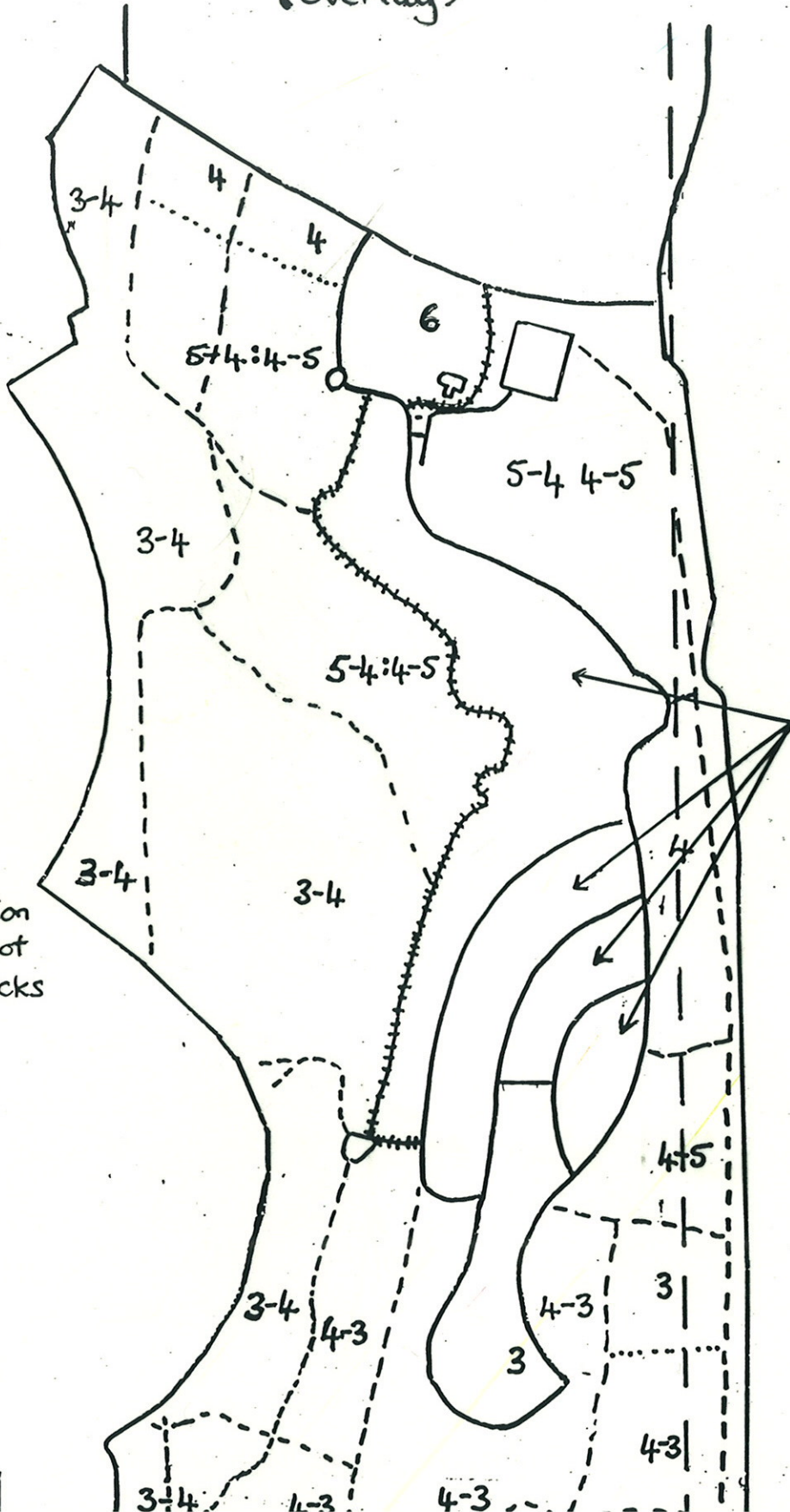


Map 2: Vegetation Condition Ratings
(overlay)

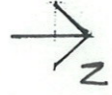


Bushland
Islands
4-5
Lawn Areas
6

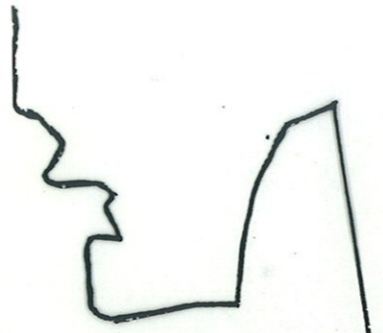
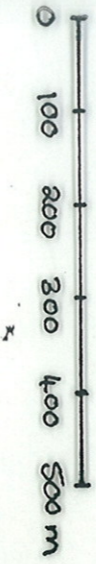
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PINNAROO VALLEY MEMORIAL PARK CONCEPT PLAN

PETER CALA & ASSOCIATES
LANDSCAPE ARCHITECTS & URBAN DESIGNERS
11 FORREST ST. SUDBORO W.A. 6107 PH (08) 9418440



Scale 1: 8 000



MAP 1: Landform Vegetation Units
(overlay)



Legend


- CREMATORIUM
- TOILET BLOCK
- OVERFLOW CAR PARK
- LAWN & GRASS AREAS
- HEADSTONE BURIAL AREAS
- TREES
- SHRUBS/SCRUB
- ROUGH GRASS
- WATER
- SEWAGE EASEMENT

Key to Overlay

- A Water features and landscaped gardens
- B Memorial lawns with bushland islands
- Recent Clearing
- Spearwood Dune Vegn
- Transitional Vegn
- Quindalup Dune Vegn
- Tracks
- Roads
- Boundary between bushland and landscaped areas



BUSHPLAN SITE 303
SOUTHERN PORTION
ORTHO-RECTIFIED AERIAL IMAGE
CONTOURS & CADASTRE

-  Bushplan Sites (boundaries)
- Cadastre with Lot Numbers
- Contours - 5m (DOLA)

Map Ident: plot991104_1


DATE: 04 Nov 1999

Prepared By: Andrea Zappacosta

Prepared For: CATHERINE THOMSON

Scale 1:8000

MFP INTERNAL USE ONLY

0  500 m



**BUSHPLAN SITE 303
SOUTHERN PORTION
VEGETATION COMPLEXES
PROPOSED GREENWAYS**

Map Ident: plot991104_1

DATE: 04 Nov 1999







Prepared By: Andrea Zappacosta

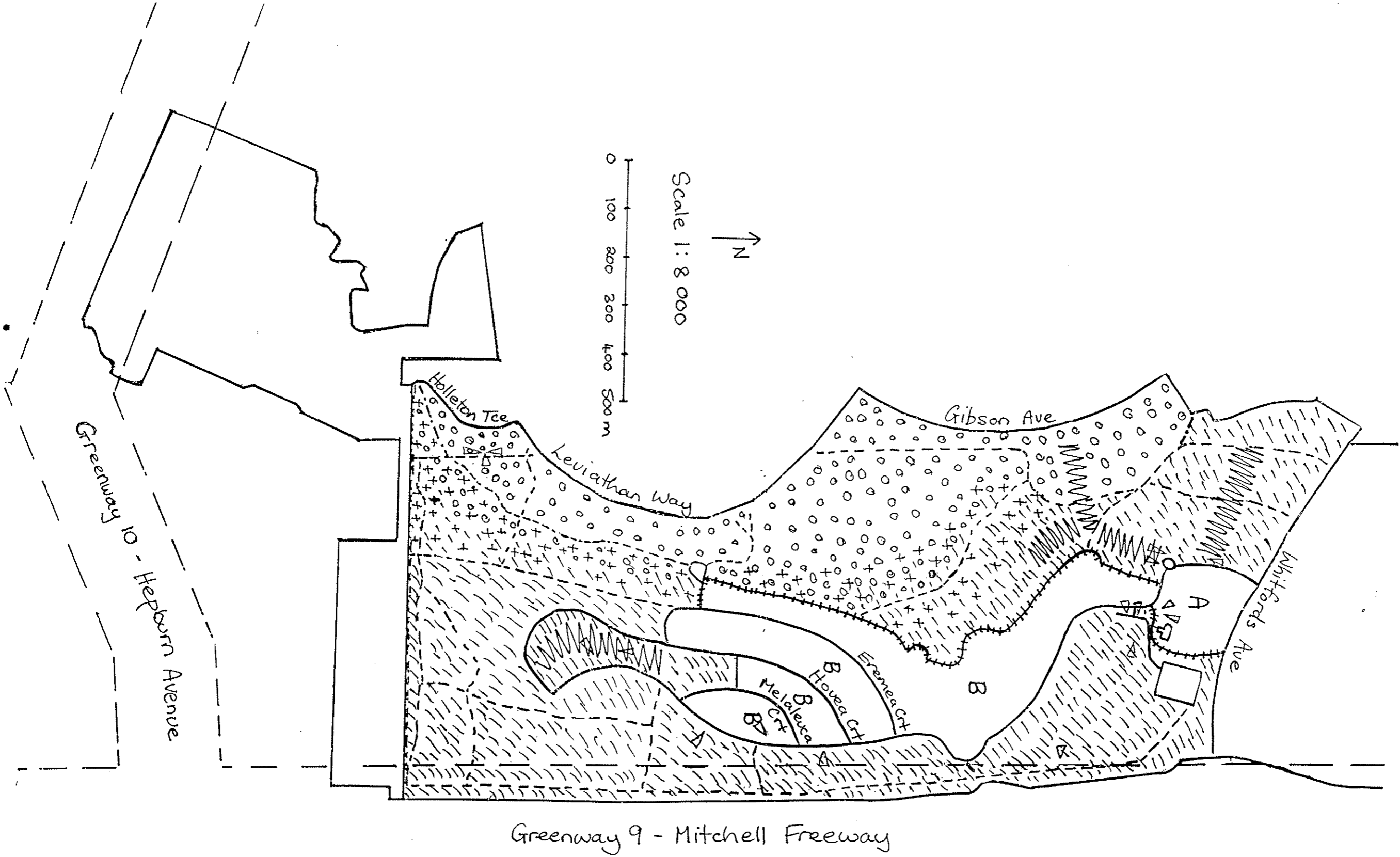
Prepared For: CATHERINE THOMSON

Scale 1:8000

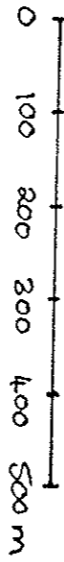
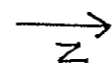
MFP INTERNAL USE ONLY

0 500 m

-  Bushplan Sites (boundaries)
-  Cadastre with Lot Numbers
-  Karrakatta Complex-Central And South
-  Cottesloe Complex-Central And South
-  Quindalup Complex
-  Proposed Greenway



Scale 1: 8 000



Greenway 9 - Mitchell Freeway

Key

- A Water features and landscaped gardens
- B Memorial lawns with bushland islands
- Recent clearing
- Spearwood Dune Vegen (Karrikerup Complex Transitional Vegen)
- Quindalup Dune Vegen (Quindalup Complex)
- Tracks
- Roads
- Boundary between bushland and landscaped areas
- Ministry for Planning Photo Points.
- Boundary of Core Natural Area



PINNAROO VALLEY MEMORIAL PARK CONCEPT PLAN



PETER CALA & ASSOCIATES
LANDSCAPE ARCHITECTS & URBAN DESIGNERS
14 FOREST ST. SYDNEY N.S.W. 2000

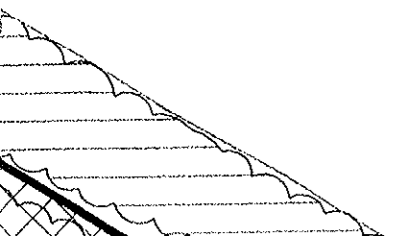


- Legend**
- CREMATORIUM
 - CHAPELS
 - TOILET BLOCK
 - OVERFLOW CAR PARK
 - LAWN & FIRM AREAS
 - HEADSTONE BURIAL AREAS
 - TREES
 - SHRUB/SCRUB
 - ROUGH GRASS
 - WATER
 - SEWAGE EASEMENT

Scale 1:8000







1 : 2000

PINNAROO VALLEY MEMORIAL PARK
BUSHPLAN PROPOSAL

(Version 7)

SHEET SHEET OF OF 1

DRAWING No.

P/99/08/BP/7

Acc/Job No.

A 0

12.4ha

AN (Core Conservation Area) = 25.2ha = 22%

RETAINED IN ENVIRONMENTALLY

CEMETERY DEVELOPMENT = 5.9ha = 6%

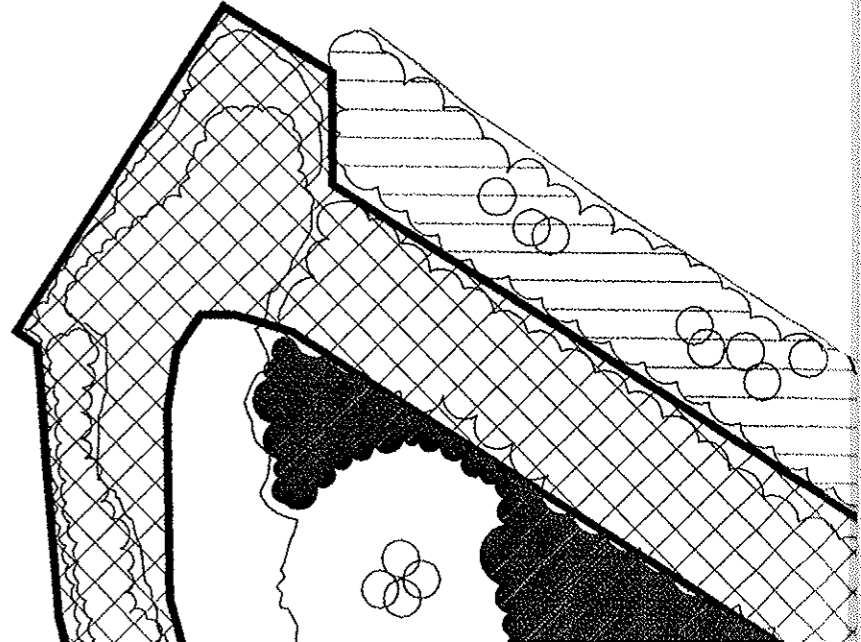
S BUSHLAND CEMETERY = 81.3ha =

100%

SLANDS AND CANOPY LINKAGES

ADS (Indicative only)

