melaleuca acerosa; Hibbertia hypericoides; Dryandra nivea; Melaleuca hueglii; Phylanthus calycinus; Acacia truncata; Petrophile serruriae; Leucopogon parviflorus; Lomandra maritma; Templetonia retusa; Calothamnus quadrifidus.
2. Sedgeland: Lepidosperma gladiatum.
3. Heath: Acacia rostellifera.
4. Scrub: Eucalyptus decipiens.
5. Low heath: Frankenia pauciflora.
6. Low heath: Acanthocarpus preissii.
7. Closed heath: Dryandra sessilis.
8. Low closed heath: Xanthorrhoea preisseii (dominant)
9. Remnant woodland: Banksia attenuata.
10. Open heath: Acacia cyclops.
11. Low heath: Grevillea vestita.
12. Planted exotics.

cl: Cleared areas.

DEGREES OF DEGRADATION

a. relatively undisturbed
b. minor weed invasion
c. weeds predominate in understorey
d. tree cover only
cl. cleared

V & C Semeniuk Research Group 1997	**Legend to Map of Coastal Reserve M91**	Figure 3



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Brownman Swamps, Lake Mt. Brown area and Henderson Regional Open Space

Figure 4

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