agement





METROPOLITAN CEMETERIES BOARD

RAILWAY ROAD KARRAKATTA

Telephone: (08) 9384 7144 Fax: (08) 9383 3683

Email: Administrator@mcb.wa.gov.au

DESIGNED

DRAWN L.PROSPERO

CHECKED P.DEAGUE

RECOMMENDED

07

00

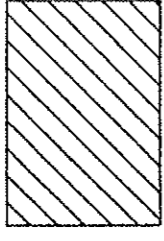
07

00

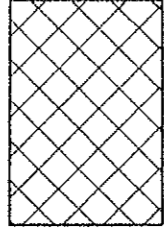
TOTAL AREA =

Deed title states 115.9487ha

LEGEND



TO BUSH PI



**BUSHLAND
SENSITIVE**



RETAINED /



BUSHLAND



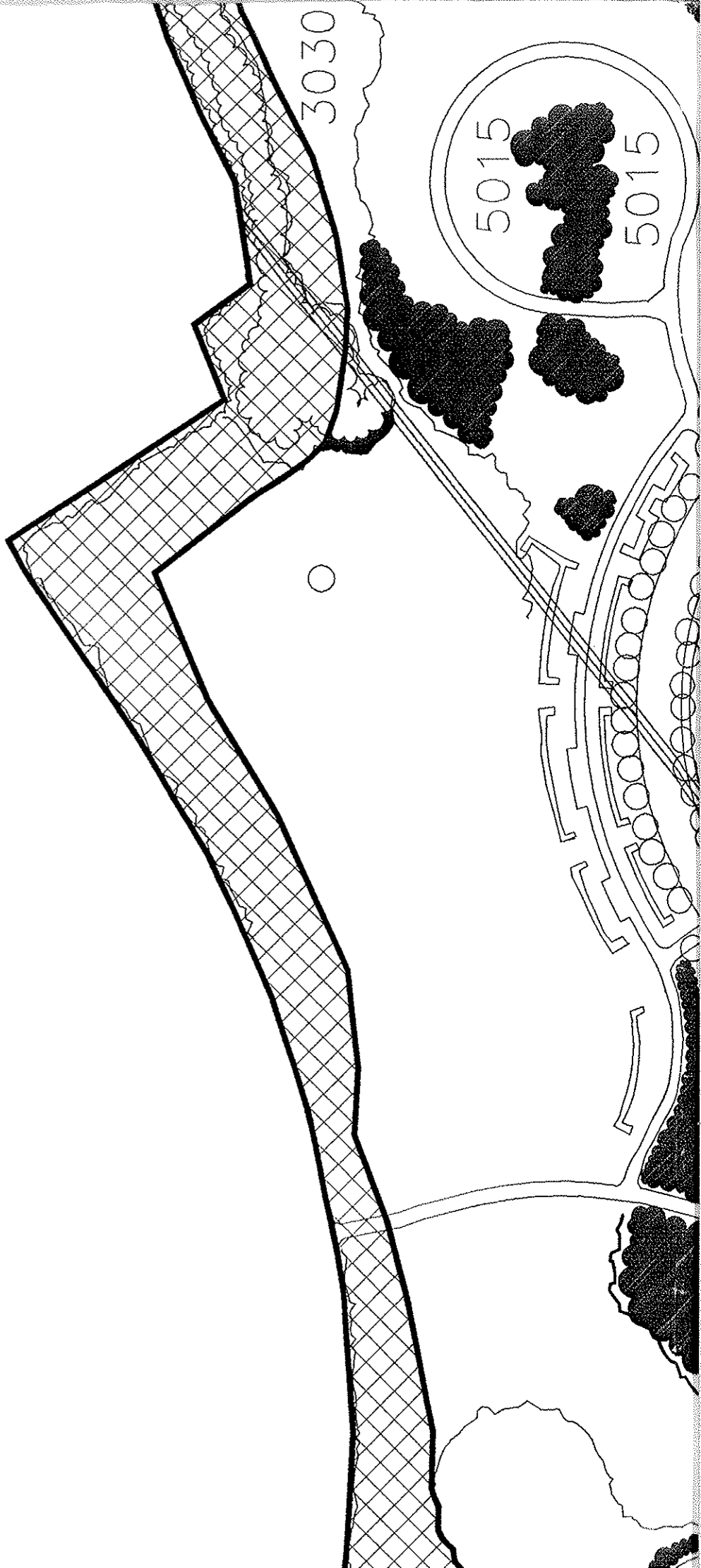
FUTURE RO

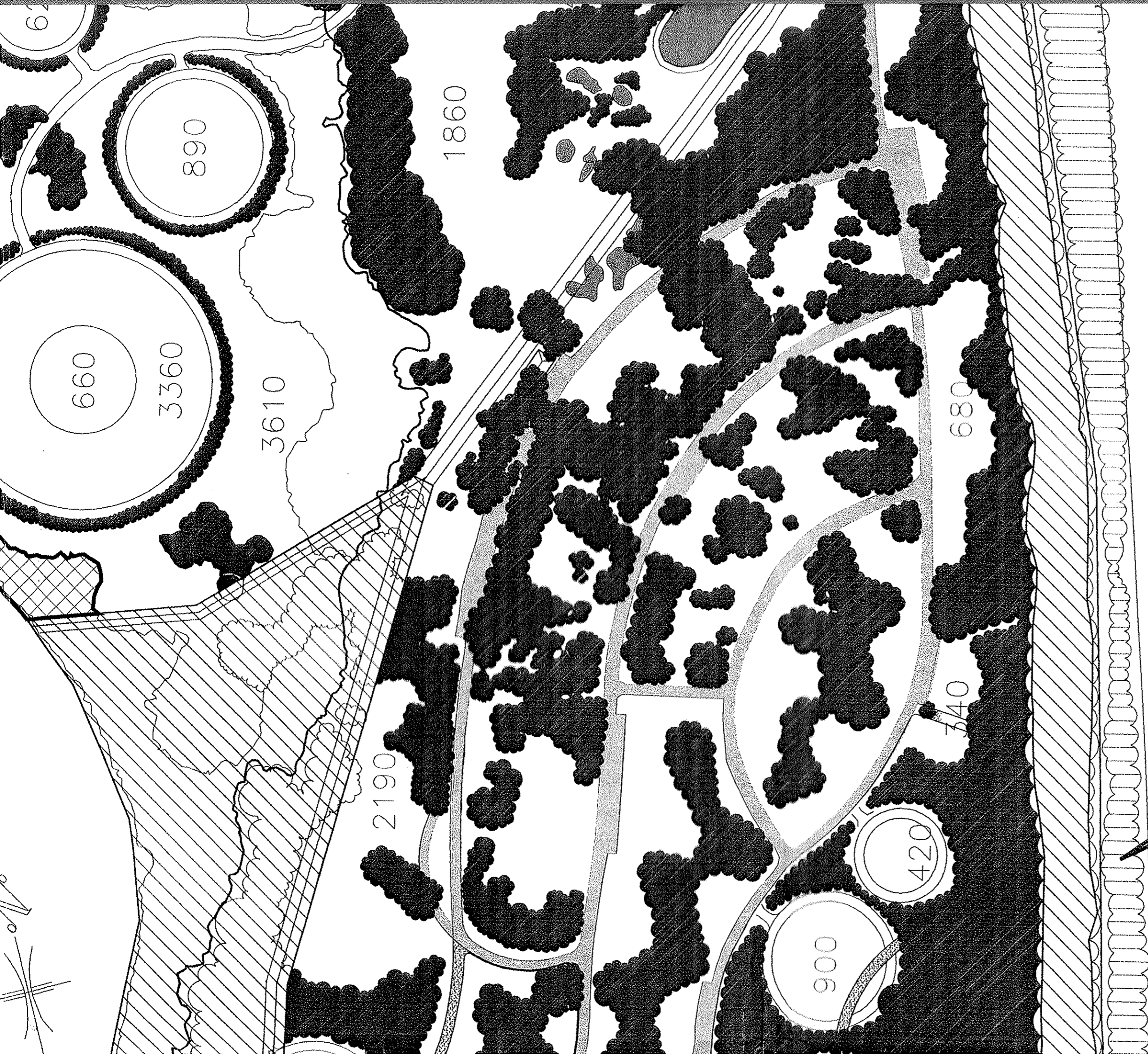


Existing road



2.7ha sewer





1860

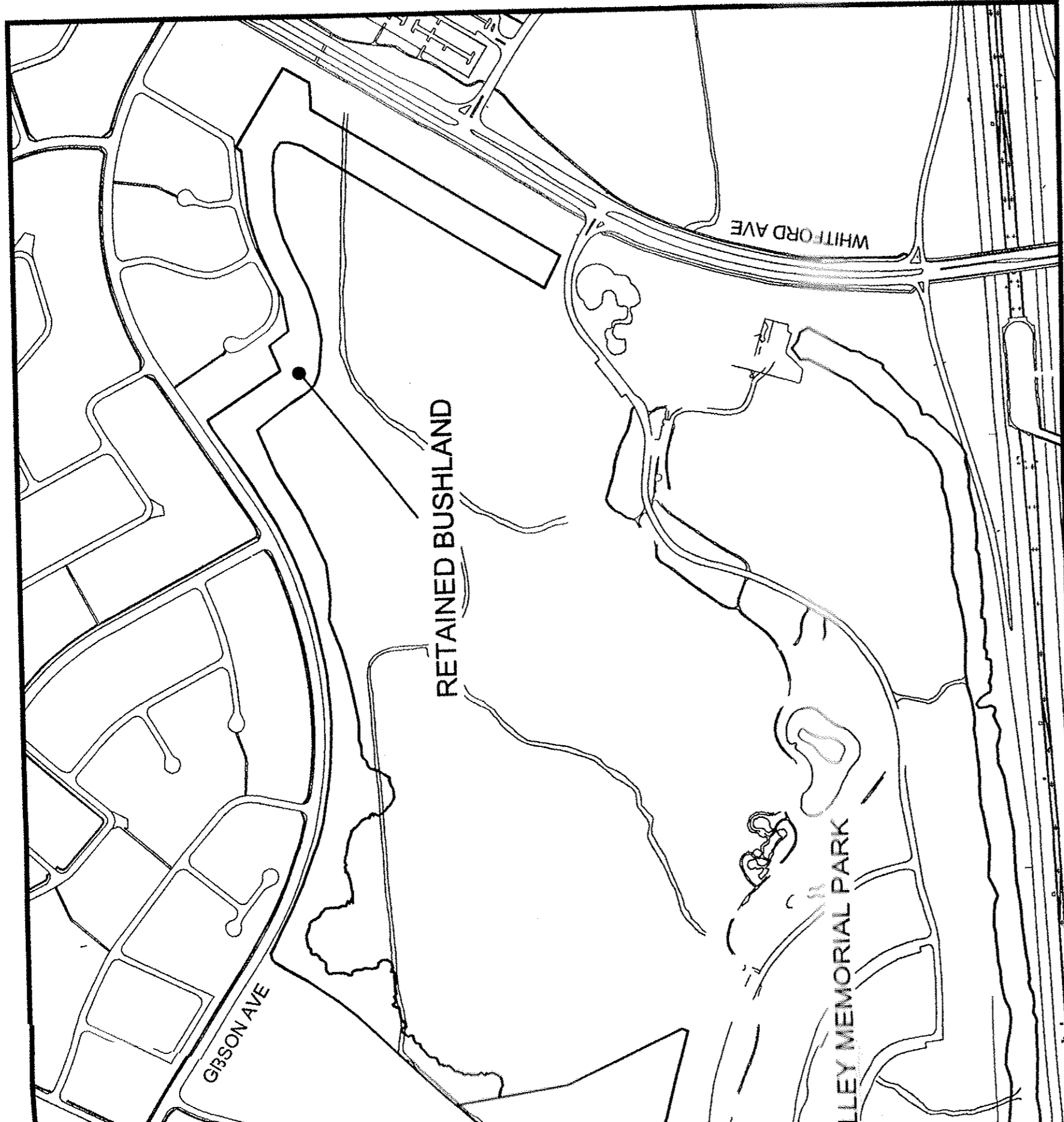
3610

680

2190

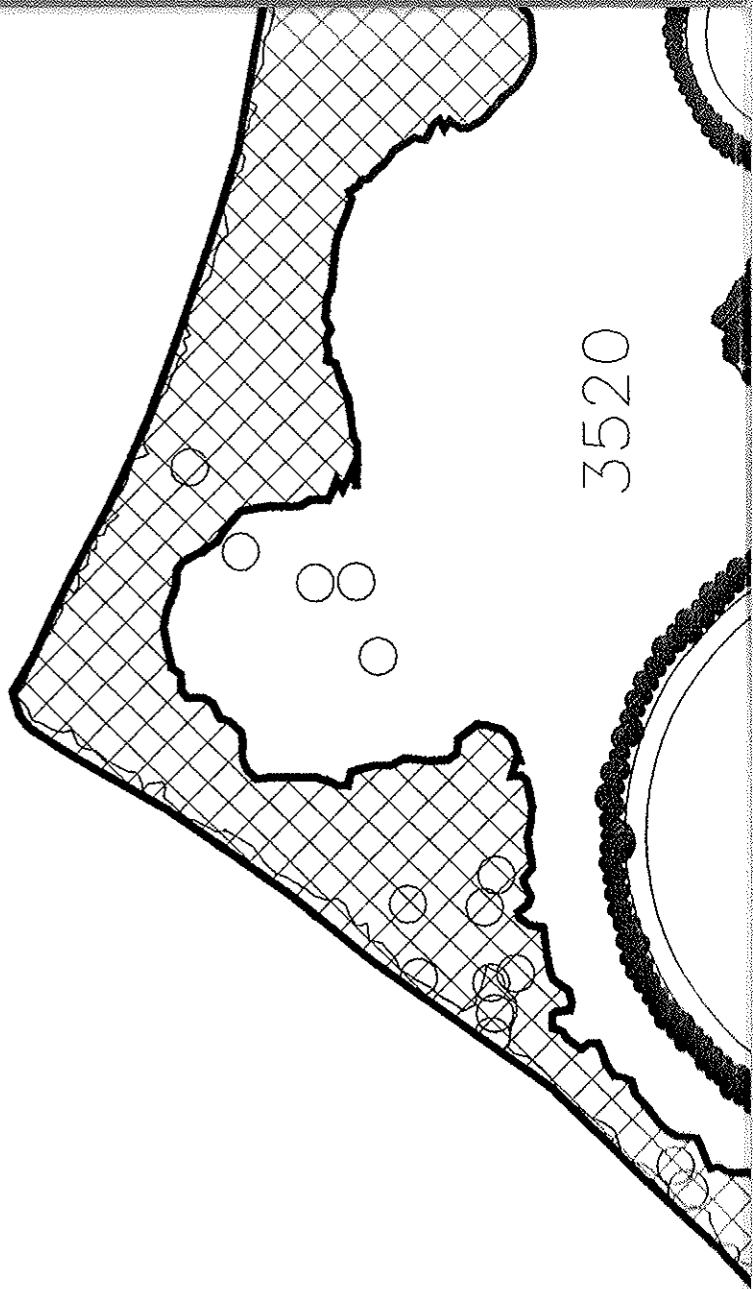
340

MAIN ROADS BUSH RESERVE



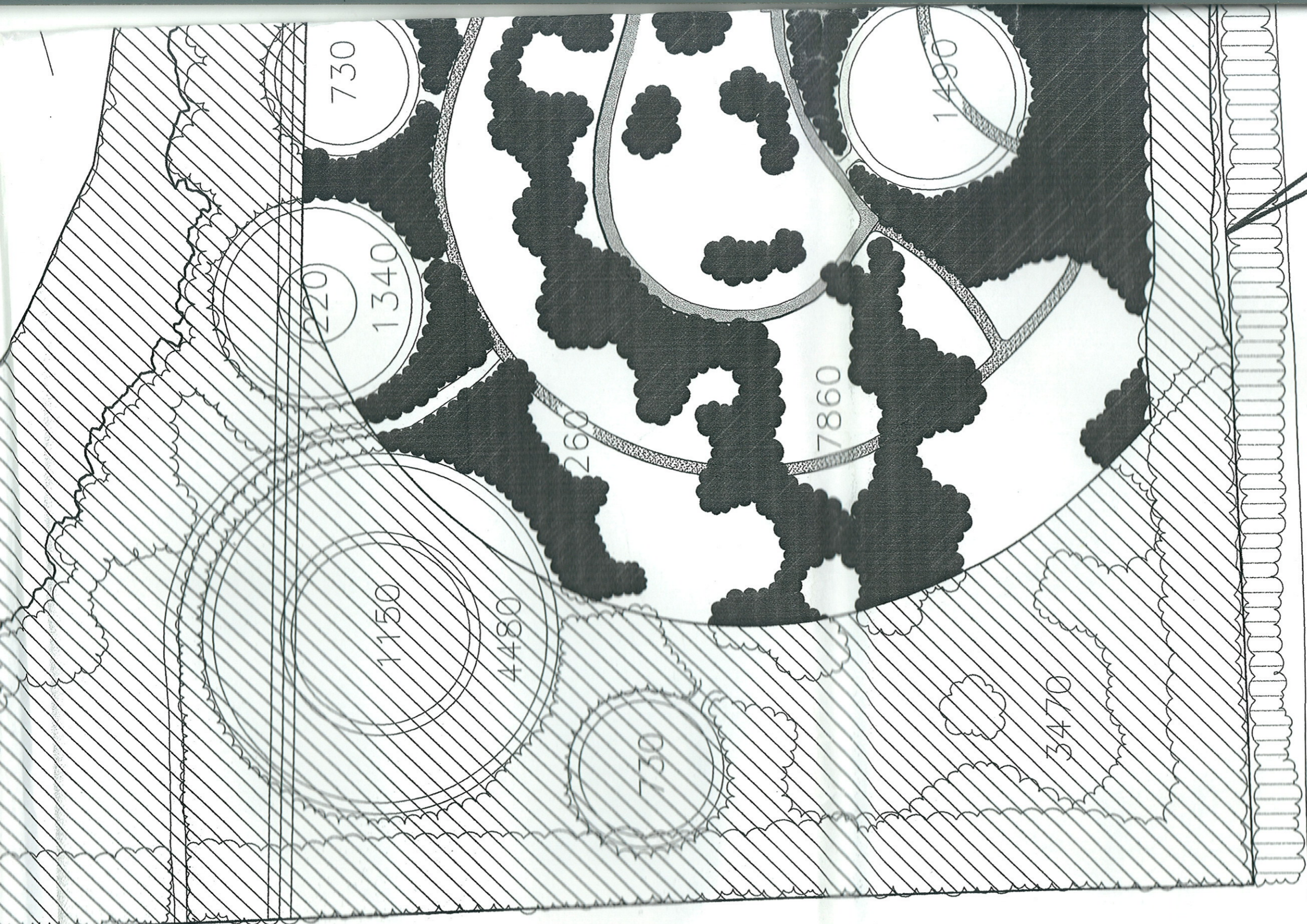
Y PLAN

5000



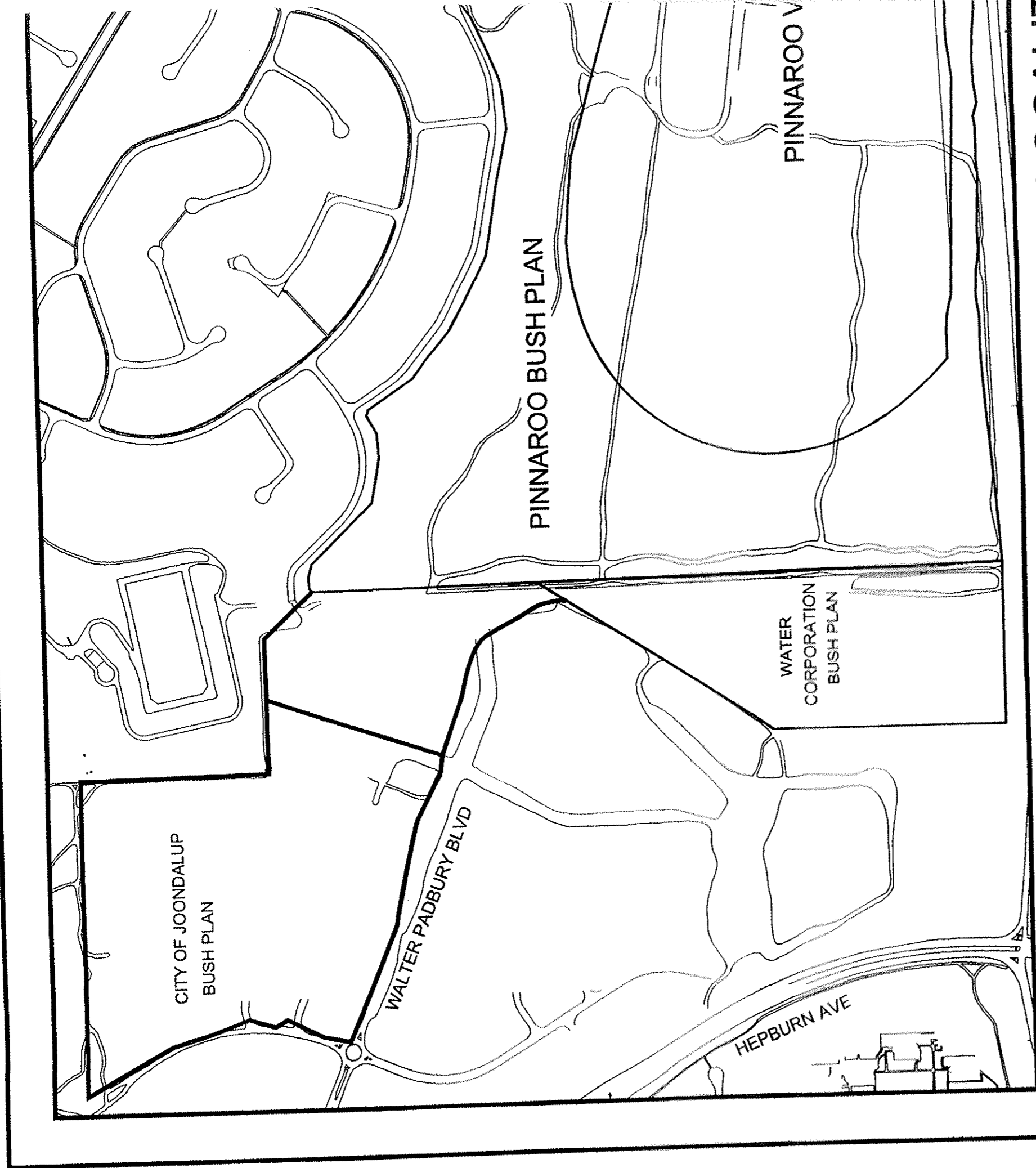
3520





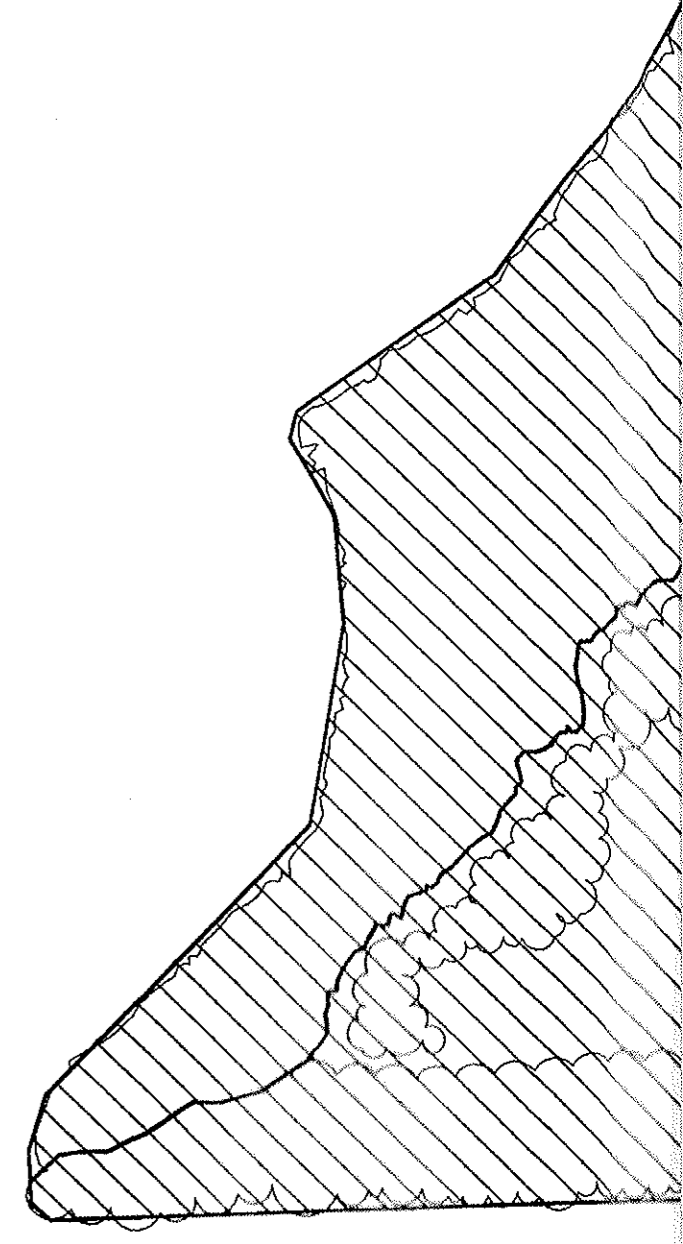
FENCE LINE

Amendments		SURVEY		Vesting Area
		FILE NAME		
		TAX SHEET		Purpose
		FIELD BOOK		File No.
		LEVEL BOOK		
No. Date	By	App'd	REVISION	ARCHIVE DISK No.



LOCALIT

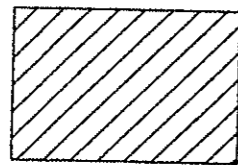
SCALE



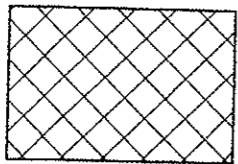
TOTAL AREA = 112.4ha

Deed title states 115.9487ha

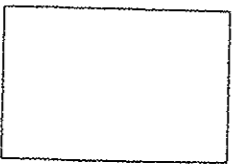
LEGEND



TO BUSH PLAN (Core Conservation Area) = 25.2ha = 22%



BUSHLAND RETAINED IN ENVIRONMENTALLY SENSITIVE CEMETERY DEVELOPMENT = 5.9ha = 6%

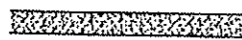


RETAINED AS BUSHLAND CEMETERY = 81.3ha = 72%

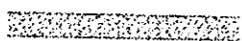
100%



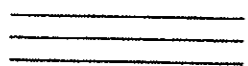
BUSHLAND ISLANDS AND CANOPY LINKAGES



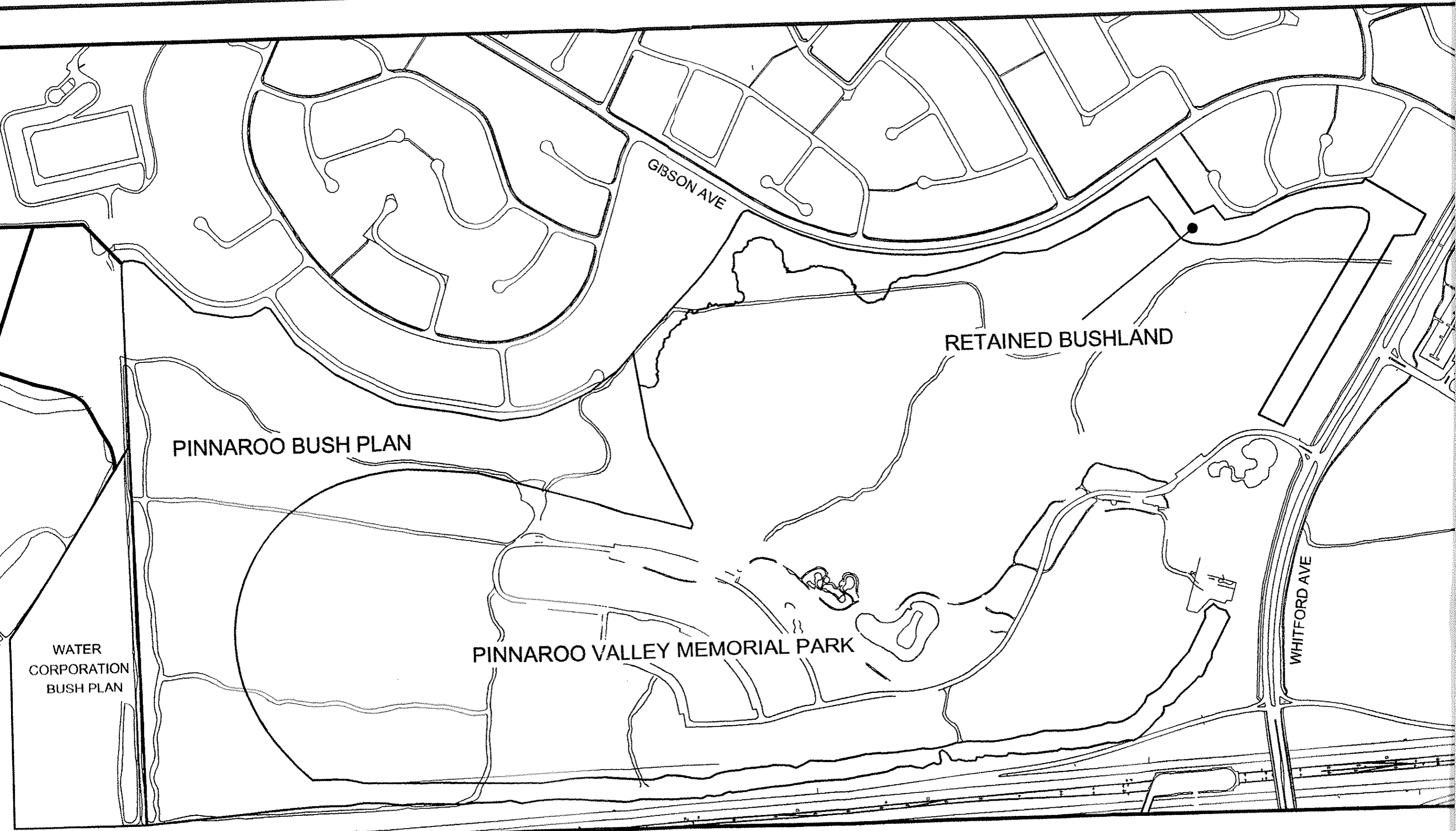
FUTURE ROADS (Indicative only)



Existing roads



2.7ha sewer easement



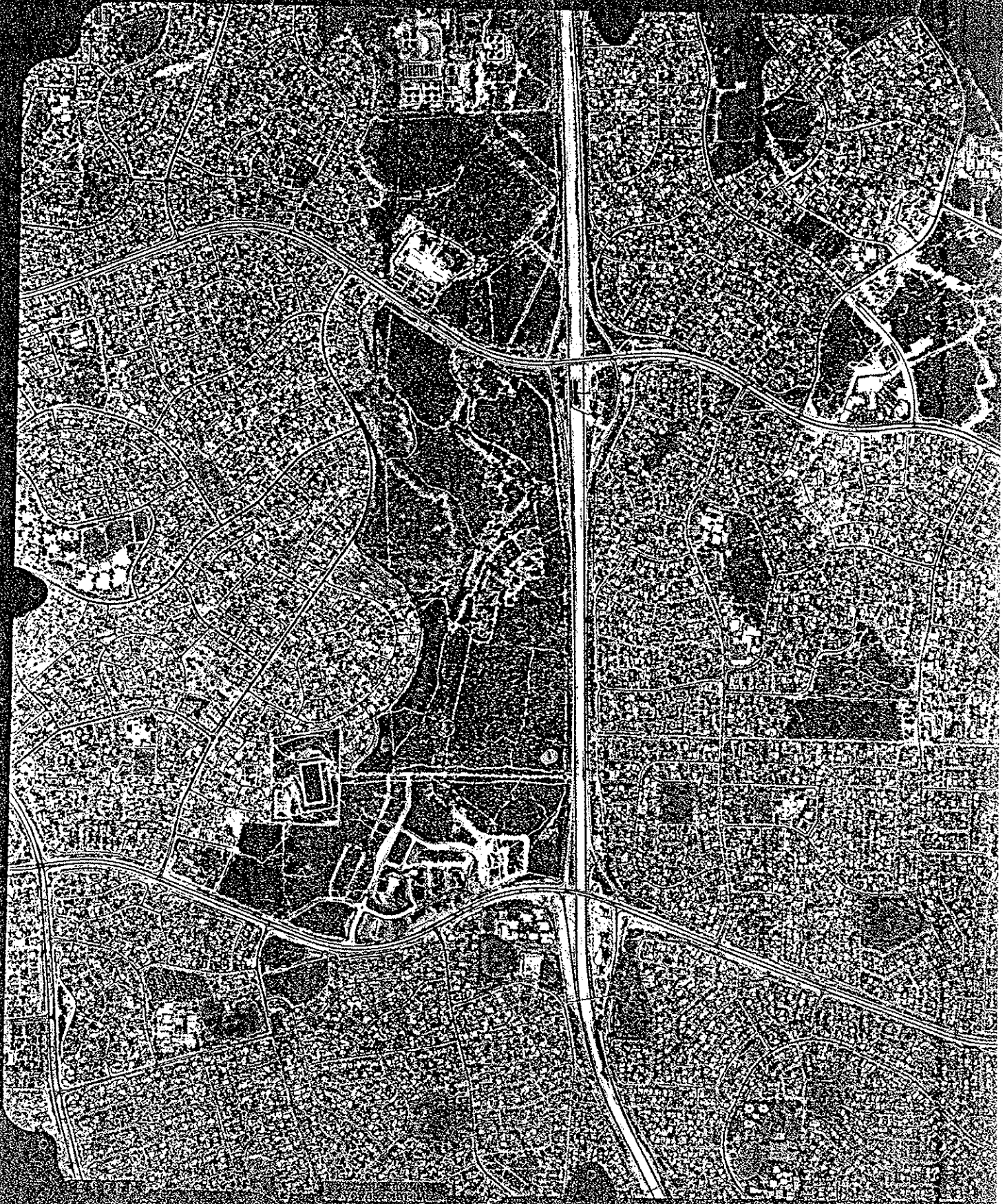
LOCALITY PLAN

SCALE 1:5000

↑
N

photo 5139

65 (C) METRO REGIONAL AREA & EXT. RUN 3 (5079-5160) 1:20000 11-DEC-92 920676 1



(146) Pinnaroo Valley Memorial Park
Pinn 01-03

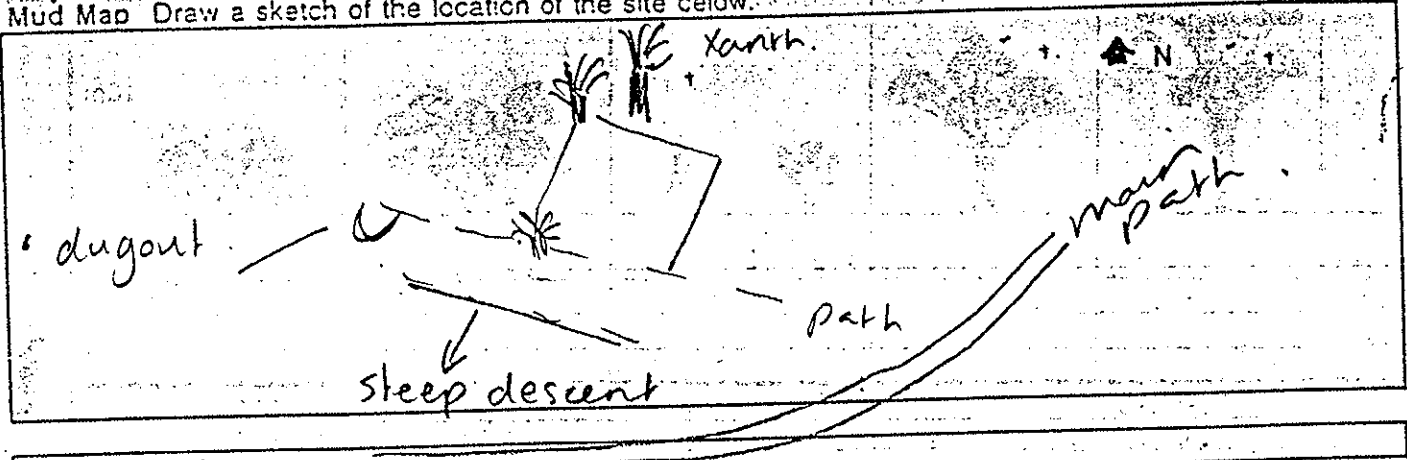
BUSHLAND PLANT SURVEY RECORDING SHEET 1- use pencil only

BUSHLAND AREA HEPBURN CONS. RESERVE SITE NUMBER HEPB02
 DATE TRIP 12-9-95 RECORDERS BK, NCT
 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 3 Nedlands WA 6008

1. LOCATION of the QUADRAT

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

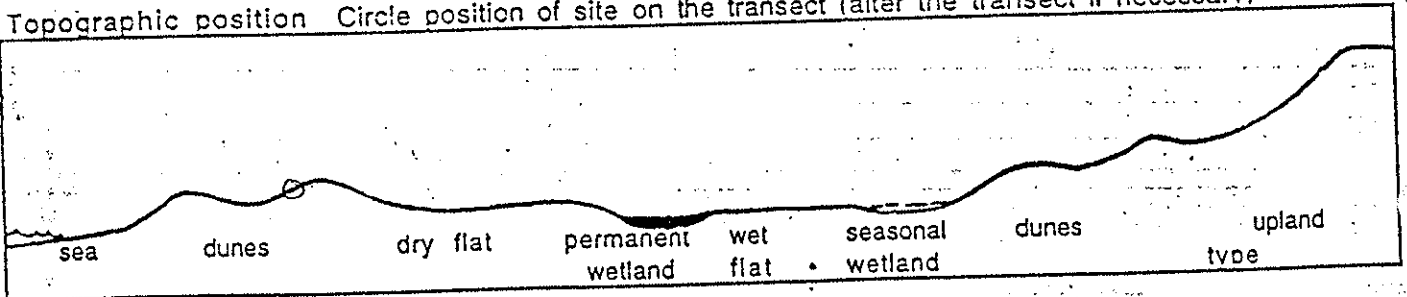


Road Location _____

Geographic Location Latitude 31°49.001 S Longitude 115°46.305 E Altitude 115
 Reference Map _____

Photograph _____ Photographer's Name NCT Photo No 16

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 dk brown

Exposed rock type limestone % surface 2

Sub-surface Soil Colour _____
 Rock type limestone depth to rock _____

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

Litter zero % cover _____
 Depth cm Bare Ground 2-10 % 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 8m
					30m 10m
COVER CLASS (%)					
DOMINANT SPECIES					
LIFE FORM	SHRUBS				SHRUBS
	over 2m	2m - 1.5m	1.5 - 1m	1 - 0.5m	under 0.5m
					2m 1m
COVER CLASS (%)			70+	MIXED	
DOMINANT SPECIES					
LIFE FORM	GRASSES	HERBS	SEDGES		
			over 0.5m	under 0.5m	
					
COVER CLASS (%)	10-30	30-70			
DOMINANT SPECIES	Braea max & minor Vulpia	Trachymene pilosa + caer. Heliophylla pusilla Hypochaeris			

4. VEGETATION CONDITION

	PRISTINE	EXCELLENT	VERY GOOD	GOOD	DEGRADED	COMMENTS
1						
2						
3			✓			burnt 2-3 yrs ago, abt in regrowth alot of moss on ground
4						
5						

BUSHLAND PLANT SURVEY RECORDING SHEET 1- use pencil only

BUSHLAND AREA HEPBURN CONS RESERVE SITE NUMBER HEPB 01

DATE TRIP 12-9-95 RECORDERS BJK NCT

DATE TRIP _____ RECORDERS _____

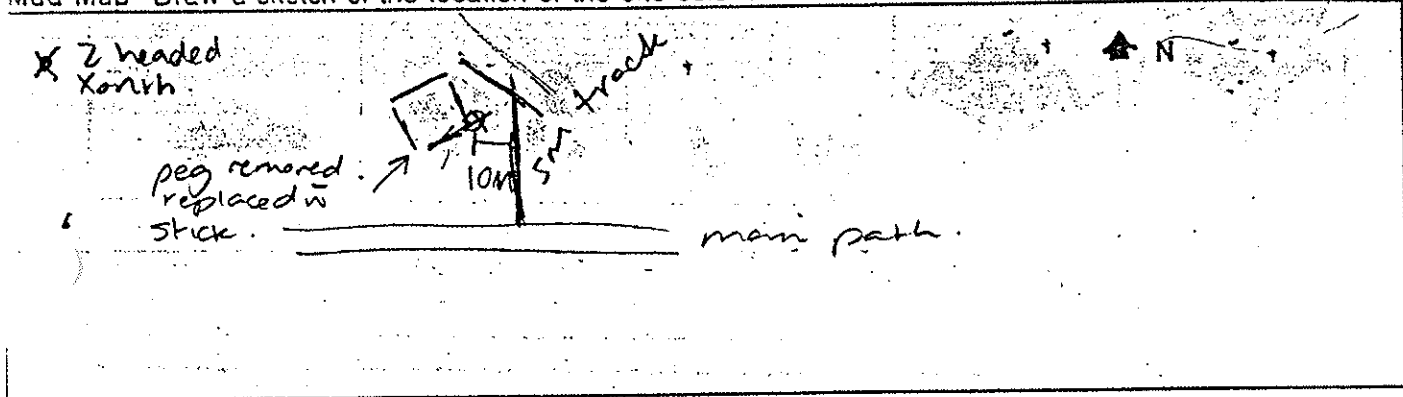
DATE TRIP _____ RECORDERS _____

BOTANIST _____

1. LOCATION of the QUADRAT

From 'Bushland Plant Survey' written by B. Keighery (1994) and published by the Wildflower Society of WA (Inc.), PO Box 54 Nedlands WA 6008.

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

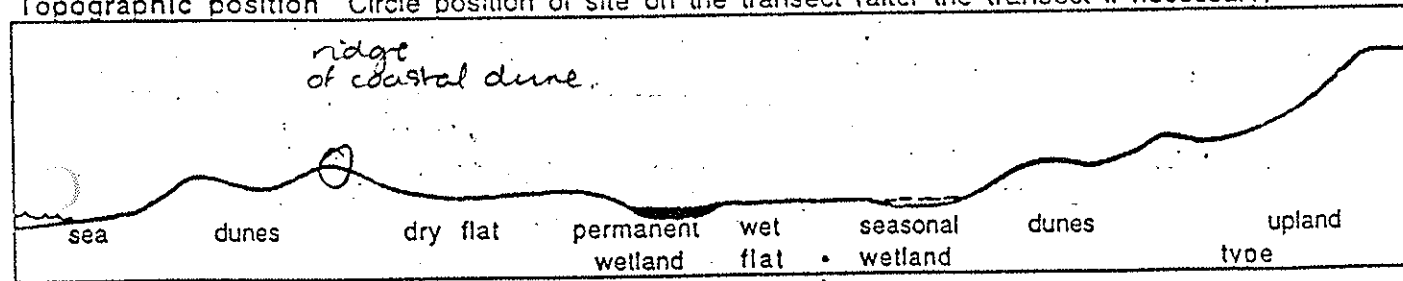


Road Location _____

Geographic Location Latitude 31° 48' 9.10" S Longitude 115° 46' 3.14" E Altitude 117
Reference Map _____

Photograph Photographer's Name NCT Photo No 15

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 brown
Exposed rock type _____ % surface _____

Sub-surface Soil sand Colour yellow orange
Rock type limestone depth to rock _____

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

Litter 2-10 % cover _____ Bare Ground 70+ % cover _____
Depth 1 leaf 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.

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
		Scattered Tuart not in site 			
COVER CLASS (%)			10-30		
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 (%)		2-10			
DOMINANT SPECIES		<i>Xanthorrhoea</i>		<i>Hibiscus</i>	
LIFE FORM	GRASSES	HERBS	SEDGES		
			over 0.5m	under 0.5m	
					
COVER CLASS (%)		30-70		30-70	
DOMINANT SPECIES		<i>Podolepis gracilis</i> <i>Hyper glab.</i>		<i>Scleria claudens</i> <i>Alexandria</i>	

4. VEGETATION CONDITION

		COMMENTS
1	PRISTINE	
2	EXCELLENT	
3	VERY GOOD ✓	rabbis fire been letting weeds in but herb layer not severely impacted upon
4	GOOD	
5	DEGRADED	kangaroos alot of moss on ground

BUSHLAND PLANT SURVEY RECORDING SHEET 3 - use pen only

5. SPECIES PRESENCE

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

SITE No PINN03
Date 5/10/95

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	Fl	ID	SHRUBS (cont.)	No	Fl	ID	HERBS (cont.)	No	Fl	ID
Euc. gomph.				HERBS				o. Por. microphylla			
Banksia prionotes				Acantho. preissii				o. Glad. darg.			
				Caladenia flava				o. Swerbaea laxiflora			
				Haem. sp. (long stony lvs)				o. Conostylis aculeata			
				(?laxum)				o. Ortho. laxus			
								o. Erag. spin. sp. spin. entire	as p		anath. h. d. s. p. p.
MALLEES								o. Odinetia urulei			
				GRASSES				o. Ischaemum cuneifolium			
				o. Ehrh. long.				o. Pluch. capensis			
				o. Ehrh. calycina				o. Petrorhagis velutina			
SHRUBS				o. Briza max.				o. Romulea rosea			
Xanth. preissii				o. Briza minor				o. Thysanotus p. p. p.	Ver		Ver
Circ. vestita				o. Danthonia sp.				SEDGES			
Daviesia triflora				o. Vulpia myuros	Ver			o. Maso. pseudostygi.			
Gomph. capitata				o. Arena tet.				o. Alex. nitens.			
o. Pel. capitata				o. Bromus diandrus				o. Hor. flex.			
o. Philothus (rosette) green) polysted.				HERBS				o. Schoenus clandest.			
o. Gomph. tom.				o. Com. ?cespitosa				o. Lepid. scabrum.			
o. Hibba hyp.				o. Daucus glachid.							
o. Daviesia nudiflora				o. Urs. anthom.							
o. Persoonia (long) saecula				o. Sporans bulla							
o. Dry. lind. J)				o. Hypochaeris glabra							
o. Hibb. raemosa				o. Clover (Suber) Trit. subt.	Ver			o. Trifolium dubium			Ver
o. Ricinus carnosus glaucus				o. Hom. homa							
o. Houa trispalma vertic.				o. Trachy. pilosa							
o. Astraloma pulidum				o. Homera flaccida							
o. Daviesia decurrens.				o. Burchardia congesta							
				o. Clover big yellow	check			o. Trit. campestr.			Ver
				o. Kenned. prostrata							
				o. Hom. flaccida				o. Medicago polymorpha (added by NR 2/1/95)			Ver

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 9m	under 9m
			Scattered Tuart to Woodland Low woodland 		
COVER CLASS (%)			10-30		
DOMINANT SPECIES			Bank prun.		

LIFE FORM	SHRUBS			SHRUBS	
	over 2m	2m-1.5m	1.5-1m	1-0.5m	under 0.5m
			Heath B 		
COVER CLASS (%)			30-70		
DOMINANT SPECIES			Cree rest Xanth. prei		

LIFE FORM	GRASSES	HERBS	SEDGES	over 0.5m	under 0.5m
		Grasses 	Herbs 		
COVER CLASS (%)	30-70	30-70			2-10
DOMINANT SPECIES	Bris min * Erh. long * Bris moss	Orth locus Trocky pil. Conostylis acul.			Meso pseudo

4. VEGETATION CONDITION

	COMMENTS
1 'PRISTINE'	Fire ≈ 7-10 years ago, regrowth Bank prun. (adj mature specimen)
2 EXCELLENT	
3 VERY GOOD	
4 GOOD	
5 DEGRADED	

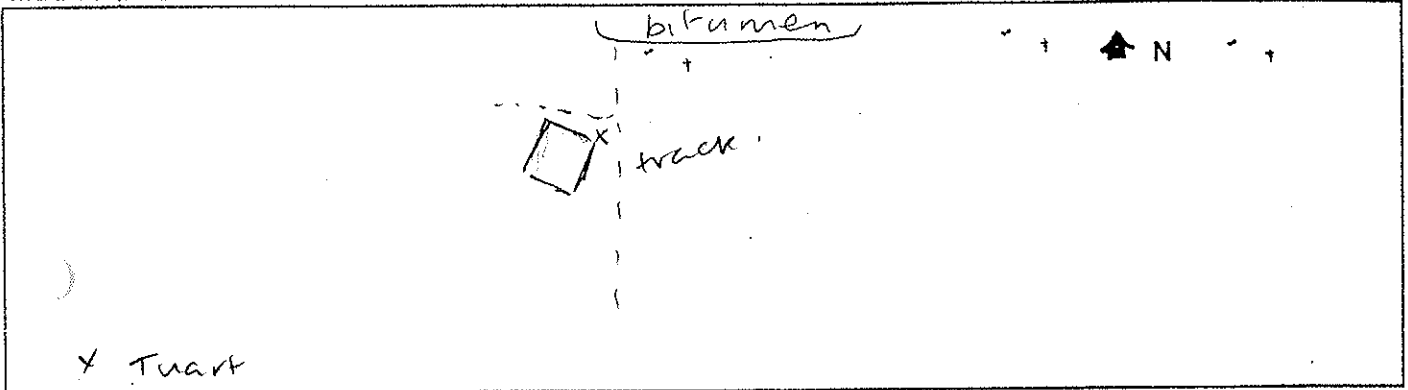
BUSHLAND PLANT SURVEY RECORDING SHEET 1- use pencil only

BUSHLAND AREA PINNAROO SITE NUMBER PINNØ3
 DATE TRIP 5-10-95 RECORDERS BTK, NCT
 DATE TRIP _____ RECORDERS _____
 DATE TRIP _____ RECORDERS _____
 BOTANIST _____

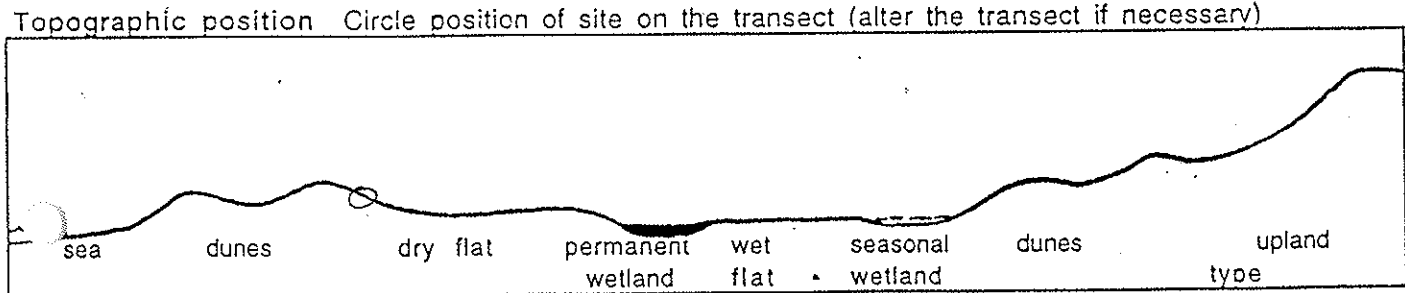
From 'Bushland Plant Survey' written by B. Keighery (1994) and published by the Wildflower Society of WA (Inc.), PO Box 24 Nedlands WA 6008.

1. LOCATION of the QUADRAT

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



Road Location _____
 Geographic Location Latitude 31° 48' 64S S Longitude 115° 46' 59E E Altitude _____
 Reference Map EPG 166 mt
 Photograph _____ Photographer's Name NCT Photo No 24



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 brown
 Exposed rock type _____ % surface _____
 Sub-surface Soil type sand Colour yellow
 Rock type _____ depth to rock _____
 Drainage wet mod poor depth water _____ cm Wet all year winter/spring
 Litter 30-70 % cover _____ Bare Ground 2 % cover
 Depth 0.5-1 cm

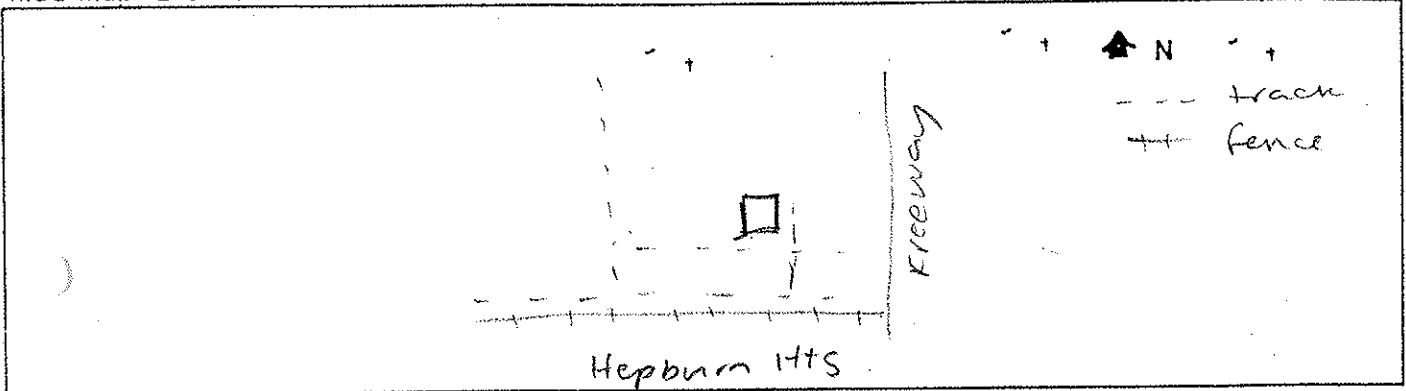
BUSHLAND PLANT SURVEY RECORDING SHEET 1- use pencil only

BUSHLAND AREA PINNAROO SITE NUMBER PINN01
 DATE TRIP 5-10-95 RECORDERS BJK NCT
 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 24 Nedlands WA 6008.

1. LOCATION of the QUADRAT

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

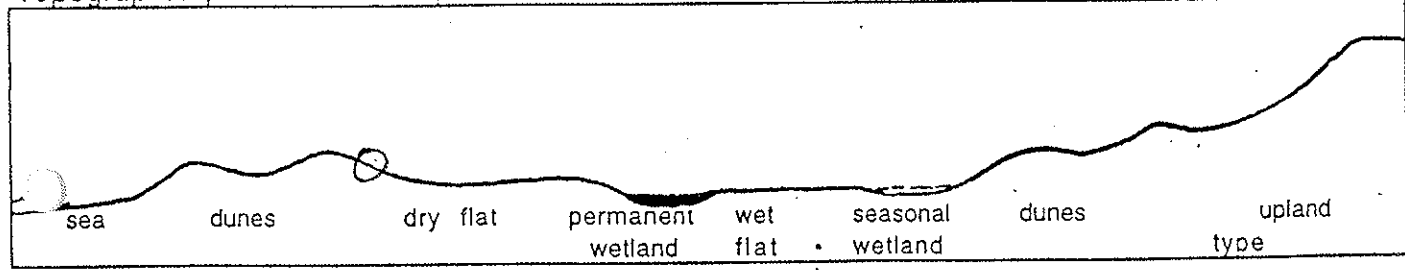


Road Location Whitfords Ave ??

Geographic Location Latitude 31°48'03" S Longitude 115°46'9" E Altitude 49 m
 Reference Map EP 49 m

Photograph _____ Photographer's Name BJK 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	<u>gentle</u>	steep	Aspect	N	NE	<u>E</u>	SE	S	SW	W	NW	
Surface Soil	type						<u>sand</u>	Colour	<u>brown</u>				
Exposed rock	type						% surface						
Sub-surface Soil	type						<u>Sand</u>	Colour	<u>orange/yellow</u>				
Rock	type						depth to rock						
Drainage	<u>well</u>	mod	poor	depth water	cm	Wet	all year	winter/spring					
Litter	<u>30-70</u>	% cover			Bare Ground	<u>2</u>	% cover						
	Depth	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
			? Low Forest A 		
COVER CLASS (%)		2-10	30-70		
DOMINANT SPECIES		E. marg.	B. menz B. att.		

LIFE FORM	SHRUBS			SHRUBS	
	over 2m	2m-1.5m	1.5-1m	1-0.5m	under 0.5m
				open dwarf Scrub C 	
COVER CLASS (%)				2-10	
DOMINANT SPECIES				Xanth. preissii	

LIFE FORM	GRASSES	HERBS	SEDGES	over 0.5m	under 0.5m
			Open Herbs 		
COVER CLASS (%)		10-30			30-70
DOMINANT SPECIES		Trach. pil Podol. gracil Homeria flac (clover) Tri. camp			Meso pseudo Ataxopogon Schoenus Neland Lax flex.

4. VEGETATION CONDITION

1	'PRISTINE'	5	COMMENTS overgrazing by roos + rabbits
2	EXCELLENT	4	
3	VERY GOOD	3	
4	GOOD	✓ 2	
5	DEGRADED	1	

BUSHLAND PLANT SURVEY RECORDING SHEET 3 - use pencil only

5. SPECIES PRESCENCE

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

SITE No PINN02
Date 5/10/95

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
								Senecio lantana			
								Podolmea angust			
								= ad 5/10/95 except			
								This calceol. group			
								*Brassica boun			✓
								*Sorgho straceus			
MALLEES								*Thys. pat			
				GRASSES				(Purple Parasite)			
				*Lag. orchus				= Orobanche dust.			
				*Avena fat							
				*Bromus diandrus							
SHRUBS				*Stipa flavescens				SEDGES			
*Mel. acerosa				*Pod. porphyrocladus				*Triglochin calceol. calcitropa			✓
*Acacia lasia ssp lasio				*Aira cany				*Tetraria octandra			
*Grevillea crithmifolia				*Lolium rigid (small)				*Lot. flex			
*Tarsonia breviceps								*Atripid. angust.			
*Pteris baccata				HERBS							
*P. l. capit. (seedling)				*Heliophilla pusila							
				*Stellaria med (Hairy Chick)							
				*Acanthocarpus prostris							
				*Lomandra maritima							
				*Lomalea rosea							
				*Conostylis aculeata							
				*Dichisma (Small) orn							
				*Crassula glomerata							
				*Petrohastis velutina							
				*Tick (alc) Erodi. moschat.	VSP			= cicutarium			✓
				*Colandrinia fruticosa	VSP			= fruticosa corriguloides			✓
				*Daucus sochrid							
				*Sorgho straceus							

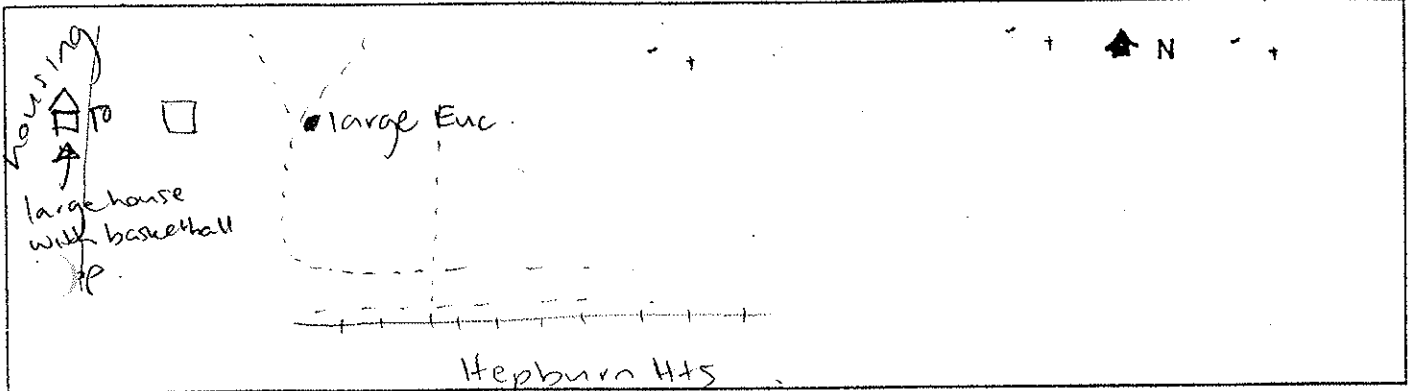
BUSHLAND PLANT SURVEY RECORDING SHEET 1- use pencil only

BUSHLAND AREA PINNAROO CEMETARY SITE NUMBER PINN 02
 DATE TRIP 5-10-95 RECORDERS BJK, NCT
 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 24 Nedlands WA 6008.

1. LOCATION of the QUADRAT

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

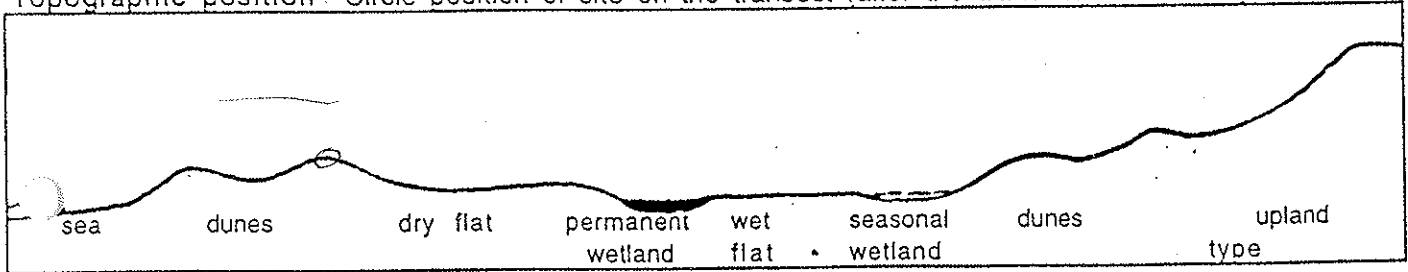


Road Location _____

Geographic Location Latitude 31°48.729'S Longitude 115°46.484'E Altitude _____
 Reference Map EPE 51mt

Photograph _____ Photographer's Name NCT Photo No 22

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 type sand Colour brown
 Exposed rock type _____ % surface _____

Sub-surface Soil type sand Colour pale yellow
 Rock type _____ depth to rock _____

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

Litter	<u>2-10</u> % cover	Bare Ground	<u>22</u> % cover
Depth	<u>0.5</u> cm		














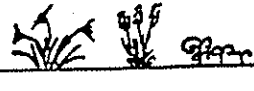
BUSHLAND PLANT SURVEY RECORDING SHEET 2 (Muir)- use pencil only

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 9m	under 9m
					
COVER CLASS (%)					
DOMINANT SPECIES					
LIFE FORM	SHRUBS			SHRUBS	
	over 2m	2m - 1.5m	1.5 - 1m	1 - 0.5m	under 0.5m
				Low Heath 	
COVER CLASS (%)				30-70	
DOMINANT SPECIES				Mel. aurea Acac. lasio	
LIFE FORM	GRASSES	HERBS	SEDGES	SEDGES	
	over 0.5m	over 0.5m	over 0.5m	over 0.5m	under 0.5m
	Dense grasses 	Very open herbs 		Very open low sedges 	
COVER CLASS (%)	70+	2-10		2-10	
DOMINANT SPECIES	*Lag. ovata *Bromus diand. Stipe Haw	*Helio. pusil. Lom. merit *Stell. med.		Lox flex	

4. VEGETATION CONDITION

		COMMENTS
1	'PRISTINE'	
2	EXCELLENT	
3	VERY GOOD	
4	GOOD	Annual layer 30-70% Lag ovata (Pussy)
5	DEGRADED	*Bromus, Stellaria Layer Kangaroo dung. In area many mossy patches but weeds in patches

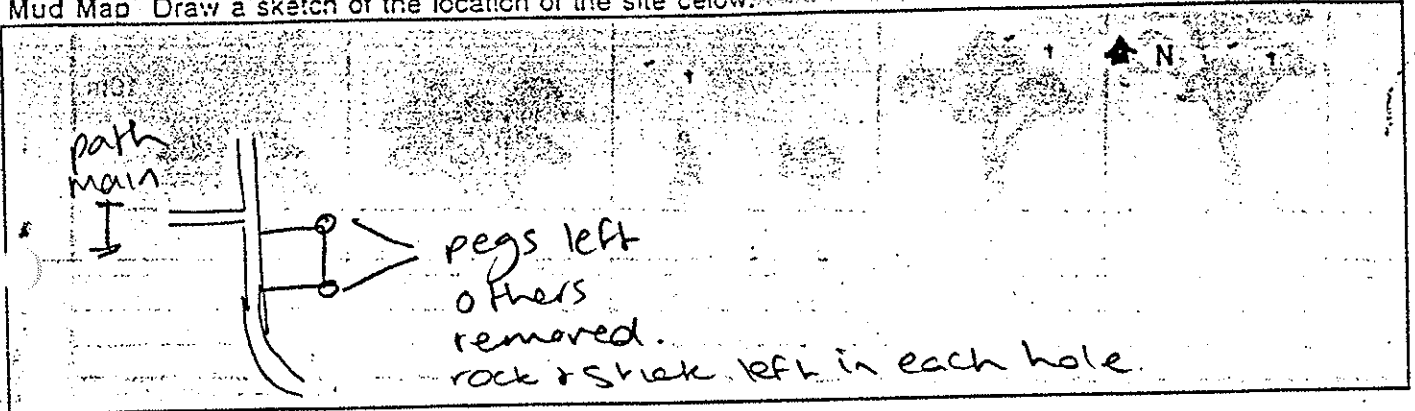
BUSHLAND PLANT SURVEY RECORDING SHEET 1- use pencil only

BUSHLAND AREA HEPURN COOK RESERVE SITE NUMBER HEPR 03
 DATE TRIP 12-9-95 RECORDERS BJK, NCT
 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 2, Nedlands WA 6008.

1. LOCATION of the QUADRAT

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

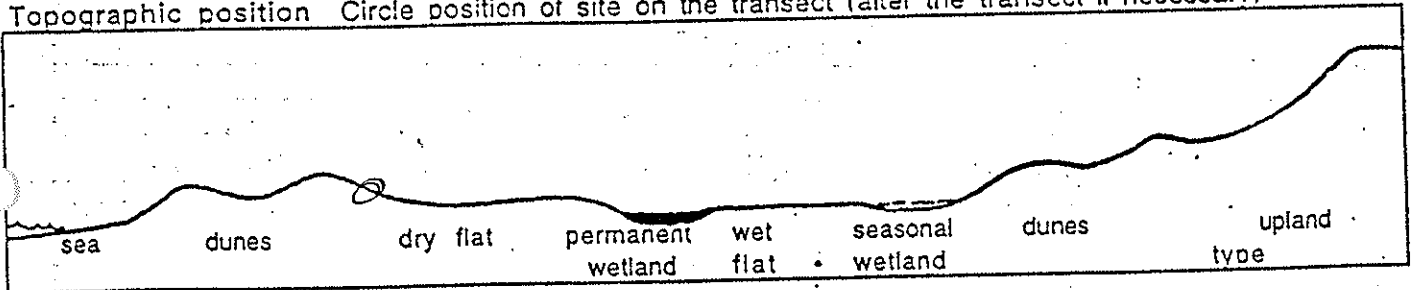


Road Location

Geographic Location Latitude 31°48'960S Longitude 115°46'244E Altitude ? 87
 Reference Map

Photograph Photographer's Name NCT Photo No 16

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 brown
 Exposed rock type _____ % surface _____

Sub-surface Soil orange Colour sand
 Rock type limestone depth to rock _____

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

Litter 10-30 % cover _____
 Depth 0.5 cm Bare Ground 12-10 % cover _____

to branch thick















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

From 'Bushland Plant Survey' written by B. Keighery (1991) and published by the Wildflower Society of WA Inc., PO Box 61 Nedlands WA 6008

VEGETATION STRUCTURE AND COVER

or 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%

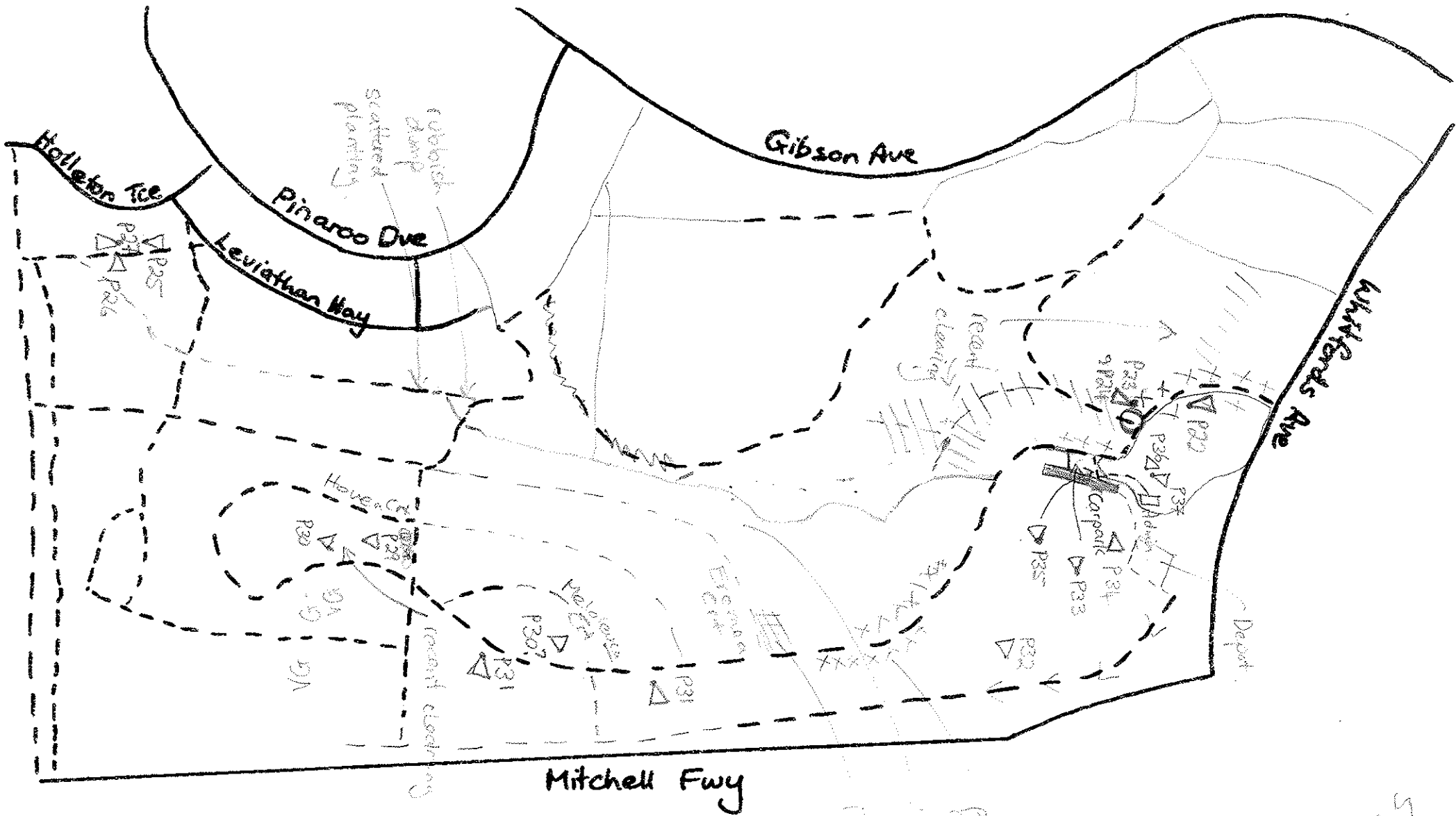
LIFE FORM	TREES			MALLEES	
	over 30m	15-30m	5-15m <u>under 5m</u>	over 8m	under 8m
					
COVER CLASS (%)			~2		
DOMINANT SPECIES			Acacia saligna		
LIFE FORM	SHRUBS			SHRUBS	
	over 2m	2m - 1.5m	1.5 - 1m	1-0.5m	under 0.5m
					
COVER CLASS (%)			30-70		
DOMINANT SPECIES			Acacia rostellifera A. cochlearis Calothamnus quad.		
LIFE FORM	GRASSES	HERBS	SEDGES	SEDGES	
			over 0.5m	under 0.5m	
					
COVER CLASS (%)		2-10		30-70	
DOMINANT SPECIES		Misc		Lox. flex	

4. VEGETATION CONDITION

1 PRISTINE	COMMENTS Acacia cochlearis would have made 1.5-2m shrub layer impacted by fire lots of Cape Tulip
2 EXCELLENT	
3 VERY GOOD	
4 GOOD	
5 DEGRADED	

5/11/99

1:10000



plantings above
 (P30) E.
 (P30) features
 (P30) ground

5/11/99 Pinaroo Cemetery

Site A 6. Compl. Degraded.

Artificial Wetland by Admin. looking NW.
from carpark.

Site B 5-4 Degraded-good Bushland behind admin.
P34 but varies to good-degraded.

Overstorey structure intact, rabbits, brush cutting -
Whipper snipping/^{mowing}, herb layer & grasses & sedges missing
(except *Loxocarya*, & occas. *Meslome*.) replaced by weeds
layer. Scattered *Jurrah* over *Banksia* occ. *Tuart*.

Lots of Kang. grazing. Only veld grass in Kang.
exclusion areas.

(Site B1 In front of carpark - island - not viable.
but not mown greater diversity, plantings made)
4-5 Good-degraded.
P33 Geraldton way

Scattered shrubs, scattered sedges
Lech linear present - NB survives kangaroos.

Rhicino. glauca

P32 - Euphorb.

Tuart dominant here ie varies scattered → dom.

Bad fire in past ^(ages ago) has killed trees

Plantings on edge of road.

Power line along eastern boundary - soil banded.
up on western side of track.

(southern B section)
Heading south verging on good (top of good) density
but patches refl - (yellow) & variety shrubs has
↑ 30-70% & sedge layer ↑
(before under 10-30%) but same weeds.

Good - Very good

better verging on v. good: und. patches of disturbance:

B. Becoming ~~Very good~~ as move south esp. opp. D area.

C. Memorial Lawns - Melaleuca Court.
P30?

Good → Degraded, no plantings in Melaleuca Court, left ~~B~~ eucs, not banksias patches of bush, equiv. to B but. good - degraded. ^{same weed} _{hard} no edge, herbicide spraying
Lawn = Completely degraded

Waikzia soavelans extending
Worthing system into bushland

D. Very good bushland patches - weeds not a problem. ^{autumn - early spring} ~~just recently~~
Clearing has taken place - ~~just recently~~ just recently
Young jarrah/banksia seedlings + spring annuals in "autumn" clearing. Selected eucs left

P30 new clearing

P29 mulch pile.

Bushland patches - native grasses, herbs

Prob. Equivalent to our plots? ?

But not less perhaps - Haken taller

No Euphorbia terasena.

Bank prionotes patches

C. Old memorial lawns west of Melaleuca Court
P28.

E. Very good

} same vegn as B.

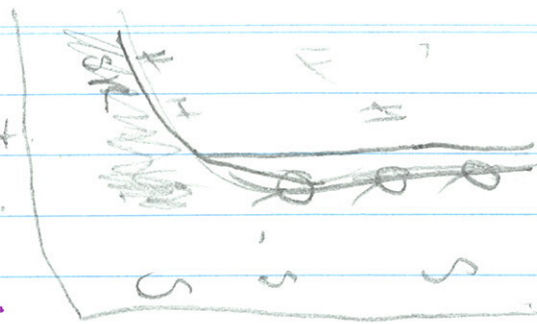
} No euph terasena.

F. Good - very good

} patchy v. good sections

G. Between 2 tracks.

F Tuart & jarrah. dominant
 Jacksonia sericea present.
 No Lachen. reflexa
 No Euphorb. terrecena.



G low in landscape. - patch of Jarrah, base of valley

H ~~Good~~ Good - V. good - Transition Quind & Spearwood
 with degraded patches } use quadrat. for condition
 Euphorb. back } along track Sth boundary
 Osteospermum - garden & patches
 escape

B. prionotes with native understorey rare in metro area
 Plantings in patches along base of Quind edge

NB: End of a parabolic dune - quindalup

Whole area High spp richness Quid - Spear & interface

J Very good - good - native grasses present
 P27. Sth v. weedy in patches
 P26 Across Valley
 P25 Nth

Wed next week
15 Cemeteries Board.

Condition mapping across site
 Existing facilities - current roads.
 Contiguous area bush for protection
 - based on what's there
 - document values.
 Overlay at same scale as Master Plan

* rationalise?
 Quind / Spearwood systems - conserve both & transition.
 C areas - map bushland islands (if poss) have no regional values.
 Management plan
 - existing future weed problems *
 - access tracks - fire Vegn boundaries etc.
 New bushland line
 Differentiate lawn & bushland islands

C - adj to J Cassia Court
Laguna - Soldiers last again

Roundabout into bush K - clearing P24

K Bushland same type as B 9. condition.
Planting within (Quindalup ssp in Spearwood Dunes)
condition

J Better Cond Same as (B)
on west side of track

Kids BMX ramps: ditches along track.
east

Most within Quindalup Dune (recently burnt) being
invaded by Euphorbia-terecina last summer.

I Same as ~~K~~ K but condition improved.

L Quindalup Dune - v. recent fire (last summer)
Large patch of lupins at track intersection -
Condition same as J v. hot burn? / cleared previously
Lagurus (Hare's tail grass) only few
not dominant / present
→ S Patch dead because - fire?

M Same as L & J but older fire than L
& J older than M



























BUSHLAND PLANT SURVEY RECORDING SHEET 2 - use pencil only

3. VEGETATION STRUCTURE AND COVER

From 'Bushland 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%

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

4. VEGETATION CONDITION

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











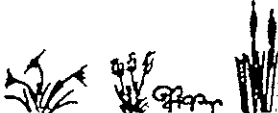
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For each layer record - appropriate life form, cover class (see below), and dominant species in each layer.

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

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

4. VEGETATION CONDITION

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



























BUSHLAND PLANT SURVEY RECORDING SHEET 2 - use pencil only

3. VEGETATION STRUCTURE AND COVER

From 'Bushland 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%

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

4. VEGETATION CONDITION

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

Pinaroo Cemetery

Vegetation Condition

✓ Zone A - Completely Degraded 6: Artificial wetlands, lawns and landscaped beds.

Zone B - Degraded - Good 5-4, varying to Good - Degraded 4-5: Bushland behind administration.

- Changes to Good 4 as move south

- Verging on Very Good 3 as move further south opposite Zone D

Sp/5-4:4-5 (Karrakata - Central and South)

Sp/4
Zone B1 - Good - Degraded 4-5: Bushland islands between carpark and loop road. Not viable.

Sp/4-5 (Karrakata - Central and South)

Zone C - Good - Degraded 4-5: Melaleuca Court Memorial Lawns bushland islands.

(Karrakata - Central and South)

- Completely Degraded 6: Melaleuca Court Memorial Lawns lawn areas.

✓ Zone C - Good - Degraded 4-5?: Hovea Court Memorial Lawns bushland islands

(Karrakata - Central and South)

- Completely Degraded 6 :Hovea Court Memorial Lawns lawn areas

✓ Zone C - Good - Degraded 4-5?: Cassia/Eremea? Court Memorial Lawns bushland islands

(Karrakata - Central and South)

- Completely Degraded 6 :Cassia/Eremea? Court Memorial Lawns lawn areas

Zone D - Very Good 3: Southern end of Hovea Court bushland

- Condition?: Illegal clearing within Southern end of Hovea Court bushland, very recent (autumn-early spring 1999).

Sp/3 (Karrakata - Central and South)

Zone E - Very Good 3:

Sp/3 (Karrakata - Central and South)

Zone F - Good - Very Good in patches 4-3:

Sp/4-3 (Karrakata - Central and South)

Zone G - Condition?: Between two most southern east-west tracks.

(Karrakata - Central and South)

4-3
Zone H - Good - Very Good with Degraded patches (check quadrat data for condition) 3-4/5:

Tr/4-3
Transitinal vegetation between Cottesloe - Central and South and Karrakatta - Central and South.

Zone I - Good 4?:

Sp/4 (Karrakata - Central and South)

Zone J - Very Good - Good 3-4, weedy in patches:

Sp/3-4 (Karrakata - Central and South)

Zone K - Degraded - Good 5-4, varying to Good - Degraded 4-5:

Sp/5-4:4-5 (Karrakata - Central and South)

Zone L - Very Good - Good 3-4: Cottesloe - Central and South vegetation? Recent fire

Zone M - Very Good - Good 3-4: Cottesloe - Central and South vegetation? Less recent fire

Zone N - Very Good - Good 3-4: Cottesloe - Central and South vegetation? Old fire

Qv/3-4

- Need to maintain corridor N-S along Ecm boundary
- Need to maintain corridor from N-S corridor thru to SW corner of site to link through to E-W greenway

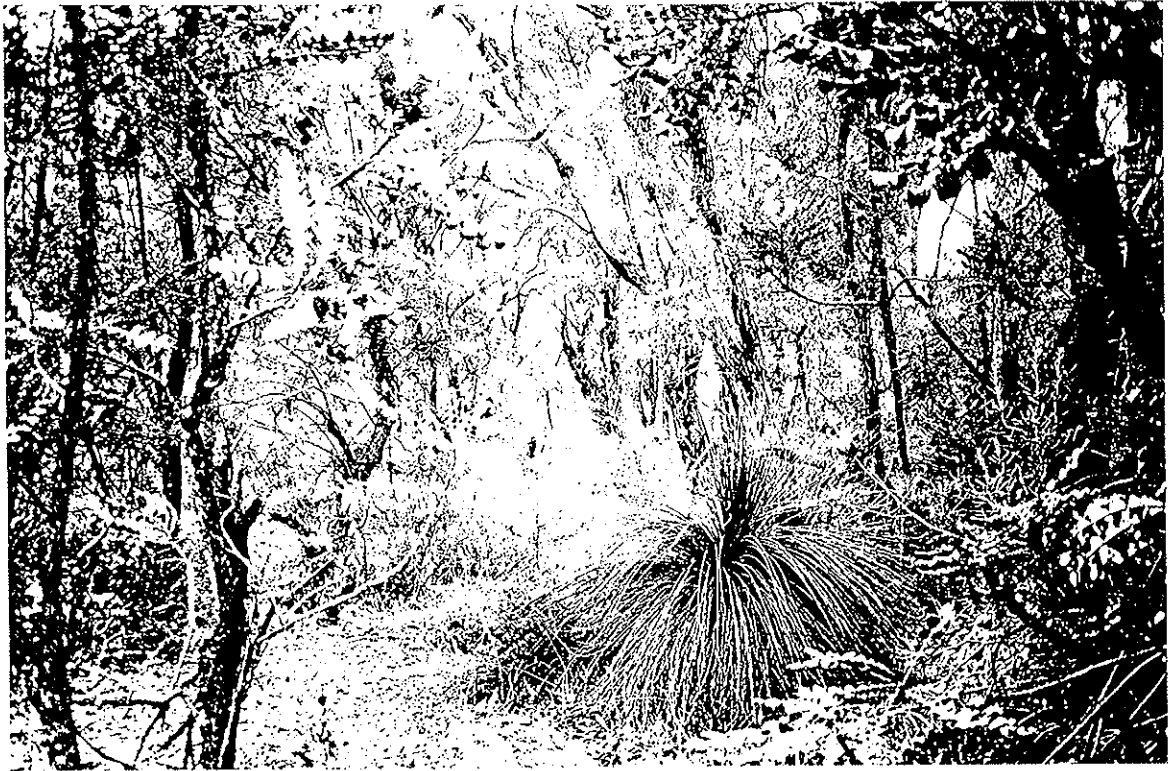


Figure 1: Spearwood landform vegetation unit in very good condition (no. 3 rating) in the south-eastern section of the Pinnaroo Cemetery bushland.



Figure 2: Quindalup landform vegetation unit in the foreground on a dune looking over the transitional vegetation in the south-western section of Pinnaroo valley. This is contiguous across the southern section of the site into the Spearwood unit. Shows the remnant vegetation band recommended for conservation.



Figure 3: Quindalup landform vegetation unit on the sand dune running north-south along the western side of Pinnaroo Valley.



Figure 4: Memorial lawns in the southern section of Melaleuca Court with bushland islands in the background which at present are in good condition.



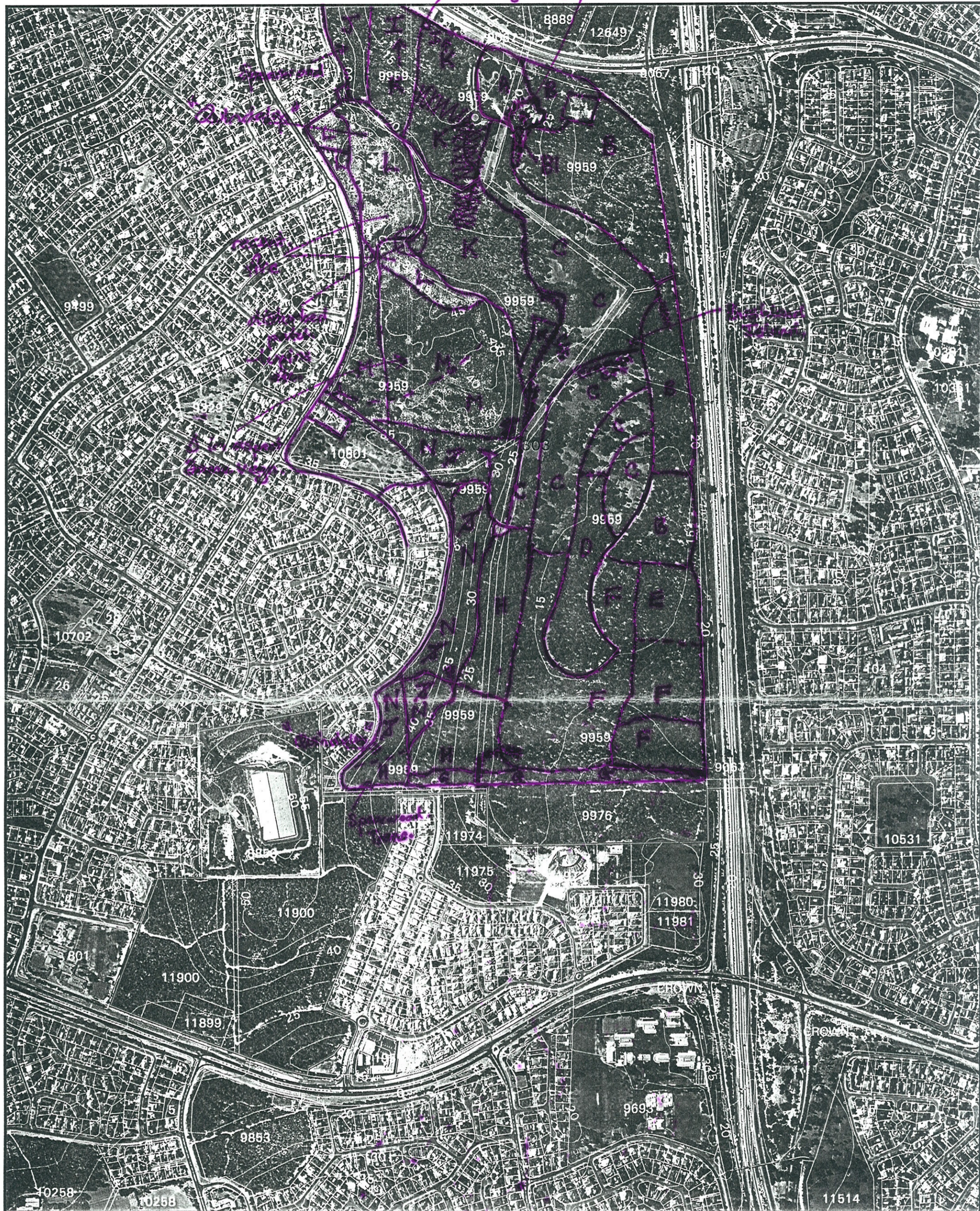
Figure 5: The edge of a bushland island in the memorial lawns of Melaleuca Court.



Figure 6: Bushland island in one of the older memorial lawn areas, the vegetation structure and species present have been substantially altered from that of the original bushland remnant. This island is now degraded with a condition rating of 5.

5/11/99 Site Visit - BJK, Kc, Cl, CT

Drainage Sump, A P87 + P86



BUSHPLAN SITE 303
SOUTHERN PORTION
ORTHO-RECTIFIED AERIAL IMAGE
CONTOURS & CADASTRE

-  Bushplan Sites (boundaries)
-  Cadastre with Lot Numbers
-  Contours - 5m (DOLA)

Map Ident: plot991104_1	DATE: 04 Nov 1999
Prepared By: Andrea Zappacosta	Prepared For: CATHERINE THOMSON
Scale 1:8000	MFP INTERNAL USE ONLY



**Department of Environmental Protection System 6 Update: Site Based Flora List for
Hepburn Bushland Reserve, Padbury (Subm no. 159)**
(178 taxa, Hepb01-03, B.J. Keighery, 7/6/96)

116
Amaranthaceae

Ptilotus declinatus
Ptilotus drummondii

Anthericaceae

Caesia micrantha
Sowerbaea laxiflora
Thysanotus arenarius
Thysanotus patersonii
Thysanotus sp. manglesianus/patersonii scps
Tricoryne elatior

Apiaceae

Daucus glochidiatus
Homalosciadium homalocarpum
Trachymene coerulea
Trachymene pilosa

Asteraceae

Asteridea pulverulenta
* Hypochaeris glabra
Podolepis gracilis
Podolepis sp. scps
Podotheca chrysantha
Podotheca gnaphalioides
Quinetia urvillei
Senecio lautus
* Sonchus oleraceus
* Ursinia anthemoides

Brassicaceae

* Heliophila pusilla

Campanulaceae

Wahlenbergia preissii

Caryophyllaceae

* Cerastium glomeratum
* Petrorhagia velutina
* Silene gallica

Centrolepidaceae

Centrolepis drummondiana

Colchicaceae

Burchardia congesta

Crassulaceae

Crassula colorata

Cyperaceae

Isolepis marginata

Lepidosperma angustatum

Mesomelaena pseudostygia

Schoenus clandestinus

Schoenus grandiflorus

Dasypogonaceae

Lomandra caespitosa

Lomandra maritima

Dilleniaceae

Hibbertia hypericoides

Hibbertia racemosa

Droseraceae

Drosera erythrorhiza

Drosera pallida

Epacridaceae

Conostephium pendulum

Leucopogon parviflorus

Leucopogon polymorphus

Euphorbiaceae

Phyllanthus calycinus

Geraniaceae

* *Pelargonium capitatum*

Goodeniaceae

Dampiera linearis

Lechenaultia linarioides

Scaevola anchlussifolia

Scaevola canescens

Scaevola thesioides

Gyrostemonaceae

Tersonia cyathiflora

Haemodoraceae

Conostylis aculeata

Iridaceae

- * Gladiolus caryophyllaceus
- * Homeria flaccida
- Orthrosanthus laxus
- * Romulea rosea

Juncaginaceae

Triglochin sp. A FPR (BJK&NG 095)
Triglochin trichophorum

Mimosaceae

Acacia cochlearis
Acacia pulchella
Acacia rostellifera
Acacia saligna
Acacia truncata

Myrtaceae

Calothamnus quadrifidus
Eucalyptus gomphocephala
Melaleuca acerosa

Orchidaceae

Caladenia flava
Caladenia georgei MS
Caladenia sp. scps
Diuris longifolia
Lyperanthus nigricans
Pterostylis aff. nana scps
Pterostylis vittata

Papilionaceae

Daviesia divaricata
Daviesia nudiflora
Daviesia triflora
Gompholobium tomentosum
Hardenbergia comptoniana
Hovea pungens
Hovea trisperma

Jacksonia sericea
Kennedia prostrata
Sphaerolobium medium
Templetonia retusa
* Trifolium campestre

Phormiaceae

Dianella revoluta

Poaceae

* Briza maxima
* Briza minor
* Ehrharta longiflora
* Pentaschistis airoides
Stipa flavescens
* Vulpia myuros
* Vulpia sp. scps

Portulacaceae

Calandrinia corrigioloides

Primulaceae

* Anagallis arvensis

Proteaceae

Banksia attenuata
Banksia menziesii
Dryandra nivea
Dryandra sessilis
Grevillea thelemanniana subsp. preissii
Grevillea vestita
Hakea lissocarpha
Synaphea spinulosa

Restionaceae

Alexgeorgea nitens
Loxocarya flexuosa

Rubiaceae

Opercularia vaginata

Scrophulariaceae

* Dischisma arenarium

Stylidiaceae

Stylidium brunonianum
Stylidium calcaratum
Stylidium junceum
Stylidium macrocarpum

Thymelaeaceae

Pimelea calcicola

Violaceae

Hybanthus calycinus

Xanthorrhoeaceae

Xanthorrhoea preissii

Zamiaceae

Macrozamia riedlei

BACKGROUND

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Bronwen Keighery and Natalie Thorning from DEP surveyed the area in 1995 as part of the System 6 Update program to identify the regional floristic units present in the Cemetery bushland and to assess vegetation condition. At this time discussions with Cemetery Board staff (John Holman and Brian Darbee, September/November 1995) indicated that it was intended that 30% of the Cemetery land remain as bushland.

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- assess the condition of the bushland, with particular reference to the size of the individual bushland areas and
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Being November there were relatively few plants flowering and many annually renewed plants were dead. Vegetation condition assessments are subject to revision on a mid spring inspection.

The principal landform/vegetation units and the condition of these units was mapped (Maps 1 and 2).

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The Pinnaroo Cemetery bushland is included in Bushplan Site 303 as it meets the following three of the criteria for inclusion in Draft Perth's Bushplan. These and the explanation for the application of these criteria are given below.

Representation of ecological communities

Under this criterion two sets of regional data were considered:

(i) Representation of vegetation complexes (Heddle *et al.* 1980)

The bushland is mapped as containing the Karrakatta Complex — Central and South and Cottesloe Complex — Central and South from the Spearwood Dune System. While these two complexes are both present in Bushplan Site 303 only the Karrakatta Complex — Central and South is present in the Pinnaroo Cemetery bushland. While not mapped by Heddle *et al.* an additional vegetation complex, the Quindalup Complex (from the Quindalup Dune System), is also present in the Pinnaroo Cemetery bushland (see Figures 1 to 3, Map 1 and 2 and Appendix 1, Landforms and Soils). The presence of the Quindalup Dunes in the Pinnaroo Cemetery bushland is clearly indicated in a variety of maps of soils and landform units (see Diversity criterion and Appendix 1). The scale of the Heddle *et al.* mapping was likely to be responsible for the discrepancy in mapped units.

Less than 10% of the Karrakatta Complex — Central and South is recognised for protection in Draft Perth's Bushplan.

(ii) Representation of floristic community types (DEP 1996)

Two floristic community types were determined from the three plots located in 1995:

- 28 Spearwood *Banksia attenuata* or *B. attenuata* — *Eucalyptus* woodlands
 29a Coastal shrublands on shallow sands

These community types are from Supergroup 4 (Uplands centred on Spearwood and Quindalup Dunes) and are representative of the Spearwood and Quindalup Dunes respectively.

The condition of the vegetation of the bushland in the Pinnaroo Cemetery bushland ranges from Very Good to Degraded (See Map 2). Spearwood Dunes have been subject to significant historical disturbance (grazing, settlement, horticulture etc) and the general condition of vegetation in this dune system is generally lower than for the other dune systems. As a consequence areas in Very Good to Good condition are a high priority for protection.

Diversity

Landforms

Two of the dune systems of the Swan Coastal Plain (Appendix 1 and McArthur and Bartle 1980) are present in the Pinnaroo Cemetery bushland

- Quindalup Dune System (a Q2 dune after McArthur and Bartle 1980) and
- Spearwood Dune System (Ky Karrakatta sands derived from Tamala limestone after McArthur and Bartle 1980).

Vegetation

A variety of vegetation units occur on the Pinnaroo Cemetery bushland (see Figures 1 to 3, Map 1 and Appendix 1) related to the presence of the Spearwood and Quindalup Dunes and the transition between them. The *Banksia prionotes* Open Woodland to Forest appears to be a feature of the transitional zone between the Quindalup Dune and the low lying Spearwood Sands to the east. There are few examples in the Perth Metropolitan Region on the Swan Coastal Plain of structurally and floristically intact vegetation dominated by *Banksia prionotes*. In general the understorey of these areas is severely impacted and weed species predominate. While there is evidence of disturbance in this unit in the Pinnaroo Cemetery bushland (in particular from repetitive fires) the understorey is in Good to Very Good condition.

Species

Two hundred and ^{thirty} ~~fifty~~ five native taxa are listed for the Bushplan Site 303 (see Table 1).

This is a diverse list for these dune systems. This is especially so when compared with the most directly comparable area on geomorphology and floristic community types, Trigg Dune Reserve. This can probably be accounted for by the greater area of Spearwood limestones and sands in Bushplan Site 303 and the presence of a substantial interface between the Spearwood and Quindalup Dunes. These soils have a more species rich flora than the Quindalup sands which predominate in the Trigg Dune Reserve. While the flora list for the Pinnaroo Cemetery bushland would be less than for the entire area the juxtaposition of the two landform systems in the Pinnaroo Cemetery bushland, would again, be expected to result in a relatively diverse flora.

Table 1: A comparison of Bushplan Site area and species diversity
(source Draft Perth's Bushplan, Volume 2B, references listed in each Bushplan Site description)

Bushland Area	Area (ha)	Native Flora
Quindalup/Spearwood Dunes		
Whitfords Ave Bushland (BS 303)	252	235
Trigg Bushland (BS 308)	178	175
Spearwood Dunes		
Warwick Open Space (BS 202)	74	118
Woodvale Nature Reserve (BS 407)	38	170

Scientific or evolutionary importance

Three regional floristic plots are located in the area.

In addition, the Pinnaroo Cemetery bushland within Bushplan Site 303 is important for linking bushland to the north and south. The area is also part of Greenways 9 and 10 (see Map 1).

SITE COMMENTS/ADJUSTMENT**Bushland retention within Pinnaroo Cemetery**

At present the lands within the Cemetery can be divided into three categories

(1) Garden developments (see Map 1, Area A)

In these areas the bushland is entirely cleared and replaced by grass, gardens and ponds. Occasional individual native species remain as specimen trees. While the gardens are designed to have a 'natural' look very few of the plantings are species found locally. Most of the species used in the landscaping are from outside WA or not from the Swan Coastal Plain (see Appendix 2). Many of these species are potential or known bushland weeds (see Appendix 2). As a consequence these areas do not contribute to bushland protection.

(2) 'Natural' developments (see Map 1, Area B)

The 'natural' developed areas of the Pinnaroo Cemetery have retained the original forest/woodland eucalypts (Tuart and Jarrah) and scattered bushland remnants amongst the grassed areas (see Figure 4). These isolated remnants form small islands of bushland within an alien landscape and the edge to area ratio is so large that edge disturbances are able to impact the entire bushland patch.

The inspections of the Pinnaroo Cemetery bushland (1994, 1995 and 1999) clearly show these small remnants are degrading (see Figure 5 and 6). Types of disturbance observed in the Pinnaroo Cemetery bushland contributing to this decline are:

- continued fragmentation of the bushland remnants by incremental clearing, grassed areas, walk trails
- lawn/mower incursions into bushland edges (see Figure 5)
- 'enrichment plantings' that is plantings of species in the bushland not found in that plant community and of plants from that community but from non-local stock (see Figure 6 and Appendix 2 & 3)
- weed invasion from presently naturalised non-native taxa and potentially from plantings of invasive species in the cultivated beds (see Figure 6 and Appendix 2)
- fertilizer drift from grassed areas

- change in the water regime through water 'drift' from irrigated areas and direct irrigation
- grazing: overgrazing by kangaroos and rabbits

That is while there is an intention on behalf of management of the Park to retain bushland within the Cemetery development it is apparent that the impact of the disturbance factors on bushland preservation is not understood.

(3) *Bushland - undeveloped areas* (see Map 1, shaded areas)

The large areas of bushland yet to be fragmented are maintaining their condition. However these areas are also subject to a series of disturbances related to the lack of active management. Types of disturbance observed in the larger areas of the Pinnaroo Cemetery bushland are:

- fragmentation of the bushland by clearing, fire breaks, roads, walk trails (see Map 1 and 2)
- frequent fire
- 'enrichment plantings' that is plantings of species in the bushland not found in that plant community and of plants from that community but from non-local stock (see Figure 6 and Appendix 2 & 3)
- weed invasion from presently naturalised non-native taxa
- soil movement, both removal and dumping
- fertilizer drift from grassed areas (edges of bushland)
- change in the water regime through water 'drift' from irrigated areas (edges of bushland)
- grazing: overgrazing by kangaroos and rabbits
- proliferation of unauthorised tracks on the Quindalup Dunes (see Aerial photograph).

Future Plans for the development of the Cemetery

It is apparent from the plans for the development of the entire area of the Cemetery land that the intention is to rely on small isolated remnants and a thin bushland 'edge' to account for bushland retention. Such a design forms an exaggerated edge, resulting in a substantial edge to area ratio allowing each bushland patch to be subject to massive disturbance as no part of the patch is far from the edge. **This design is not compatible with bushland protection over the long term.**

While the concept of a 'Memorial Park' such as is being developed at Pinnaroo is relatively new there are many examples of bushland degradation as a result of exaggerated fragmentation. The bushland fragmentation currently proposed for the Cemetery is comparable with that in golf courses formed in bushland remnants. Many golf courses in Perth have been developed within bushland remnants where bushland was retained between the fairways (Wembley, Armadale etc). The older golf courses (eg Wembley) retain a few of the original trees and occasional understorey species but no bushland.

Core Natural Areas in the Pinnaroo Cemetery bushland

To maintain the values of the regionally significant bushland in the Pinnaroo Cemetery bushland and accommodate development of the cemetery there is a need to identify a consolidated bushland area that, with appropriate management, is adequate to protect these values. The selection of this area needs to take into account

- size (isolated remnants in grassed areas will not maintain their values over time)
- Quindalup and Spearwood Dunes landforms and vegetation (Figure 1, 2 and 3)
- the north south linkage function (Map 1 and 2) and
- vegetation condition (Map 2 and Figures 1, 2 and 3).

The areas appropriate to be protected are highlighted on Map 1. The dashed line indicates the an eastern vegetation band to maintain landscape values to the east.

REFERENCES

(In addition to those listed in Draft Perth's Bushplan Volume 2B)

McArthur, W. M. and Bartle, G.A. (1980) Landforms and Soils as an Aid to Urban Planning in the Perth Metropolitan Northwest Corridor, Western Australia. Land resources and Management Series No 5. CSIRO, Australia.

Morald, T. and Ogden, G. (1994) Flora of Craigie Open Space. Unpublished report, Edith Cowan University, Western Australia.

APPENDIX 1: Part Bushplan Site 303 description**WHITFORDS AVENUE BUSHLAND, CRAIGIE/PADBURY**

Bushplan Site no. 303 Map no. 38, 44

Boundary Definition: protected area/bushland (part taken to cadastre and zoning)boundary**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: S2, LS4)

VEGETATION AND FLORA**Vegetation Complexes****Spearwood Dunes**

Karrakatta Complex — Central and South

Cottesloe Complex — Central and South

Floristic Community Types**Supergroup 4: Uplands centred on Spearwood and Quindalup Dunes**

24 Northern Spearwood shrublands and woodlands

26b Woodlands and mallees on limestone

28 Spearwood *Banksia attenuata* or *B. attenuata* — *Eucalyptus* woodlands

29a Coastal shrublands on shallow sands

WETLANDS

No wetlands mapped

THREATENED ECOLOGICAL COMMUNITIES

Not assessed

SECTION 3: SPECIFIC SITE DETAIL**Landscape Features:** limestone ridge, tall dune, vegetated uplands**Vegetation and Flora:** detailed survey (part Bushplan Site, Hepburn Heights — Keighery, GJ, 1991b, Tingay, Alan & Associates 1991a ; Craigie Open Space — Allen *et al.* 1994); limited survey (DEP 1996 (Hepb 01-03), (Pinn 01-03); Pinnaroo Cemetery — Foulds 1987)**Structural Units:** mapping (part Bushplan Site, Craigie Open Space — Allen *et al.* 1994; part Bushplan Site — Hepburn Heights, Pinnaroo Cemetery and Craigie Open Space: Semeniuk, V&C Research Group 1991a; part Bushplan Site — Hepburn Heights and Pinnaroo Cemetery — Tingay, Alan & Associates 1991a)**Quindalup Dunes**Uplands: *Melaleuca acerosa* and *Acacia lasiocarpa* Open Low Heath; *Eucalyptus gomphocephala* Woodland; *Banksia prionotes* Woodland**Spearwood Dunes**Uplands - Sands derived from Tamala Limestone: Open Forest to Woodland dominated by *Eucalyptus marginata*, *E. calophylla* or *E. gomphocephala*; Low Woodland to Open Low Woodland dominated by *Banksia attenuata*, *B. menziesii*, *B. prionotes* or *Allocasuarina fraseriana* and combinations of these (these areas may contain scattered emergent *Eucalyptus marginata* or *E. gomphocephala*); *Acacia saligna* Shrubland; *Acacia rostellifera* Shrubland

Department of Environmental Protection

B. Keighery and K. Clarke, November 1999

Uplands - Tamala Limestone: *Eucalyptus decipiens* Low Woodland; *Acacia rostellifera* Shrubland; *Acacia truncata* Shrubland; *Dryandra sessilis* var. *cygnorum* Closed Heath; *Lepidosperma gladiatum* Sedgeland

Scattered Native Plants: *Eucalyptus gomphocephala* Woodland

Vegetation Condition: >70% Very Good to Excellent, <30% Good to Degraded, with areas of severe localised disturbance

Total Flora: 235 native taxa, 66 weeds (compiled from Allen *et al.* 1994, Foulds 1987, Keighery, GJ, 1991b, Tingay, Alan and Associates 1991a) (estimated >85% of expected flora)

Significant Flora: *Sarcocornia bicarinata* (3), *Jacksonia sericea* (3); *Lechenaultia linarioides*, *Ricinocarpus glaucus*, *Callitris preissii* (most northern population on the Plain); typical Tamala Limestone taxa: *Grevillea preissii*, *Diplopeltis huegelii*, *Trymalium ledifolium* subsp. *ledifolium*

Fauna: multiple and structured surveys by Western Australian Museum of Natural Science and Edith Cowan University (Allen *et al.* 1994) for birds (36), native mammals (3), reptiles (19) and amphibians (2) (How *et al.* 1996). Significant bird species: category 3 (6) including Grey Shrike-thrush, Weebill, Yellow-rumped and Western thornbills and Splendid Fairy-wren, and category 4 (2). Significant mammal species: Western Brush Wallaby, Quenda (Friend 1996 D). Significant reptile species: Two-striped Snake (*Simoselaps bimaculata*) and Half-ringed Snake (*S. semifasciata*)

Linkage: no adjacent bushland; part of a regionally significant fragmented bushland/wetland linkage (Volume 2A, Map 8)

Other Special Attributes: recommended for protection in study of City of Wanneroo bushland (Trudgen 1996); contains Quindalup/Spearwood Dunes System interface; Quindalup Dunes at 9kms from the coast; part Bushplan Site recommended for conservation by Semeniuk, V&C Research Group (1991a); part of proposed Greenways 10, 11 (Tingay, Alan & Associates 1997a)

SECTION 4: INTERNATIONAL AND NATIONAL SIGNIFICANCE

Interim List of the Register of the National Estate

SECTION 5: SELECTION CRITERIA AND RECOMMENDATIONS

Criteria: Representation of ecological communities, Diversity, Rarity, Scientific or evolutionary importance

APPENDIX 2: Plantings at Pinnaroo Cemetery

While the Pinnaroo Cemetery area was completely vegetated before development much of this vegetation has been cleared and replaced by a variety of plantings. In other areas the natural vegetation has been 'enriched' by a variety of plantings. Comment on the suitability of these species for planting in and alongside bushland is divided into five categories according to the origin/natural distribution of these species. Not all species observed are listed, but it is intended that this selection illustrate that the plantings in the Garden and 'Natural' developments do not contribute to bushland retention.

Plantings in bushland that can contribute to bushland retention and restoration must be of local native species. Local species are here considered to be the local variants of species recorded as occurring within the Pinnaroo Cemetery and/or within 15 kms in the same landscape/vegetation unit.

Some guiding principles in determining what can be considered 'local plant material' for revegetation work within the Cemetery area are given in Appendix 3.

Key to Column 2, after Map 1

- A Plantings in Area A/(1) *Garden developments*
- B Plantings in bushland remnants in Area B/(2) *'Natural' developments*
- C Plantings in Bushland/(3) *Bushland - undeveloped areas*
- R Roadside, adjacent to bushland at the entrance

Category 1 - NOT Australian species

Species	Area after Map 1	Origins	Weediness
Asparagus species	B	Africa	Known weed
Asclepias curassvica	B	America	Known weed
Olea europea (Olive)	B	Mediterranean	Known weed
Chrysanthemum species	B	Mediterranean	possible weed
Schinus terebinthifolia (Pepper Tree)	B	Brazil	Known weed, highly invasive
(Virginia Creeper)	B	America	possible weed
Ficus species (Fig)	B	Mediterranean	Known weed

Category 2 - NOT Western Australian species

Species	Area after Map 1	Origins	Weediness
Acacia iteaphylla	A	east	Known weed, invasive
Eucalyptus maculata	A, R	east	Known weed, highly invasive
Casuarina species	A	east	
Callistemon 'Kings Park'	A	hybrid, eastern species	possible weed, seed germinates in damp areas
Callistemon species	A, R	east	possible weed, seed germinates in damp areas

Category 3 - NOT Swan Coastal Plain species

Species	Area after Map 1	Origins	Weediness
<i>Eucalyptus camaldulensis</i>	A	Geraldton N in WA	Known weed, invasive
<i>Eucalyptus erythrocorys</i>	A, B	Encabba N	recorded weed in Kings Park
<i>Eucalyptus caesia</i>	A, B, C	granite rocks	not known
<i>Eucalyptus platypus</i>	A	south	Known weed, invasive
<i>Grevillea olivacea</i>	A	north	Known weed, invasive
<i>Banksia speciosa</i>	B	south	

Category 4 - NOT Swan Coastal Plain species found in the locality of the Cemetery

Species	Area after Map 1	Distribution on the SCP	Weediness
<i>Agonis flexuosa</i>	A, B, R	Quindalup Dunes	Known weed, highly invasive
<i>Chamelaucium uncinatum</i>	C, R	Quindalup Dunes, west	Known weed, invasive
<i>Melaleuca cardiophylla</i>	C	Tamala Limestones	not known
<i>Calothamnus quadrifidus</i>	C	Tamala Limestones	
<i>Sollya heterophylla</i>	A	uncommon on the Plain	Known weed
<i>Lechenaultia floribunda</i>	A	uncommon on the Plain, east	

Category 5 - Swan Coastal Plain species found in the broad locality BUT planted in inappropriate landscape/vegetation units

Species	Area after Map 1	Naturally occurring unit	Weediness
<i>Callitris preissii</i>	B	Quindalup Dunes	known to seed after fire from plantings
<i>Melaleuca huegelii</i>	A, B, C	Tamala Limestones	not known

APPENDIX 3: Selection of propagating material suitable for planting in and alongside natural areas

Revegetation with Local Plants with particular reference to the Swan Coastal Plain

B. Keighery February 1998

While bushland management for the conservation of biodiversity should focus on augmenting natural regeneration, through limiting disturbance, revegetation will be necessary in some areas. However it should always be appreciated that the complexity of most plant communities on the Swan Coastal Plain is great and there is no possibility that they can be re-created once destroyed. At best revegetation work can only establish elements of these communities.

As the revegetation work is aimed at restabilising elements of the local plant communities all revegetation should be done using local plant material (that is seed and other propagating material). The use of the term 'local' is dependant on the local conditions, the nature of the local plant communities and the patterns of variation in the particular plant (species, subspecies, variety or form) being considered for use.

Some guiding principles in determining what can be considered 'local plant material' for revegetation work for the conservation of biodiversity are:

- In all cases the precautionary principle should be followed.

That is

- when the source of propagating material is not known it should NOT be used
 - if local material is not available and there is insufficient information available to determine if the material is from more widespread sources is of the same form it should NOT be used
 - if there is insufficient information on the patterns of variation in a species then material should only be used from the study area.
- ONLY plant species recorded for the study area should be considered for use in revegetation unless revegetation is focusing on a community that has been totally destroyed in the study area. In the later case a 'reference' community (determined as described below) in the local area should be used as the guide for selection of appropriate species.
 - NO plant material from outside WA should ever be used.
 - Focus revegetation on that complement of species which best to 'mimic' the natural community and will grow from locally collected material.
 - If the pattern of genetic variation is known for a species then material can be collected for use from within the range of the genetic variant identified in the local area. For example *Banksia ilicifolia* has several distinct variants in the south west of WA. All of the material on the Swan Coastal Plain has been identified as belonging to one variant.
 - When there is known to be a high percentage of local forms of a species or the pattern of variation in the species is not well known collection should be confined to within 15 km of the revegetation area and be collected from the same position in the landscape (that is the same ecological niche). To do this plant material for revegetation should also be selected on a site by site basis. That is material should be selected to match the topographic position, soils, drainage and natural plant communities of the area where they are to be planted.

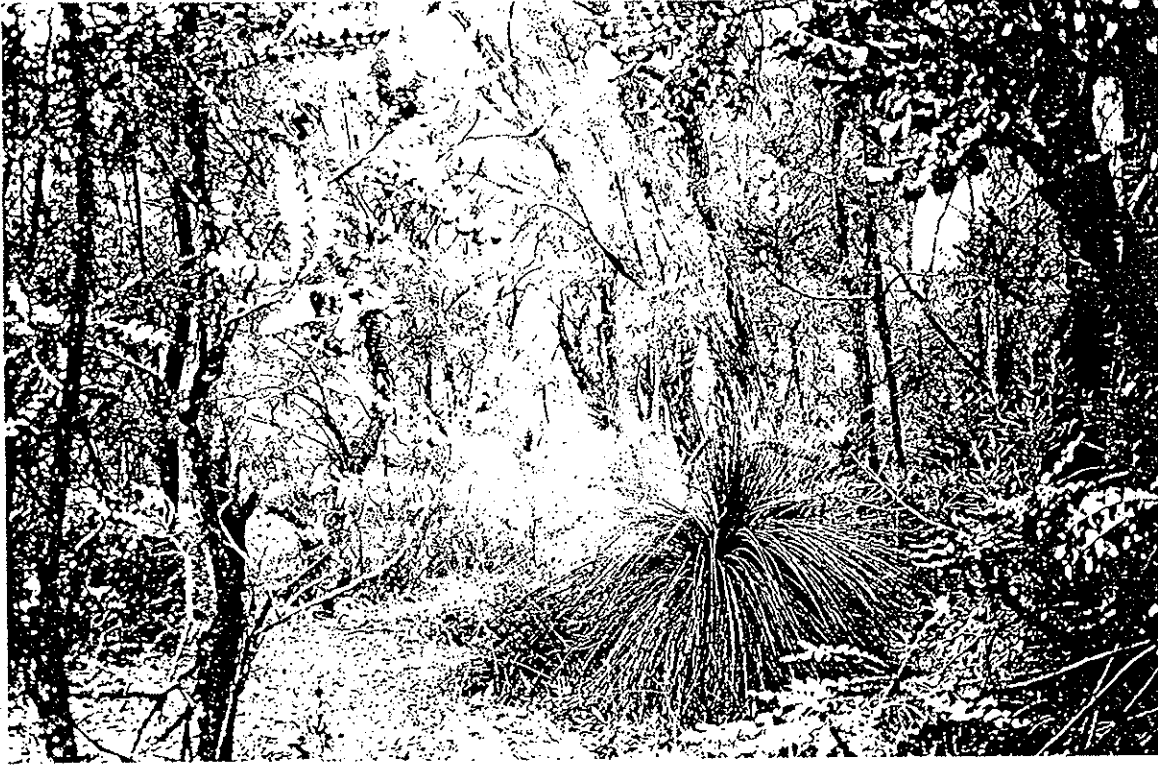


Figure 1: Spearwood landform vegetation unit in very good condition (no. 3 rating) in the south-eastern section of the Pinnaroo Cemetery bushland.



Figure 2: Quindalup landform vegetation unit in the foreground on a dune looking over the transitional vegetation in the south-western section of Pinnaroo valley. This is contiguous across the southern section of the site into the Spearwood unit. Shows the remnant vegetation band recommended for conservation.

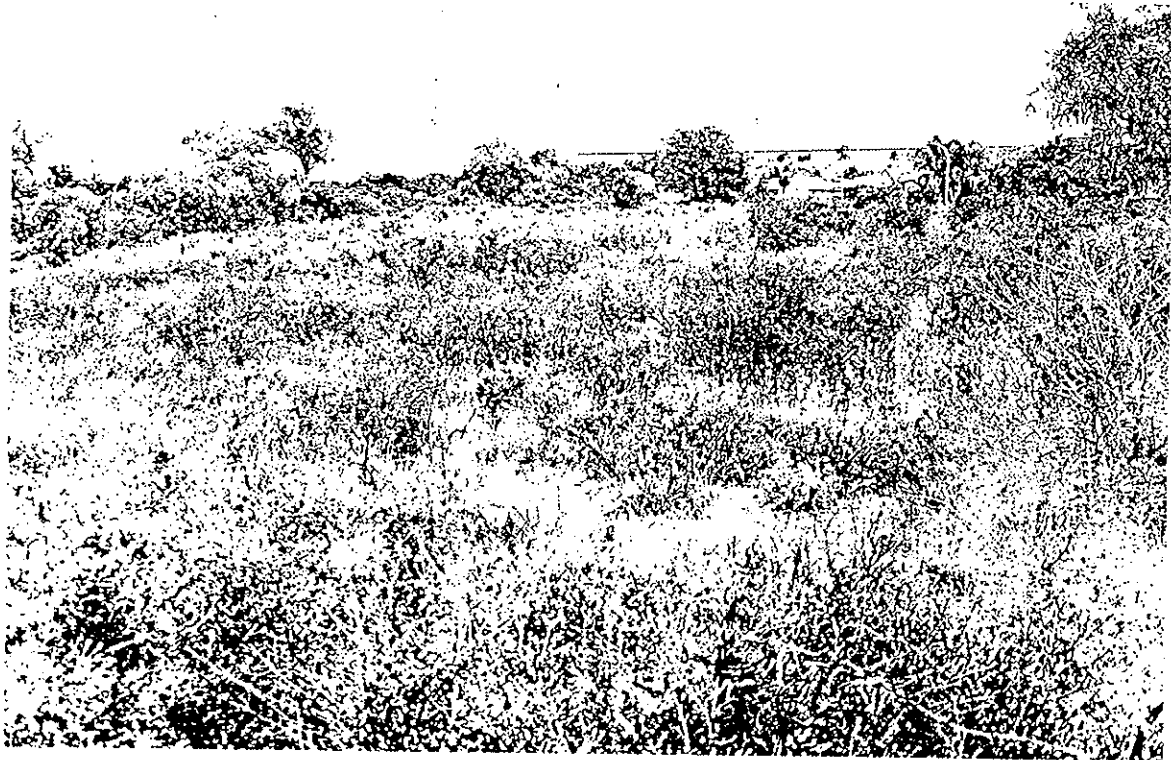


Figure 3: Quindalup landform vegetation unit on the sand dune running north-south along the western side of Pinnaroo Valley.



Figure 4: Memorial lawns in the southern section of Melaleuca Court with bushland islands in the background which at present are in good condition.



Figure 5: The edge of a bushland island in the memorial lawns of Melaleuca Court.



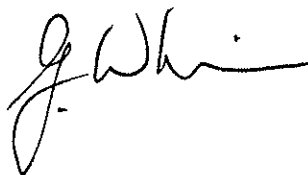
Figure 6: Bushland island in one of the older memorial lawn areas, the vegetation structure and species present have been substantially altered from that of the original bushland remnant. This island is now degraded with a condition rating of 5.

DRAFT PERTH'S BUSHPLAN

**DETAILED ASSESSMENT OF VALUES FOR A
NEGOTIATED PLANNING SOLUTION**

PART BUSHPLAN SITE 303 - Pinnaroo Cemetery Bushland

Department of Environmental Protection
B. Keighery and K. Clarke
November 1999

A handwritten signature in black ink, appearing to read 'J. White', is positioned below the typed text. The signature is fluid and cursive, with a small dot above the 'i'.

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The bushland in the Pinnaroo Cemetery Bushplan Site had been subject to a series of inspections as part of Perth's Bushplan.

Bronwen Keighery and Natalie Thorning from DEP surveyed the area in 1995 as part of the System 6 Update program to identify the regional floristic units present in the Cemetery bushland and to assess vegetation condition. At this time discussions with Cemetery Board staff (John Holman and Brian Darbee, September/November 1995) indicated that it was intended that 30% of the Cemetery land remain as bushland.

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(i) Representation of vegetation complexes (Hedde *et al.* 1980)

The bushland is mapped as containing the Karrakatta Complex — Central and South and Cottesloe Complex — Central and South from the Spearwood Dune System. While these two complexes are both present in Bushplan Site 303 only the Karrakatta Complex — Central and South is present in the Pinnaroo Cemetery bushland. While not mapped by Hedde *et al.* an additional vegetation complex, the Quindalup Complex (from the Quindalup Dune System), is also present in the Pinnaroo Cemetery bushland (see Figures 1 to 3, Map 1 and 2 and Appendix 1, Landforms and Soils). The presence of the Quindalup Dunes in the Pinnaroo Cemetery bushland is clearly indicated in a variety of maps of soils and landform units (see Diversity criterion and Appendix 1). The scale of the Hedde *et al.* mapping was likely to be responsible for the discrepancy in mapped units.

Less than 10% of the Karrakatta Complex — Central and South is recognised for protection in Draft Perth's Bushplan.

(ii) Representation of floristic community types (DEP 1996)

Two floristic community types were determined from the three plots located in 1995:

- 28 Spearwood *Banksia attenuata* or *B. attenuata* — *Eucalyptus* woodlands
- 29a Coastal shrublands on shallow sands

These community types are from Supergroup 4 (Uplands centred on Spearwood and Quindalup Dunes) and are representative of the Spearwood and Quindalup Dunes respectively.

The condition of the vegetation of the bushland in the Pinnaroo Cemetery bushland ranges from Very Good to Degraded (See Map 2). Spearwood Dunes have been subject to significant historical disturbance (grazing, settlement, horticulture etc) and the general condition of vegetation in this dune system is generally lower than for the other dune systems. As a consequence areas in Very Good to Good condition are a high priority for protection.

Diversity

Landforms

Two of the dune systems of the Swan Coastal Plain (Appendix 1 and McArthur and Bartle 1980) are present in the Pinnaroo Cemetery bushland

- Quindalup Dune System (a Q2 dune after McArthur and Bartle 1980) and
- Spearwood Dune System (Ky Karrakatta sands derived from Tamala limestone after McArthur and Bartle 1980).

Vegetation

A variety of vegetation units occur on the Pinnaroo Cemetery bushland (see Figures 1 to 3, Map 1 and Appendix 1) related to the presence of the Spearwood and Quindalup Dunes and the transition between them. The *Banksia prionotes* Open Woodland to Forest appears to be a feature of the transitional zone between the Quindalup Dune and the low lying Spearwood Sands to the east. There are few examples in the Perth Metropolitan Region on the Swan Coastal Plain of structurally and floristically intact vegetation dominated by *Banksia prionotes*. In general the understorey of these areas is severely impacted and weed species predominate. While there is evidence of disturbance in this unit in the Pinnaroo Cemetery bushland (in particular from repetitive fires) the understorey is in Good to Very Good condition.

Species

Two hundred and fifty five native taxa are listed for the Bushplan Site 303 (see Table 1).

This is a diverse list for these dune systems. This is especially so when compared with the most directly comparable area on geomorphology and floristic community types, Trigg Dune Reserve. This can probably be accounted for by the greater area of Spearwood limestones and sands in Bushplan Site 303 and the presence of a substantial interface between the Spearwood and Quindalup Dunes. These soils have a more species rich flora than the Quindalup sands which predominate in the Trigg Dune Reserve. While the flora list for the Pinnaroo Cemetery bushland would be less than for the entire area the juxtaposition of the two landform systems in the Pinnaroo Cemetery bushland, would again, be expected to result in a relatively diverse flora.

Table 1: A comparison of Bushplan Site area and species diversity
(source Draft Perth's Bushplan, Volume 2B, references listed in each Bushplan Site description)

Bushland Area	Area (ha)	Native Flora
Quindalup/Spearwood Dunes		
Whitfords Ave Bushland (BS 303)	252	235
Trigg Bushland (BS 308)	178	175
Spearwood Dunes		
Warwick Open Space (BS 202)	74	118
Woodvale Nature Reserve (BS 407)	38	170

Scientific or evolutionary importance

Three regional floristic plots are located in the area.

In addition, the Pinnaroo Cemetery bushland within Bushplan Site 303 is important for linking bushland to the north and south. The area is also part of Greenways 9 and 10 (see Map 1).

SITE COMMENTS/ADJUSTMENT

Bushland retention within Pinnaroo Cemetery

At present the lands within the Cemetery can be divided into three categories

(1) *Garden developments* (see Map 1, Area A)

In these areas the bushland is entirely cleared and replaced by grass, gardens and ponds. Occasional individual native species remain as specimen trees. While the gardens are designed to have a 'natural' look very few of the plantings are species found locally. Most of the species used in the landscaping are from outside WA or not from the Swan Coastal Plain (see Appendix 2). Many of these species are potential or known bushland weeds (see Appendix 2). As a consequence these areas do not contribute to bushland protection.

(2) *'Natural' developments* (see Map 1, Area B)

The 'natural' developed areas of the Pinnaroo Cemetery have retained the original forest/woodland eucalypts (Tuart and Jarrah) and scattered bushland remnants amongst the grassed areas (see Figure 4). These isolated remnants form small islands of bushland within an alien landscape and the edge to area ratio is so large that edge disturbances are able to impact the entire bushland patch.

The inspections of the Pinnaroo Cemetery bushland (1994, 1995 and 1999) clearly show these small remnants are degrading (see Figure 5 and 6). Types of disturbance observed in the Pinnaroo Cemetery bushland contributing to this decline are:

- continued fragmentation of the bushland remnants by incremental clearing, grassed areas, walk trails
- lawn/mower incursions into bushland edges (see Figure 5)
- 'enrichment plantings' that is plantings of species in the bushland not found in that plant community and of plants from that community but from non-local stock (see Figure 6 and Appendix 2 & 3)
- weed invasion from presently naturalised non-native taxa and potentially from plantings of invasive species in the cultivated beds (see Figure 6 and Appendix 2)
- fertilizer drift from grassed areas

- change in the water regime through water 'drift' from irrigated areas and direct irrigation
- grazing: overgrazing by kangaroos and rabbits

That is while there is an intention on behalf of management of the Park to retain bushland within the Cemetery development it is apparent that the impact of the disturbance factors on bushland preservation is not understood.

(3) *Bushland - undeveloped areas* (see Map 1, shaded areas)

The large areas of bushland yet to be fragmented are maintaining their condition. However these areas are also subject to a series of disturbances related to the lack of active management. Types of disturbance observed in the larger areas of the Pinnaroo Cemetery bushland are:

- fragmentation of the bushland by clearing, fire breaks, roads, walk trails (see Map 1 and 2)
- frequent fire
- 'enrichment plantings' that is plantings of species in the bushland not found in that plant community and of plants from that community but from non-local stock (see Figure 6 and Appendix 2 & 3)
- weed invasion from presently naturalised non-native taxa
- soil movement, both removal and dumping
- fertilizer drift from grassed areas (edges of bushland)
- change in the water regime through water 'drift' from irrigated areas (edges of bushland)
- grazing: overgrazing by kangaroos and rabbits
- proliferation of unauthorised tracks on the Quindalup Dunes (see Aerial photograph).

Future Plans for the development of the Cemetery

It is apparent from the plans for the development of the entire area of the Cemetery land that the intention is to rely on small isolated remnants and a thin bushland 'edge' to account for bushland retention. Such a design forms an exaggerated edge, resulting in a substantial edge to area ratio allowing each bushland patch to be subject to massive disturbance as no part of the patch is far from the edge. **This design is not compatible with bushland protection over the long term.**

While the concept of a 'Memorial Park' such as is being developed at Pinnaroo is relatively new there are many examples of bushland degradation as a result of exaggerated fragmentation. The bushland fragmentation currently proposed for the Cemetery is comparable with that in golf courses formed in bushland remnants. Many golf courses in Perth have been developed within bushland remnants where bushland was retained between the fairways (Wembley, Armadale etc). The older golf courses (eg Wembley) retain a few of the original trees and occasional understorey species but no bushland.

Core Natural Areas in the Pinnaroo Cemetery bushland

To maintain the values of the regionally significant bushland in the Pinnaroo Cemetery bushland and accommodate development of the cemetery there is a need to identify a consolidated bushland area that, with appropriate management, is adequate to protect these values. The selection of this area needs to take into account

- size (isolated remnants in grassed areas will not maintain their values over time)
- Quindalup and Spearwood Dunes landforms and vegetation (Figure 1, 2 and 3)
- the north south linkage function (Map 1 and 2) and
- vegetation condition (Map 2 and Figures 1, 2 and 3).

The areas appropriate to be protected are highlighted on Map 1. The dashed line indicates the an eastern vegetation band to maintain landscape values to the east.

REFERENCES

(In addition to those listed in Draft Perth's Bushplan Volume 2B)

McArthur, W. M. and Bartle, G.A. (1980) Landforms and Soils as an Aid to Urban Planning in the Perth Metropolitan Northwest Corridor, Western Australia. Land resources and Management Series No 5. CSIRO, Australia.

Morald, T. and Ogden, G. (1994) Flora of Craigie Open Space. Unpublished report, Edith Cowan University, Western Australia.

APPENDIX 1: Part Bushplan Site 303 description

WHITFORDS AVENUE BUSHLAND, CRAIGIE/PADBURY

Bushplan Site no. 303 Map no. 38, 44

Boundary Definition: protected area/bushland (part taken to cadastre and zoning)boundary

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: S2, LS4)

VEGETATION AND FLORA

Vegetation Complexes

Spearwood Dunes

Karrakatta Complex — Central and South

Cottesloe Complex — Central and South

Floristic Community Types

Supergroup 4: Uplands centred on Spearwood and Quindalup Dunes

24 Northern Spearwood shrublands and woodlands

26b Woodlands and mallees on limestone

28 Spearwood *Banksia attenuata* or *B. attenuata* — *Eucalyptus* woodlands

29a Coastal shrublands on shallow sands

WETLANDS

No wetlands mapped

THREATENED ECOLOGICAL COMMUNITIES

Not assessed

SECTION 3: SPECIFIC SITE DETAIL

Landscape Features: limestone ridge, tall dune, vegetated uplands

Vegetation and Flora: detailed survey (part Bushplan Site, Hepburn Heights — Keighery, GJ, 1991b, Tingay, Alan & Associates 1991a; Craigie Open Space — Allen *et al.* 1994); limited survey (DEP 1996 (Hepb 01-03), (Pinn 01-03); Pinnaroo Cemetery — Foulds 1987)

Structural Units: mapping (part Bushplan Site, Craigie Open Space — Allen *et al.* 1994; part Bushplan Site — Hepburn Heights, Pinnaroo Cemetery and Craigie Open Space: Semeniuk, V&C Research Group 1991a; part Bushplan Site — Hepburn Heights and Pinnaroo Cemetery — Tingay, Alan & Associates 1991a)

Quindalup Dunes

Uplands: *Melaleuca acerosa* and *Acacia lasiocarpa* Open Low Heath; *Eucalyptus gomphocephala* Woodland; *Banksia prionotes* Woodland

Spearwood Dunes

Uplands - Sands derived from Tamala Limestone: Open Forest to Woodland dominated by *Eucalyptus marginata*, *E. calophylla* or *E. gomphocephala*; Low Woodland to Open Low Woodland dominated by *Banksia attenuata*, *B. menziesii*, *B. prionotes* or *Allocasuarina fraseriana* and combinations of these (these areas may contain scattered emergent *Eucalyptus marginata* or *E. gomphocephala*); *Acacia saligna* Shrubland; *Acacia rostellifera* Shrubland

Uplands - Tamala Limestone: *Eucalyptus decipiens* Low Woodland; *Acacia rostellifera* Shrubland; *Acacia truncata* Shrubland; *Dryandra sessilis* var. *cygnorum* Closed Heath; *Lepidosperma gladiatum* Sedgeland

Scattered Native Plants: *Eucalyptus gomphocephala* Woodland

Vegetation Condition: >70% Very Good to Excellent, <30% Good to Degraded, with areas of severe localised disturbance

Total Flora: 235 native taxa, 66 weeds (compiled from Allen *et al.* 1994, Foulds 1987, Keighery, GJ, 1991b, Tingay, Alan and Associates 1991a) (estimated >85% of expected flora)

Significant Flora: *Sarcocornia bicarinata* (3), *Jacksonia sericea* (3); *Lechenaultia linarioides*, *Ricinocarpus glaucus*, *Callitris preissii* (most northern population on the Plain); typical Tamala Limestone taxa: *Grevillea preissii*, *Diplopeltis huegelii*, *Trymalium ledifolium* subsp. *ledifolium*

Fauna: multiple and structured surveys by Western Australian Museum of Natural Science and Edith Cowan University (Allen *et al.* 1994) for birds (36), native mammals (3), reptiles (19) and amphibians (2) (How *et al.* 1996). Significant bird species: category 3 (6) including Grey Shrike-thrush, Weebill, Yellow-rumped and Western thornbills and Splendid Fairy-wren, and category 4 (2). Significant mammal species: Western Brush Wallaby, Quenda (Friend 1996 D). Significant reptile species: Two-striped Snake (*Simoselaps bimaculata*) and Half-ringed Snake (*S. semifasciata*)

Linkage: no adjacent bushland; part of a regionally significant fragmented bushland/wetland linkage (Volume 2A, Map 8)

Other Special Attributes: recommended for protection in study of City of Wanneroo bushland (Trudgen 1996); contains Quindalup/Spearwood Dunes System interface; Quindalup Dunes at 9kms from the coast; part Bushplan Site recommended for conservation by Semeniuk, V&C Research Group (1991a); part of proposed Greenways 10, 11 (Tingay, Alan & Associates 1997a)

SECTION 4: INTERNATIONAL AND NATIONAL SIGNIFICANCE

Interim List of the Register of the National Estate

SECTION 5: SELECTION CRITERIA AND RECOMMENDATIONS

Criteria: Representation of ecological communities, Diversity, Rarity, Scientific or evolutionary importance

APPENDIX 2: Plantings at Pinnaroo Cemetery

While the Pinnaroo Cemetery area was completely vegetated before development much of this vegetation has been cleared and replaced by a variety of plantings. In other areas the natural vegetation has been 'enriched' by a variety of plantings. Comment on the suitability of these species for planting in and alongside bushland is divided into five categories according to the origin/natural distribution of these species. Not all species observed are listed, but it is intended that this selection illustrate that the plantings in the Garden and 'Natural' developments do not contribute to bushland retention.

Plantings in bushland that can contribute to bushland retention and restoration must be of local native species. Local species are here considered to be the local variants of species recorded as occurring within the Pinnaroo Cemetery and/or within 15 kms in the same landscape/vegetation unit.

Some guiding principles in determining what can be considered 'local plant material' for revegetation work within the Cemetery area are given in Appendix 3.

Key to Column 2, after Map 1

- A Plantings in Area A/(1) *Garden developments*
- B Plantings in bushland remnants in Area B/(2) *'Natural' developments*
- C Plantings in Bushland/(3) *Bushland - undeveloped areas*
- R Roadside, adjacent to bushland at the entrance

Category 1 - NOT Australian species

Species	Area after Map 1	Origins	Weediness
Asparagus species	B	Africa	Known weed
Asclepias curassvica	B	America	Known weed
Olea europea (Olive)	B	Mediterranean	Known weed
Chrysanthemum species	B	Mediterranean	possible weed
Schinus terebinthifolia (Pepper Tree)	B	Brazil	Known weed, highly invasive
(Virginia Creeper)	B	America	possible weed
Ficus species (Fig)	B	Mediterranean	Known weed

Category 2 - NOT Western Australian species

Species	Area after Map 1	Origins	Weediness
Acacia iteaphylla	A	east	Known weed, invasive
Eucalyptus maculata	A, R	east	Known weed, highly invasive
Casuarina species	A	east	
Callistemon 'Kings Park'	A	hybrid, eastern species	possible weed, seed germinates in damp areas
Callistemon species	A, R	east	possible weed, seed germinates in damp areas

Category 3 - NOT Swan Coastal Plain species

Species	Area after Map 1	Origins	Weediness
<i>Eucalyptus camaldulensis</i>	A	Geraldton N in WA	Known weed, invasive
<i>Eucalyptus erythrocorys</i>	A, B	Eneabba N	recorded weed in Kings Park
<i>Eucalyptus caesia</i>	A, B, C	granite rocks	not known
<i>Eucalyptus platypus</i>	A	south	Known weed, invasive
<i>Grevillea olivacea</i>	A	north	Known weed, invasive
<i>Banksia speciosa</i>	B	south	

Category 4 - NOT Swan Coastal Plain species found in the locality of the Cemetery

Species	Area after Map 1	Distribution on the SCP	Weediness
<i>Agonis flexuosa</i>	A, B, R	Quindalup Dunes	Known weed, highly invasive
<i>Chamelaucium uncinatum</i>	C, R	Quindalup Dunes, west	Known weed, invasive
<i>Melaleuca cardiophylla</i>	C	Tamala Limestones	not known
<i>Calothamnus quadrifidus</i>	C	Tamala Limestones	
<i>Sollya heterophylla</i>	A	uncommon on the Plain	Known weed
<i>Lechenaultia floribunda</i>	A	uncommon on the Plain, east	

Category 5 - Swan Coastal Plain species found in the broad locality BUT planted in inappropriate landscape/vegetation units

Species	Area after Map 1	Naturally occurring unit	Weediness
<i>Callitris preissii</i>	B	Quindalup Dunes	known to seed after fire form plantings
<i>Melaleuca huegelii</i>	A, B, C	Tamala Limestones	not known

APPENDIX 3: Selection of propagating material suitable for planting in and alongside natural areas

Revegetation with Local Plants with particular reference to the Swan Coastal Plain

B. Keighery February 1998

While bushland management for the conservation of biodiversity should focus on augmenting natural regeneration, through limiting disturbance, revegetation will be necessary in some areas. However it should always be appreciated that the complexity of most plant communities on the Swan Coastal Plain is great and there is no possibility that they can be re-created once destroyed. At best revegetation work can only establish elements of these communities.

As the revegetation work is aimed at restabilising elements of the local plant communities all revegetation should be done using local plant material (that is seed and other propagating material). The use of the term 'local' is dependant on the local conditions, the nature of the local plant communities and the patterns of variation in the particular plant (species, subspecies, variety or form) being considered for use.

Some guiding principles in determining what can be considered 'local plant material' for revegetation work for the conservation of biodiversity are:

- In all cases the precautionary principle should be followed.
That is
 - when the source of propagating material is not known it should NOT be used
 - if local material is not available and there is insufficient information available to determine if the material is from more widespread sources is of the same form it should NOT be used
 - if there is insufficient information on the patterns of variation in a species then material should only be used from the study area.
- ONLY plant species recorded for the study area should be considered for use in revegetation unless revegetation is focusing on a community that has been totally destroyed in the study area. In the later case a 'reference' community (determined as described below) in the local area should be used as the guide for selection of appropriate species.
- NO plant material from outside WA should ever be used.
- Focus revegetation on that complement of species which best to 'mimic' the natural community and will grow from locally collected material.
- If the pattern of genetic variation is known for a species then material can be collected for use from within the range of the genetic variant identified in the local area. For example *Banksia ilicifolia* has several distinct variants in the south west of WA. All of the material on the Swan Coastal Plain has been identified as belonging to one variant.
- When there is known to be a high percentage of local forms of a species or the pattern of variation in the species is not well known collection should be confined to within 15 km of the revegetation area and be collected from the same position in the landscape (that is the same ecological niche). To do this plant material for revegetation should also be selected on a site by site basis. That is material should be selected to match the topographic position, soils, drainage and natural plant communities of the area where they are to be planted.

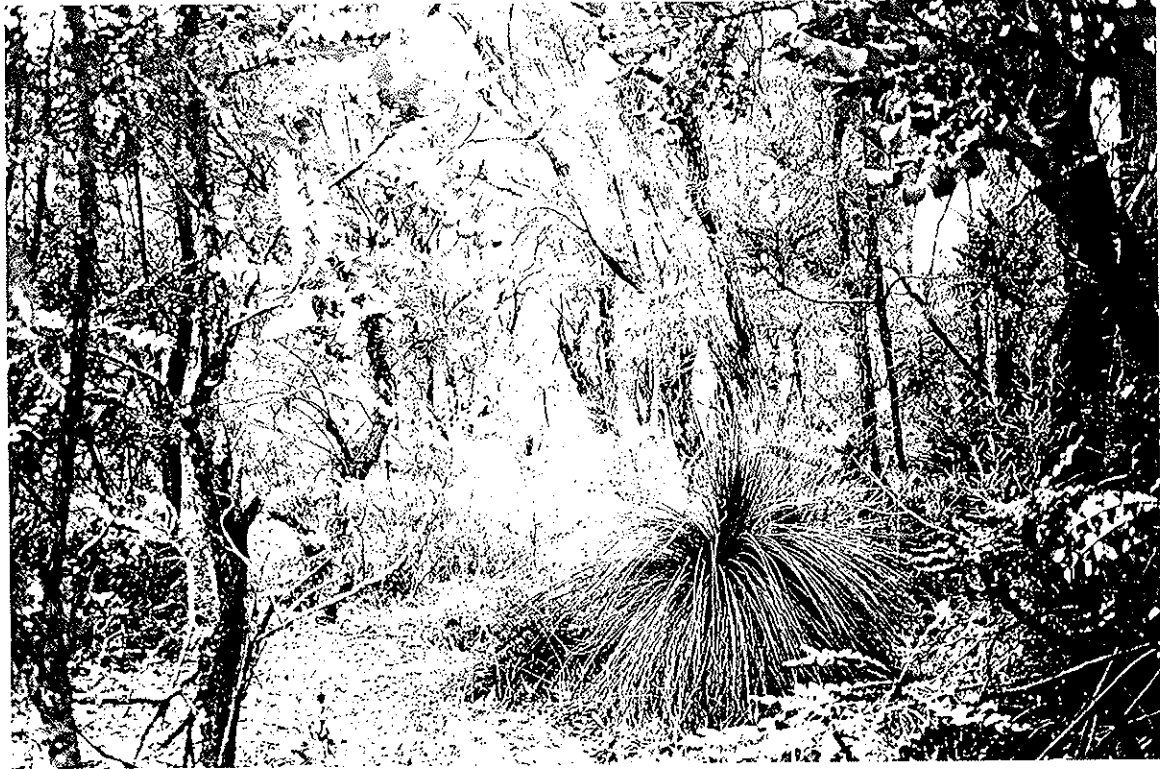


Figure 1: Spearwood landform vegetation unit in very good condition (no. 3 rating) in the south-eastern section of the Pinnaroo Cemetery bushland.



Figure 2: Quindalup landform vegetation unit in the foreground on a dune looking over the transitional vegetation in the south-western section of Pinnaroo valley. This is contiguous across the southern section of the site into the Spearwood unit. Shows the remnant vegetation band recommended for conservation.



Figure 3: Quindalup landform vegetation unit on the sand dune running north-south along the western side of Pinnaroo Valley.



Figure 4: Memorial lawns in the southern section of Melaleuca Court with bushland islands in the background which at present in are in good condition.



Figure 5: The edge of a bushland island in the memorial lawns of Melaleuca Court.



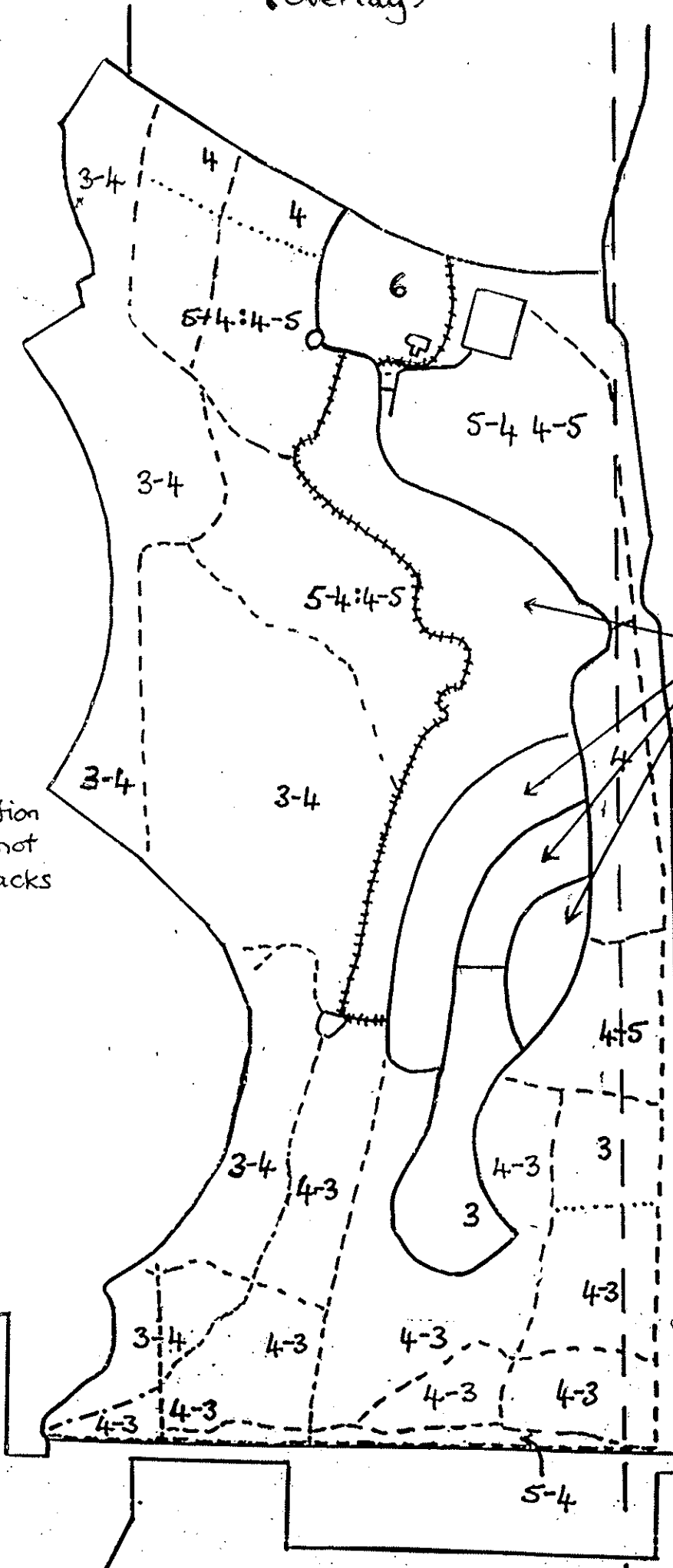
Figure 6: Bushland island in one of the older memorial lawn areas, the vegetation structure and species present have been substantially altered from that of the original bushland remnant. This island is now degraded with a condition rating of 5.

Map 2: Vegetation Condition Ratings (overlay)

Condition Ratings:

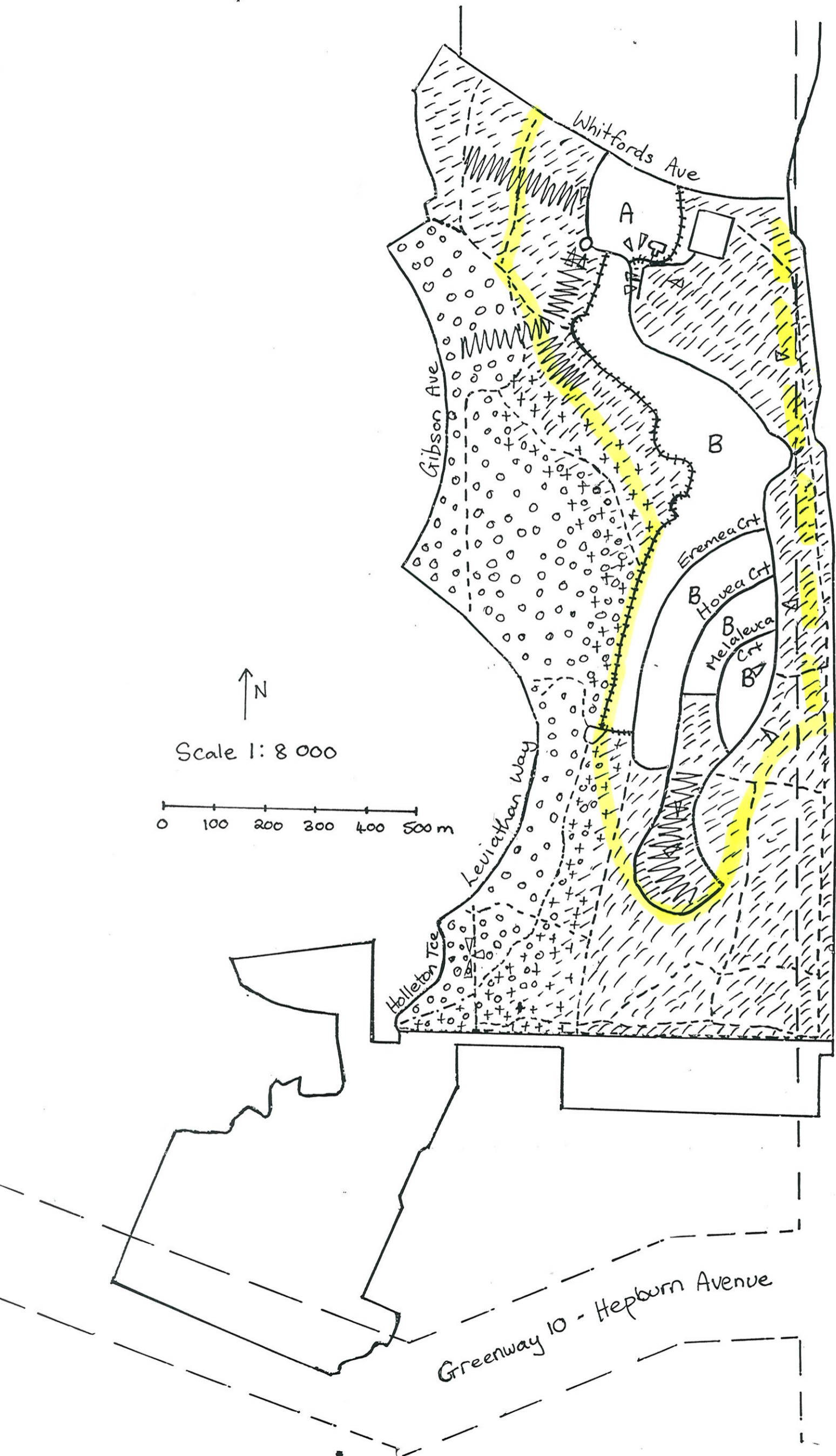
- 1 = Pristine
- 2 = Excellent
- 3 = Very Good
- 4 = Good
- 5 = Degraded
- 6 = Completely Degraded

..... Boundary between condition ratings where not indicated by tracks



Bushland Islands
4-5
Lawn Areas
6

Map 1: Landform Vegetation Units



↑ N
Scale 1: 8 000
0 100 200 300 400 500 m

Greenway 9 - Mitchell Freeway

Greenway 10 - Hepburn Avenue

- Key
- A Water features and landscaped gardens
 - B Memorial lawns with bushland islands
 - Recent Clearing
 - Spearwood Dune Vegn (Karrakatta Complex - Central & South)
 - +++ Transitional Vegn
 - Quindalup Dune Vegn (Quindalup Complex)
 - Tracks
 - Roads
 - ++++ Boundary between bushland and landscaped areas
 - ▷ Ministry for Planning Photo Points
 - Boundary of Core Natural Areas



BUSHPLAN SITE 303
SOUTHERN PORTION
ORTHO-RECTIFIED AERIAL IMAGE
CONTOURS & CADASTRE

-  Bushplan Sites (boundaries)
-  Cadastre with Lot Numbers
-  Contours - 5m (DOLA)

Map Ident: plot991104_1

DATE: 04 Nov 1999

Prepared By: Andrea Zappacosta

Prepared For: CATHERINE THOMSON

Scale 1:8000

MFP INTERNAL USE ONLY

0  500 m



Apace Western Australia

Apace Aid Incorporated

Winter House 1 Johannah Street

North Fremantle Western Australia 6159

Phone 08 9336 1262

Fax 08 9430 5729

apace@argo.net.au

Gary Whisson

Department of Environmental Protection
Westralia Square Building
172 St. George's Terrace
Perth 6000

DEPARTMENT OF ENVIRONMENTAL PROTECTION RECORDS SECTION	
10 MAY 2001	
FILE NO	PB118
NAME	Gary Whisson
FILE NO	
NAME	

Bushplan Site 303

Dear Gary,

Please find enclosed a revegetation plan for degraded areas within the above site. The plan has been prepared on behalf of LandCorp. Apace has been contracted by LandCorp to prepare the plan and implement the works in order to discharge LandCorp's obligations incurred in respect to the resumption of a portion of the site for the purpose of constructing an access road.

Our contract requires us to gain the approval of the Department of Environmental Protection for the proposed works prior to implementation. I therefore submit a plan of proposed works and await your response.

As you can appreciate, timing of the works that it is proposed to undertake is critical, and I would appreciate it if you could give this matter your earliest possible attention.

I am of course happy to discuss any matter that you wish to raise in regard to the works.

Yours sincerely

Greg Reid
Projects Co ordinator
Apace Aid(Inc)

REVEGETATION PLAN

for

Bushplan Site 303 Padbury

Prepared for LandCorp

by

G.Reid
Apace Aid (Inc)
April 2001

REVEGETATION PLAN

for

Bushplan Site 303 Padbury

☞ Description

The plant species to be used for planting and direct seeding have been derived from direct observation of the site and the list provided. Due to the short gestation period of the project, stock of some desirable species, (eg *Banksia attenuata*) that conform to the supply criteria, will not be available.

The planting and seeding works have been designed to, as far as is possible, reflect the major species occurring adjacent to the tracks, or in the immediate vicinity. Two community units are identified and these are shown on the map.

They are Community 1 (C1) and Community 2 (C2). C2 is the Marri - Jarrah community found in the centre and C1 occurs on the rises at either end of the project site and contains species that have an affinity with limestone, such as *Acacia lasiocarpa* and *Rhagodia baccata*. These areas are then divided into areas P1&2 and S1&2 indicating planting and seeding areas respectively.

Planting and seeding rates have been designed to reflect the natural preponderance of lifeforms (trees, shrubs, etc) within the locality.

SPECIES LIST – COMMUNITY TYPES – PLANTING AND SEEDING

Trees		P1	P2	S1	S2
<i>Allocasuarina</i>	<i>fraseriana</i>		▲		
<i>Banksia</i>	<i>attenuata</i>				▼
<i>Banksia</i>	<i>menziesii</i>		▲		▼
<i>Banksia</i>	<i>prionotes</i>	▲	▲	▼	
<i>Eucalyptus</i>	<i>calophylla</i>	▲	▲		▼
<i>Eucalyptus</i>	<i>gomphocephala</i>	▲		▼	
<i>Eucalyptus</i>	<i>marginata</i>		▲		▼
Large Shrubs		P1	P2	S1	S2
<i>Acacia</i>	<i>cyclops</i>	▲			
<i>Allocasuarina</i>	<i>humilis</i>	▲	▲	▼	▼
<i>Dryandra</i>	<i>sessilis</i>	▲		▼	
<i>Grevillea</i>	<i>crithmifolia</i>	▲	▲	▼	▼
<i>Grevillea</i>	<i>vestita</i>	▲			
<i>Hakea</i>	<i>lissocarpha</i>	▲	▲	▼	▼
<i>Hakea</i>	<i>prostrata</i>		▲		▼
<i>Jacksonia</i>	<i>furcellata</i>		▲		▼
<i>Melaleuca</i>	<i>systema</i>	▲	▲	▼	▼
<i>Spyridium</i>	<i>globulosum</i>	▲		▼	

Small shrubs		P1	P2	S1	S2
<i>Acacia</i>	<i>lasiocarpa</i>	▲		▼	
<i>Grevillea</i>	<i>preissii</i>	▲		▼	
<i>Gompholobium</i>	<i>tomentosum</i>		▲		▼
<i>Hypocalymma</i>	<i>robustum</i>		▲		▼
<i>Jacksonia</i>	<i>sericea</i>		▲		▼
Understorey		P1	P2	S1	S2
<i>Conostylis</i>	<i>aculeata</i>		▲		▼
<i>Dryandra</i>	<i>nivea</i>		▲		▼
<i>Hardenbergia</i>	<i>comptoniana</i>	▲		▼	
<i>Lepidosperma</i>	<i>angustatum</i>		▲		
<i>Philotheca</i>	<i>spicata</i>		▲		
<i>Rhagodia</i>	<i>baccata</i>	▲		▼	

The works will consist of the following items:

⊕ Remedial earthworks

The BMX bike course that has been constructed along the tracks at the western end will be filled and levelled using a bobcat.

⊕ Planting

Planting will occur in thirty metre bands to the north of the roadway and south of the limestone service road. Plant species zones will be as shown on the map and their composition will reflect the slight change in community type observable across the length of the project site.

Scatter planting will occur throughout the seeded zones as a further deterrent to foot traffic. The plant stock will be supplied in either 70mm x 70mm x 100mm pots or 50mm x 50mm x 125mm tree tubes. All plant stock will be new season stock and show no signs of inhibited root development.

Plants will be transported to the site in covered vehicles. Plants will be planted slightly below ground level and a planting bowl formed around each plant to collect water. Holes will be backfilled and soil firmed around the root ball.

Planting is to be undertaken at a rate of one plant per square metre.

Plastic tree guards supported by bamboo stakes and adequately tensioned, will be installed around each plant. Plants will be watered in with two litres of water around the root ball at planting. Follow up watering of all plant stock will occur in December and again at the beginning of February in the following year.

⌘ Direct seeding

Direct seeding will be undertaken in the central strip between the planting zones where watering would be difficult. The seed will be purchased from a reputable commercial source that asserts the provenance to be as assigned in the seeding schedule.

Seed will be batched and treated with the appropriate pre germination treatment. This will be scarification for *Acacia cyclops* and *Hardenbergia comptoniana* and smoking for the remainder. Seed batches will be smoked in the facility at the Apace nursery that is used for the treatment of all of the seed used for propagation. The treatment consists of placing the seed in the smoke saturated chamber for a one hour duration.

The seed species schedule has been designed to reflect the natural plant densities with a weighting towards those species of known high germinability and the exclusion of those that we know will have a low yield. The seed will be bulked with a suitable bulking agent and sown by hand.

This will consist of planting personnel walking along gridlines and trickling small quantities of the bulked seed mix down a tube that has a short hook and a chain attached at ground level. The seed rolls down the tube into the small furrow created by the plough and is smudged into the soil bed by the trailing chain.

This method ensures an even distribution of the seed and positive contact between the soil and the seed. The seeded tracks will be brushed with whatever seed bearing branches can be opportunistically gathered from the immediate vicinity. This will benefit the seeded areas by reducing traffic, providing additional seed and microclimate.

⌘ Track barriers

Small barriers will be erected at the beginning and end of seeded areas. These will help to deter foot traffic and will have signs affixed to them to enhance their effect. The barriers will be 1.8 metre RL4 CCA treated pine posts sunk 900mm into the ground and strung with sight wire or rabbit wire.

✿ Signage

☞ External Signage


Two large signs 900mm x 600mm will be attached to the fence at the western and eastern ends of the access road. The signs will be white colorbond with green vinyl lettering . They will read:


Revegetation in Progress


Bushplan Site 303

This bushland is subject to planting and direct seeding works during winter 2001. The work is aimed at re establishing naturally occurring vegetation to in degraded areas. Your cooperation by staying off these areas is appreciated.

Bushland is a long term community resource that requires everyone's cooperation to survive.



LANDCORP


City of
Joondalup


IACA
INTEGRATED AREA COUNSELLORS ASSOCIATION

☞ Internal Signage

Signs measuring 400mm x 400mm will be attached to the seeding area barriers erected at either end. The layout is shown below.



City of
Joondalup

**This is a revegetation zone.
The survival of bushland is
everyones responsibility.
Please keep off. Thank you.**

Weed control

Weed control will be undertaken at two six weekly intervals after the completion of the seeding and planting works. It will consist of herbicide spot spraying to affected areas and hand weeding if required. The suite of annual weed species present at the site is not yet known, however it is anticipated that they will be largely grasses. A record will be kept of the weed species noted during this work.

Herbicide spraying will be undertaken by a suitably qualified and licensed contractor. Signage alerting the public to the works will be in place for the duration of the works. Glyphosate will be used in the planted areas as the planting bags will provide adequate protection from incidental overspray. Fusilade® will be employed throughout the seeded areas as it will not affect emerging native species.

Herbicide works will only take place when the prevailing conditions are suitable. That is, no precipitation during the works or expected for twenty four hours after the works and wind speeds below 10kph.

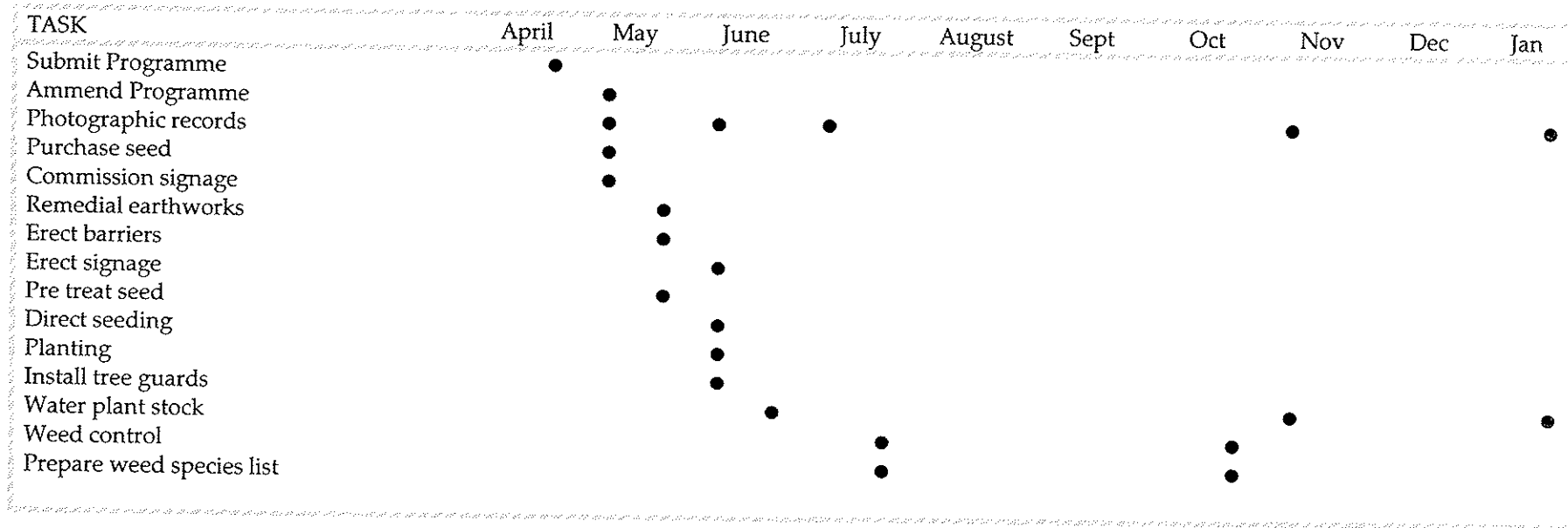
Supplementary watering

Tanker watering of plant stock will occur in late November 2001 and January 2002. Three litres of water will be applied to each plant. Water will be of good quality. Care will be exercised to preclude damage to planting bags by hose dragging. Any plants that have died will have their bags removed as part of the watering operations and a record of mortality numbers and species will be kept.

Monitoring

A series of photographs will be taken before, during and after the works from the same locations. The post work photographs will be taken at the time of the follow up waterings and again after twelve months. Small 1 m 1 m monitoring quadrats will be established within the seeded areas. All species germinating within these quadrats will be recorded.

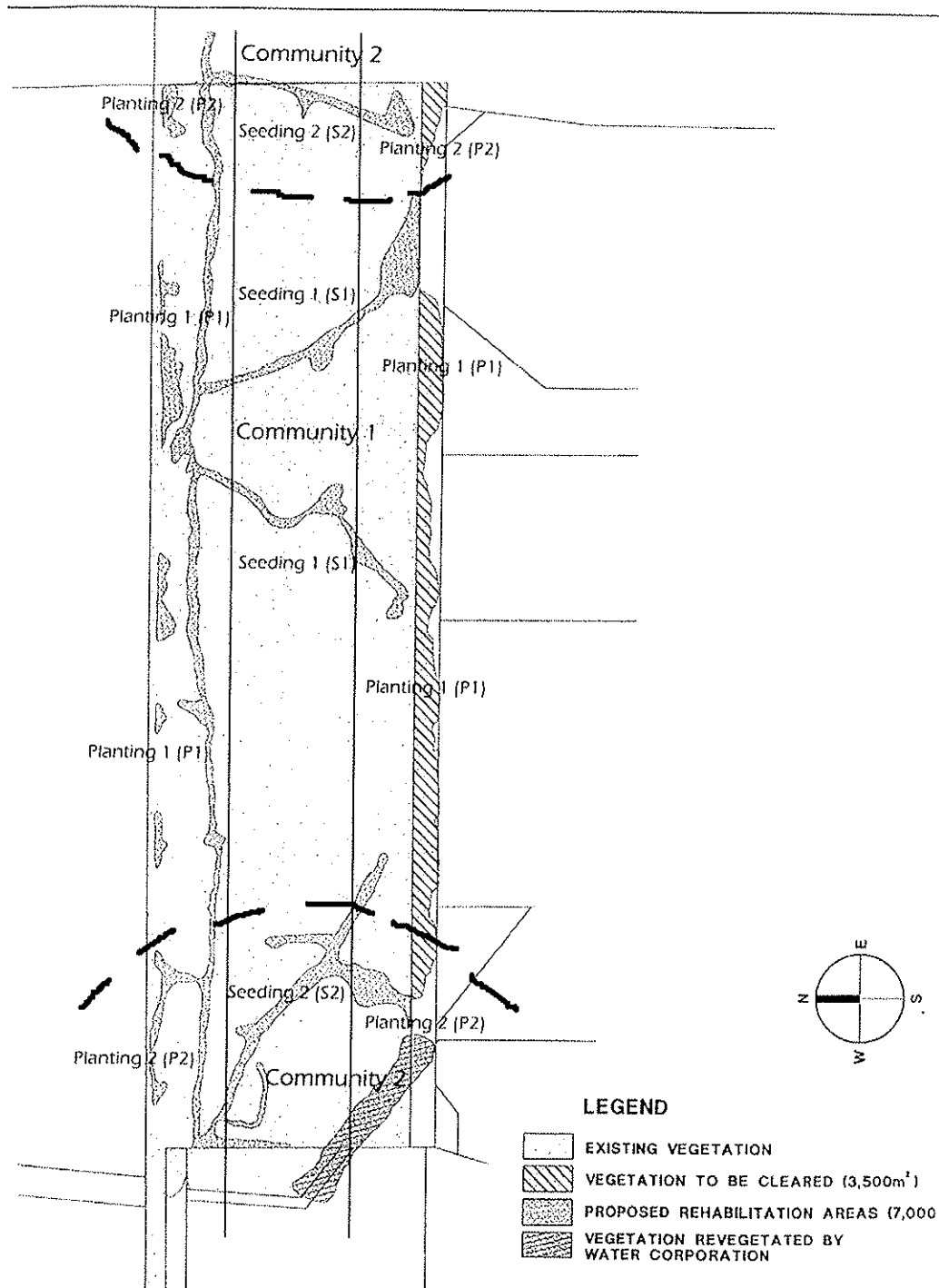
∞ Timeline



☞ Planting Schedule

Genus	Species	No.	Total	Seeds	g	Provenance
Trees						
<i>Allocasuarina</i>	<i>fraseriana</i>	84			115	Wanneroo
<i>Banksia</i>	<i>attenuata</i>	0		800		
<i>Banksia</i>	<i>menziesii</i>	80		250		Wanneroo
<i>Banksia</i>	<i>prionotes</i>	40		250		Wanneroo
<i>Eucalyptus</i>	<i>calophylla</i>	400			800	Wanneroo
<i>Eucalyptus</i>	<i>gomphocephala</i>	80			100	Wanneroo
<i>Eucalyptus</i>	<i>marginata</i>	120			400	Wanneroo
		804	804			
Shrubs						
<i>Acacia</i>	<i>cyclops</i>	42			50	Unknown
<i>Allocasuarina</i>	<i>humilis</i>	420			100	
<i>Dryandra</i>	<i>sessilis</i>	42		250		Wanneroo
<i>Grevillea</i>	<i>crithmifolia</i>	1000			300	Wanneroo
<i>Grevillea</i>	<i>vestita</i>	0			15	
<i>Hakea</i>	<i>lissocarpha</i>	1000			80	Wanneroo
<i>Hakea</i>	<i>prostrata</i>	100			15	Wanneroo
<i>Jacksonia</i>	<i>furcellata</i>	60			15	Wanneroo
<i>Melaleuca</i>	<i>systema</i>	420			75	Wanneroo
<i>Spyridium</i>	<i>globulosum</i>	20			25	Wanneroo
		3104	3104			
Small shrubs						
<i>Acacia</i>	<i>lasiocarpa</i>	40			75	Wanneroo
<i>Grevillea</i>	<i>preissii</i>	80			0	North Fremantle
<i>Gompholobium</i>	<i>tomentosum</i>	250			15	
<i>Hypocalymma</i>	<i>robustum</i>	420			40	Wanneroo
<i>Jacksonia</i>	<i>sericea</i>	40			15	
		830	830			
Understorey						
<i>Conostylis</i>	<i>aculeata</i>	420			20	Wanneroo
<i>Dryandra</i>	<i>nivea</i>	420		300		Cervantes
<i>Hardenbergia</i>	<i>comptoniana</i>	100			100	Wanneroo
<i>Lepidosperma</i>	<i>angustatum</i>	100			0	Garden Island
<i>Philothea</i>	<i>spicata</i>	122			0	Wanneroo
<i>Rhagodia</i>	<i>baccata</i>	100			50	Wanneroo
		1262	1262			
			6000	1850	2,405	

MAP OF COMMUNITIES AND PLANTING/SEEDING ZONES



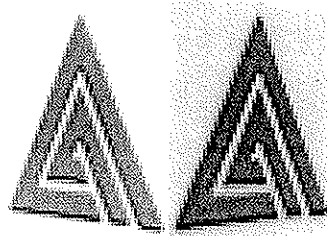
PROJECT **HEPBURN HEIGHTS REHABILITATION BRIEF**
 DRAWING TITLE **PROPOSED VEGETATION CLEARING AND REHABILITATION PLAN**
 PRINCIPAL **LANDCORP**

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	TOWN PLANNERS	Designed	BY	Checked	BY
	PROJECT MANAGERS	Drawn	DGP	Approved	BY
	ENVIRONMENTAL CONSULTANTS	Local Authority		Sheet	1

810 Centre 3 Street, Acacia
 P.O. Box 166, Brisbane
 Brisbane Queensland 4000
 Telephone 089 9373 3666
 Facsimile 1001 6364 3631

CITY OF WARMERDO
 PROJECT NUMBER: V00013
 DRAWING NUMBER: V101-SK1



Regeneration Monitoring Report

For
Part of Part C of
Bush Forever Site 303
2001

Prepared by
Greg Reid
January 2002

Regeneration Monitoring Report

for Part of Part C

Bush Forever Site 303

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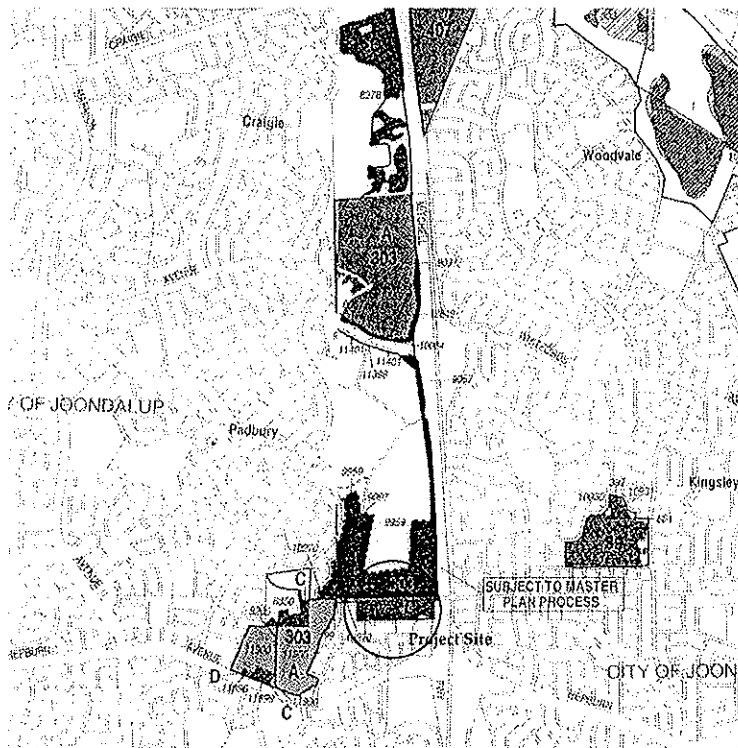
Introduction

This report has been prepared on behalf of LandCorp at the behest of the Department of Environmental Protection. The work has been undertaken as part of the fulfilment of LandCorp's obligations in respect to the resumption of a portion of the site, for the purposes of constructing an access road. The purpose is to monitor the rate at which natural regeneration is taking place, and by what species, so that a determination can be made (by the Department of Environmental Protection), as to whether further revegetation work is required. The monitoring took place between August and December 2001.

Site Location

The location of the site under consideration is shown below. It comprises a rectangular area of bushland of approximately 500 x 200 metres. It is a portion of Part C of Bush Forever Site 303. Part C is a Crown Reserve (C Class), a location for scheduled fauna and entered on the Interim List for the Register of the National Estate. It has been identified as Public Utilities in the North West Corridor Structure Plan and Underground Water Pollution Control Area – Gazetted Priority Area.

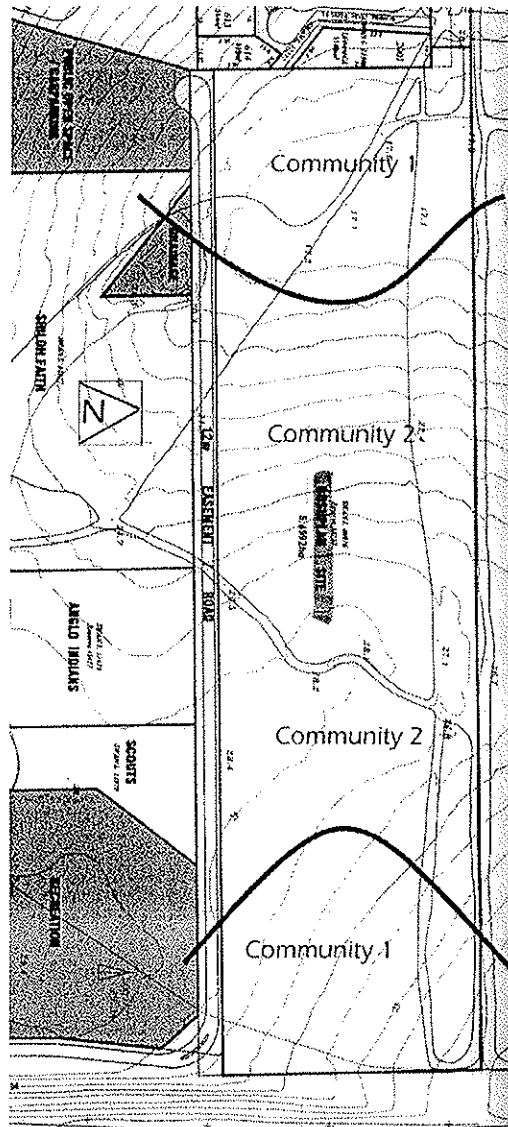
Map 1 – Location, Bush Forever Sheet



Site Description

The site has sandy soil and, as shown on the contour map below, slopes gently away to the west and northeast. The vegetation is composed of elements representing the Karrakatta (Central and South) and the Cottesloe (Central and South) Vegetation Complexes, the terms Community 2 and Community 1 refer to them respectively.

Map 2 – Plant Community Types



Quadrats

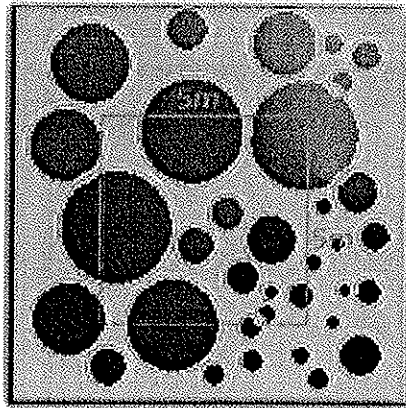
A series of nine five metre by five metre monitoring quadrats have been established throughout the site. The sites were chosen so that there were three in Community 1 East and West and three in Community 2, and spread over a range of bushland condition types, as in Fig. 1 below. They were rated according to the Vegetation Condition Scale as defined in Bush Forever Table 12 (after Keighery, B.J. 1994) so as to ensure that the data collected is comparable with other data and can form baseline

data for future monitoring. The Vegetation Condition Scale is reproduced in full in Appendix 3.

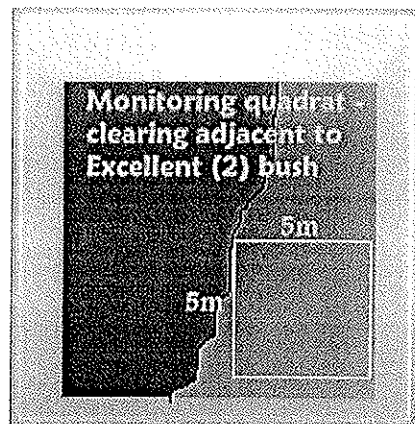
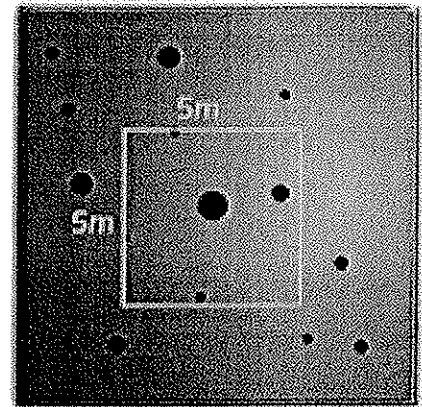
The quadrats were established in August 2001 and monitored for natural plant recruitment as well as being hand weeded over the succeeding five months. The set out of the quadrats in relation to bushland condition and the recruitment results are shown below.

Fig. 1

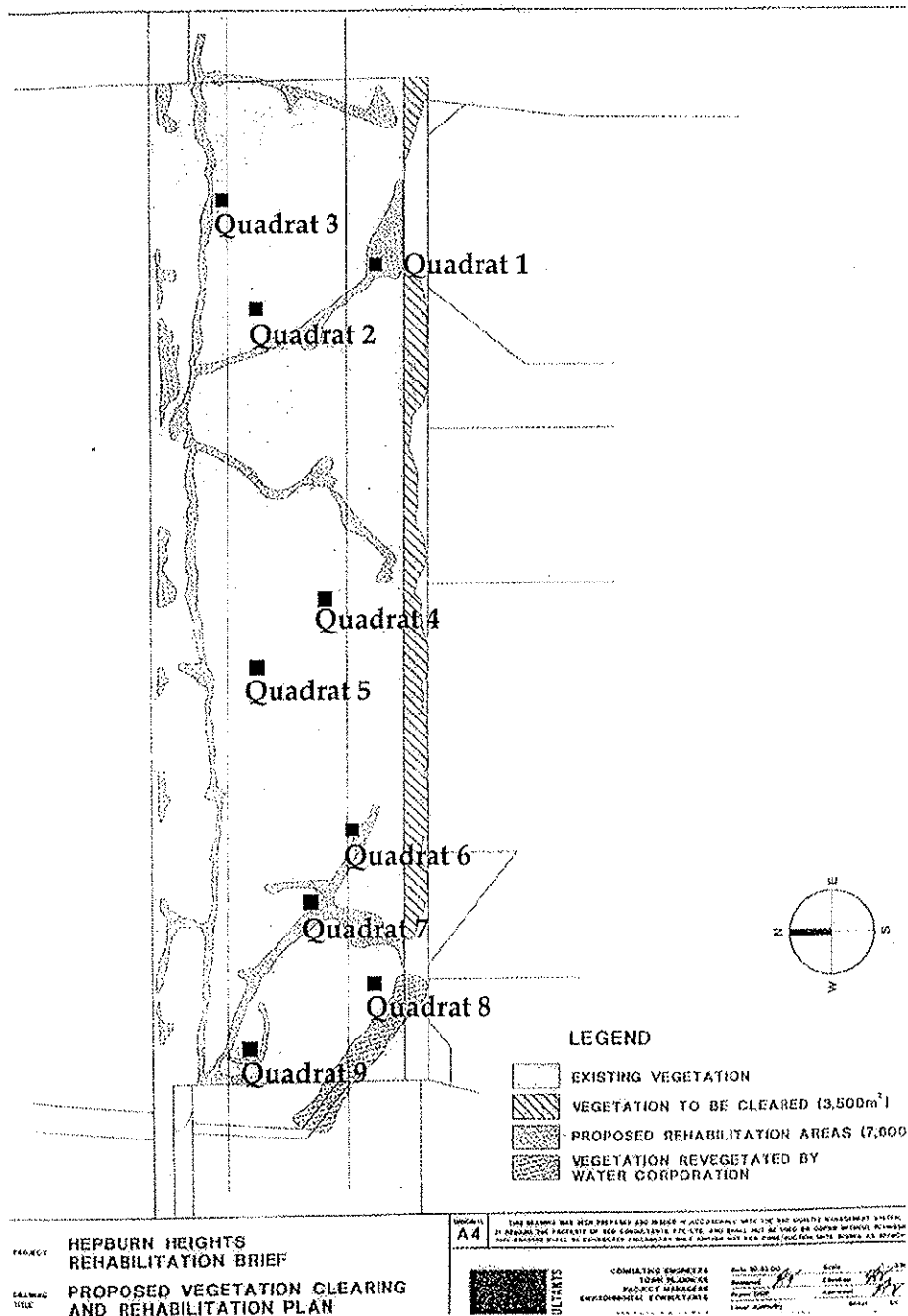
Monitoring quadrat -
good quality bushland



Monitoring quadrat -
degraded bushland



Map 3 – Quadrat Locations



QUADRAT 1

Quadrat 1 is sited in an area in a clearing at the edge of the site that immediately adjoins Jarrah/Banksia woodland in Excellent (2) condition. The quadrat itself is Completely Degraded (6), containing a single mature regrowth *Eucalyptus marginata*. The quadrat shows signs of previous soil disturbance with dips and hollows and some sub soil on the surface.

One half of the quadrat is covered in mulch derived from chainsawing of the sole Jarrah within the quadrat. There is no leaf litter on the surface of the rest of the quadrat. Although very degraded compared to the adjacent bushland, the quadrat was not heavily weed infested. The indigenous annual species *Trachymene pilosa* was present throughout the quadrat, however it has not been recorded on an individual basis.

Weed species present were **Arctotheca calendula*, **Anagallis arvensis*, **Erharta longiflora*, **Briza major*, **Homeria flaccida*, **Hypochaeris glabra*, **Gladiolus caryophyllaceous*, **Silene gallica* and **Romulea rosea*.

Regeneration numbers within quadrat

Genus	Species	No.
<i>Banksia</i>	<i>attenuata</i>	3
<i>Desmocladus</i>	<i>flexuosa</i>	6
<i>Gompholobium</i>	<i>tomentosum</i>	64
<i>Hardenbergia</i>	<i>comptoniana</i>	2
<i>Kennedia</i>	<i>prostrata</i>	1
Total		76

QUADRAT 2

Quadrat 2 is located in *Banksia* woodland that has a high sedge component as well as several annual species. It is in Very Good (3) condition. Fifty percent of the ground area of the quadrat is covered by mature clumps of *Mesemolaena pseudostygia*, twenty percent is covered with the groundcovering species *Desmocladus flexuosa*, *Scaevola canescens* and *Jacksonia sericea*.

The number of regenerating plants is low due to the high quality and composition of the vegetation. The indigenous annual species *Asteridia pulverulenta* and *Waitzia sauveolens* were present in numbers throughout the quadrat but have not been recorded on an individual basis.

One mature *Banksia attenuata* and one small *Banksia menziesii* were present. Weed species present included **Briza major*, **Homeria flaccida*, **Hypochaeris glabra*, **Petrohagia velutina*, **Ursinia anthemoides* and **Vulpia myuros*.

Regeneration numbers within quadrat

Genus	Species	No.
<i>Banksia</i>	<i>attenuata</i>	3
<i>Desmocladus</i>	<i>flexuosa</i>	1
<i>Gompholobium</i>	<i>tomentosum</i>	1
<i>Jacksonia</i>	<i>sericea</i>	1
<i>Nemcia</i>	<i>capitata</i>	1

Total	7
-------	---

QUADRAT 3

Quadrat 3 is adjacent to a track in Jarrah / Balga woodland. Its Vegetation Scale rating is Good (4). Previous soil disturbance is evident with some mounding and sub soil apparent on the surface. Approximately sixty percent of the quadrat has vegetation cover, and there is dappled sunlight throughout the day. The entire quadrat was covered in good leaf litter.

The sedges *Mesemolaena pseudostygia*, *Lepidosperma angustatum* and *Desmocladius flexuosa* form a significant part of the groundcover. To small Jarrah and one large Balga are present as are three plants of *Ricinocarpus glaucus*. The indigenous annual species *Trachymene pilosa* was evident throughout, but has not been recorded on an individual basis.

Major weed species present were **Erharta calycinus*, **Erharta longiflora* and **Trifolium campestre*.

Regeneration numbers within quadrat

Genus	Species	No.
<i>Gompholobium</i>	<i>tomentosum</i>	45
<i>Grevillea</i>	<i>vestita</i>	1
<i>Hardenbergia</i>	<i>comptoniana</i>	2
<i>Kennedia</i>	<i>prostrata</i>	1
<i>Lepidosperma</i>	<i>angustatum</i>	11
Total		60

QUADRAT 4

The quadrat is in Good (4) condition. It consists of fifty percent moderate vegetation cover and a covering of good leaf litter. Twenty percent is bare soil. Thirty percent of the area is covered with *Desmocladius* clumps with scattered individuals over another ten percent. There is one medium sized *Banksia attenuata*, a small stand of *Hakea trifurcata* with one medium sized individual.

There is one good clump of *Mesemolaena pseudostygia*, four clumps of *Conostylis aculeata*, one large *Scaevola canescens* and one *Hypocalymma robustum*. The site is subject to distinct morning sun and afternoon shade from surrounding Jarrah and Tuart woodland.

Regeneration numbers within quadrat

Genus	Species	No.
<i>Conostylis</i>	<i>aculeata</i>	1
<i>Gompholobium</i>	<i>tomentosum</i>	21
<i>Hardenbergia</i>	<i>comptoniana</i>	1
<i>Scaevola</i>	<i>canescens</i>	1
Total		24

QUADRAT 5

The quadrat is in Good (4) condition. An area of approximately fifty percent has good vegetation cover with good leaf litter, fifty percent is bare ground with sub soil evident on the surface. Animal (kangaroo) tracks pass the quadrat. Present in the site are several immature Balga, Three medium sized and four small *Hakea trifurcata*, one *Banksia attenuata*, three *Eucalyptus calophylla* regenerating from lignotubers, four stands of *Hibbertia hypericoides*, a stand of *Corynotheca micrantha*, two *Nemcia capitata*, one *Petrophile macrostaycha*, two small patches of *Mesemolaena pseudostygia*, one *Hypocalymma robustum*, a clump of *Conostylis aculeata* and small amounts of *Desmocladius flexuosa*. The only mature *Banksia* prionotes noted in the project site occurs immediately to the west of the quadrat.

Regeneration numbers within quadrat

Genus	Species	No.
<i>Acacia</i>	<i>willdenowiana</i>	3
<i>Banksia</i>	<i>attenuata</i>	5
<i>Eucalyptus</i>	<i>calophylla</i>	4
<i>Hardenbergia</i>	<i>comptoniana</i>	5
<i>Hibbertia</i>	<i>racemosa</i>	4
<i>Nemcia</i>	<i>capitata</i>	2
Total		23

QUADRAT 6

The quadrat is in Good (4) condition. It is surrounded by tall Marri and receives morning shade and afternoon sun. There is good vegetation cover over sixty percent of the area, with good leaf litter. Forty percent is bare soil with some leaf litter. The developed plant population consists of three mature *Xanthorrhoea preissii* and four smaller ones, one good stand of *Mesemolaena pseudostygia*, six *Hibbertia hypericoides*, one *Leucopogon parviflorus*, *Hypocalymma robustum*, four *Petrophile linearis*, several clumps of *Conostylis aculeata*, four *Tricoryne elatior*, one

Gompholobium tomentosum, two *Hardenbergia comptoniana*, one small *Hakea trifurcata*, Two *Hibbertia racemosa*, three *Nemcia capitata*, three *Isotropis cuneifolia* and a scattering of *Desmocladius flexuosa*

Regeneration numbers within quadrat

Genus	Species	No.
<i>Acacia</i>	<i>saligna</i>	1
<i>Caesia</i>	<i>parviflora</i>	20
<i>Eucalyptus</i>	<i>calophylla</i>	19
<i>Gompholobium</i>	<i>tomentosum</i>	5
<i>Hardenbergia</i>	<i>comptoniana</i>	2
<i>Leucopogon</i>	<i>parviflorus</i>	1
<i>Nemcia</i>	<i>capitata</i>	3
Total		51

QUADRAT 7

This quadrat is Degraded (5). Approximately thirty percent is bare of any vegetation, and ten percent is bare soil. Existing vegetation consists of one *Acacia saligna*, one *Eucalyptus marginata*, one *Xanthorrhoea preissii*, four clumps of *Mesemolaena pseudosygia*, six *Hakea trifurcata*, one *Hibbertia hypericoides*, four *Nemcia capitata*, three *Conostylis aculeata*, five *Tricoryne elatior*, one *Hibbertia racemosa* and two *Phyllanthus calycinus*. The quadrat is adjacent to a track with tall Marri on two sides. Weed species present were **Briza maxima*, **Bromus diandrus*, **Erharta calycinus*, **Erharta longiflora*, **Avena fatua*, **Freesia*, **Trifolium campestre*, **Homeria flaccida* and **Pelargonium capitatum*.

Regeneration numbers within quadrat

Genus	Species	No.
<i>Acacia</i>	<i>saligna</i>	3
<i>Desmocladius</i>	<i>flexuosa</i>	4
<i>Eucalyptus</i>	<i>calophylla</i>	5
<i>Hibbertia</i>	<i>hypericoides</i>	1
Total		13

QUADRAT 8

This quadrat is Degraded (5). The area had been recently burnt. It contains two mature *Eucalyptus calophylla*, one regrowing from the lignotuber, three mature *Xanthorrhoea preissii* and one *Macrozamia riedlii*. The soil was bare and blackened with few weeds present due to the recent fire.

Regeneration numbers within quadrat

Genus	Species	No.
<i>Acacia</i>	<i>saligna</i>	11
<i>Eucalyptus</i>	<i>calophylla</i>	3
<i>Hakea</i>	<i>trifurcata</i>	2
<i>Hardenbergia</i>	<i>comptoniana</i>	18
<i>Kennedia</i>	<i>prostrata</i>	21
<i>Phyllanthus</i>	<i>calycinus</i>	1
<i>Pterostylis</i>	<i>sp.</i>	4
<i>Spyridium</i>	<i>globulosum</i>	4
Total		64

QUADRAT 9

The quadrat is Degraded (5). Approximately fifty percent is covered with vegetation with good leaf litter throughout. Dips and hollows indicate previous soil disturbance. Mature vegetation consists of eight *Xanthorrhoea preissii*, two *Eucalyptus calophylla*, one *Hakea trifurcata*, one *Ozothamnus cordatum*, one *Acacia stenoptera*, one *Hibbertia racemosa*, two *Hardenbergia comptoniana*, three *Phyllanthus calycinus* and two *Conostylis aculeata*. Good top shade throughout.

The indigenous annual species *Trachymene pilosa* were found throughout but have not been recorded on an individual basis. The orchids *Microtis media* and *Pterostylis* were also found in this quadrat but are not recorded as regenerating species. The weed species of this quadrat were **Avena fatua*, **Bromus diandrus*, **Briza maxima*, **Erharta calycina*, **Homeria flaccida*, **Gladiolus caryophyllaceus*, **Pelagonium capitatum*, **Romulea rosea* and **Trifolium campestre*.

Regeneration numbers within quadrat

Genus	Species	No.
<i>Eucalyptus</i>	<i>calophylla</i>	17
<i>Hardenbergia</i>	<i>comptoniana</i>	9
<i>Nemcia</i>	<i>capitata</i>	1
Total		27

Summary

Totals from Quadrats

Quadrat No.	Bushland Condition	Regeneration No. (Per 25m ²)	Per m ²
Quadrat 1	Completely Degraded (6)	76	3.04
Quadrat 2	Very Good (3)	7	0.28
Quadrat 3	Good (4)	60	2.4
Quadrat 4	Good (4)	24	0.96
Quadrat 5	Good (4)	23	0.92
Quadrat 6	Good (4)	51	2.16
Quadrat 7	Degraded (5)	13	0.52
Quadrat 8	Degraded (5)	64	2.56
Quadrat 9	Degraded (5)	27	1.08
Total		345	
		Sum	13.92
		Divided by 9 = 1.55 plants per m ²	

It can be concluded from this that, on average, recruitment is taking place at a rate of two plants per 3 square metres across a range of bushland conditions, where pedestrian access is not common.

Weeds

The major weed species populations types of the site could be characterised as having a preponderance of herbaceous perennials (*Freesia*, *Homeria*) to the east where the bushland condition is better, and a similar weighting for annual grasses to the west here the bushland has a lower rating and greater canopy cover.

MAJOR WEEDS

Genus	Species	Common Name	Lifeform
* <i>Homeria</i>	<i>flaccida</i>	One Leaf Cape Tulip	Herbaceous perennial
* <i>Freesia</i>	<i>affn. Leichtlinii</i>	Freesia	Herbaceous perennial
* <i>Erharta</i>	<i>longiflora</i>	Annual Veldgrass	Annual Grass
* <i>Erharta</i>	<i>calycina</i>	Perennial Veldgrass	Grass
* <i>Avena</i>	<i>fatua</i>	Wild Oats	Annual Grass

PROBLEM WEEDS







Genus	Species	Common Name	Lifeform
* <i>Briza</i>	<i>maxima</i>	Blowfly Grass	Annual Grass
* <i>Bromus</i>	<i>diandrus</i>	Great Brome	Annual Grass
* <i>Hypochaeris</i>	<i>glabra</i>	Flat Weed	Annual
* <i>Trifolium</i>	<i>campestre</i>	Hop Clover	Annual Pulse

Bushland Condition

Map 4 – Bushland Condition

MAP 4
BUSHLAND
CONDITION



-  PRISTINE (1)
-  EXCELLENT (2)
-  VERY GOOD (3)
-  GOOD (4)
-  DEGRADED (5)
-  COMPLETELY DEGRADED (6)

Appendix 1 – Indigenous Species List

Genus	Species	Common Name	Family
Acacia	<i>saligna</i>	Orange Wattle	MIMOSACEAE
Acacia	<i>stenoptera</i>	Narrow Winged Wattle	MIMOSACEAE
Acacia	<i>pulchella</i>	Prickly Moses	MIMOSACEAE
Acanthocarpus	<i>preissii</i>	Prickle Lily	DASYPOGONACEAE
Allocasuarina	<i>humilus</i>	Dwarf Sheoak	CASURINACEAE
Allocasuarina	<i>fraseriana</i>	Fraser's Sheoak	CASURINACEAE
Asteridia	<i>pulverulenta</i>	Common Bristle Daisy	ASTERACEAE
Banksia	<i>attenuata</i>	Slender Banksia	PROTEACEAE
Banksia	<i>menziesii</i>	Firewood Banksia	PROTEACEAE
Banksia	<i>prionotes</i>	Acorn Banksia	PROTEACEAE
Burchardia	<i>umbellata</i>	Milkmaids	COLCHICAEAE
Caesia	<i>parviflora</i>	Pale Grass Lily	ANTHERICACEAE
Caladenia	<i>flava</i>	Cowslip Orchid	ORCHIDACEAE
Conostylis	<i>aculeata</i>	Prickly Conostylis	HAEMODORACEAE
Corynotheca	<i>micrantha</i>		ANTHERICACEAE
Cryptostylis	<i>huegelii</i>	Midge Orchid	ORCHIDACEAE
Daviesia	<i>nudiflora</i>		FABACEAE
Daviesia	<i>triflora</i>		FABACEAE
Daviesia	<i>decurrens</i>		FABACEAE
Desmocladius	<i>flexuosa</i>		RESTIONACEAE
Dianella	<i>divaricata</i>	Flax Lily	FABACEAE
Drosera	<i>pallida</i>	Pale Sundew	DROSERACEAE
Drosera	<i>erythrorhiza</i>		DROSERACEAE
Dryandra	<i>lindleyana</i>	Couch Honeypot	PROTEACEAE
Eremaea	<i>pauciflora</i>		MYRTACEAE
Erygium	<i>pinnatifidum</i>	Blue Devil	APIACEAE
Eucalyptus	<i>calophylla</i>	Marri	MYRTACEAE
Eucalyptus	<i>marginata</i>	Jarrah	MYRTACEAE
Eucalyptus	<i>gomphocephala</i>	Tuart	MYRTACEAE
Gompholobium	<i>tomentosum</i>	Common Yellow Pea	FABACEAE
Grevillea	<i>crithmifolia</i>		PROTEACEAE
Grevillea	<i>vestita</i>		PROTEACEAE
Haemodorum	<i>sp.</i>	Bloodroot	HAEMODORACEAE
Hakea	<i>trifucata</i>	Two - leaf Hakea	PROTEACEAE
Hardenbergia	<i>comptoniana</i>	Native Wisteria	FABACEAE
Hibbertia	<i>racemosa</i>	Stalked Guinea Flower	DILLENEACEAE
Hovea	<i>trisperma</i>	Common Hovea	FABACEAE
Hybanthus	<i>calycinus</i>	Wild Violet	VIOLACEAE
Hypocalymma	<i>robustum</i>	Swan River Mrytle	MYRTACEAE
Isotropis	<i>cuneifolia</i>	Granny Bonnets	FABACEAE
Jacksonia	<i>furcellata</i>	Grey Stinkwood	FABACEAE
Jacksonia	<i>sternbergiana</i>	Green Stinkwood	FABACEAE
Jacksonia	<i>sericea</i>		FABACEAE
Lepidosperma	<i>angustatum</i>		CYPERACEAE
Leucopogon	<i>parviflorus</i>	Coast Beard - Heath	EPACRIDACEAE
Macrozamia	<i>riedlii</i>	Zamia Palm	CYCADACEAE
Mesemolaena	<i>pseudostygia</i>		CYPERACEAE
Microtis	<i>media</i>	Common Mignonette Orchid	ORCHIDACEAE
Nemcia	<i>capitata</i>	Bacon and Eggs	FABACEAE
Ozothamnus	<i>cordatum</i>	Tangle Daisy	ASTERACEAE
Petrophile	<i>macrostachya</i>		PROTEACEAE
Phyllanthus	<i>calycinus</i>	False Boronia	EUPHORBIACEAE

<i>Podotheca</i>	<i>chrysantha</i>	Yellow Podotheca	ASTERACEAE
<i>Poranthera</i>	<i>microphylla</i>	Small Poranthera	EUPHORBIACEAE
<i>Pterostylis</i>	<i>sp.</i>	Green Hood Orchid	ORCHIDACEAE
<i>Ptilotus</i>	<i>drummondii</i>	Narrowleaf Mulla Mulla	AMARANTHACEAE
<i>Ptilotus</i>	<i>polystachyus</i>	Prince of Wales Feather	AMARANTHACEAE
<i>Rhagodia</i>	<i>baccatta</i>	Sea Berry Saltbush	CHENODODACEAE
<i>Ricinocarpus</i>	<i>glaucus</i>	Wedding Bush	EUPHORBIACEAE
<i>Scaevola</i>	<i>canescens</i>	Grey Scaevola	GOODENIACEAE
<i>Scaevola</i>	<i>paludosa</i>		GOODENIACEAE
<i>Schoenus</i>	<i>grandiflorus</i>	Large Flowered Bog Rush	CYPERACEAE
<i>Sowerbea</i>	<i>laxiflora</i>	Vanilla Lily	MYRTACEAE
<i>Stipa</i>	<i>flavescens</i>		POACEAE
<i>Stylidium</i>	<i>brunonianum</i>	Pink Fountain Triggerplant	STYLIDIACEAE
<i>Stylidium</i>	<i>sp.1</i>	Triggerplant	STYLIDIACEAE
<i>Stylidium</i>	<i>calcaratum</i>	Book Triggerplant	STYLIDIACEAE
<i>Synaphea</i>	<i>spinulosa</i>		PROTEACEAE
<i>Thysanotus</i>	<i>manglesianus</i>	Fringed Lily	ANTHERICACEAE
<i>Thysanotus</i>	<i>sparteus</i>		ANTHERICACEAE
<i>Trachymene</i>	<i>pilosa</i>	Native Parsnip	APIACEAE
<i>Trichoryne</i>	<i>elatior</i>	Yellow Autumn Lily	ANTHERICACEAE
<i>Waitzia</i>	<i>suaveolens</i>	Fragrant Waitzia	ASTERACEAE
<i>Xanthorrohea</i>	<i>preissii</i>	Balga	XANTHORRHOEACEAE

Appendix 2 – Introduced Species List

Genus	Species	Common Name	Family
*Anagalis	<i>arvensis</i>	Pimpernal	PRIMULACEAE
*Arctotheca	<i>calendula</i>	Capeweed	ASTERACEAE
*Avena	<i>fatua</i>	Wild Oats	POACEAE
*Briza	<i>maxima</i>	Blowfly Grass	POACEAE
*Bromus	<i>diandrus</i>	Great Brome	POACEAE
*Carpobrotus	<i>edulis</i>	Pigface	AIZOACEAE
*Cynodon	<i>dactylon</i>	Couch Grass	POACEAE
*Erharta	<i>calycina</i>	Perennial Veldgrass	POACEAE
*Erharta	<i>longiflora</i>	Annual Veldgrass	POACEAE
*Euphorbia	<i>terricina</i>	Geraldton Carnation Weed	EUPHORBIACEAE
*Freesia	<i>affn. Leichtlinii</i>	Freesia	IRIDACEAE
*Fumaria	<i>capreolata</i>	Fumitory	FUMARIACEAE
* Gladioule	<i>caryophyllaceus</i>		IRIDACEAE
*Heliophila	<i>pusila</i>		BRASSICACEAE
*Homeria	<i>flaccida</i>	One Leaf Cape Tulip	IRIDACEAE
*Hypochaeris	<i>glabra</i>	Flat Weed	ASTERACEAE
*Isolepis	<i>maritima</i>		CYPERACEAE
*Lachenalia	<i>reflexa</i>		HYACINTHACEAE
*Lagurus	<i>ovata</i>	Hare's Tail Grass	POACEAE
*Osteospermum	<i>clandestinum</i>	Stinking Roger	ASTERACEAE
*Pelargonium	<i>capitatum</i>	Rose Pelargonium	GERANACEAE
*Pentaschistis	<i>thurnbergii</i>		POACEAE
*Petrorhagia	<i>velutina</i>	Velvet Pink	CARYOPHYLLACEAE
*Romlea	<i>rosea</i>	Guidford Grass	IRIDACEAE
*Rumex	<i>acetosella</i>	Sheep's Sorrel	POLYGONACEAE
*Silene	<i>gallica var. gallica</i>	French Catchfly	CARYOPHYLLACEAE
*Solanum	<i>nigrans</i>	Black Berry Nightshade	SOLANACEAE
*Soliva	<i>pterosperma</i>	bindii	ASTERACEAE
*Trifolium	<i>campestre</i>	Hop Clover	FABACEAE
*Ursinia	<i>anthemoides</i>	Ursinia	ASTERACEAE
*Vinca	<i>sativa</i>	Common Vetch	FABACEAE
*Vulpia	<i>myuros</i>	Rat's Tail Fescue	POACEAE
*Wahlenbergia	<i>capensis</i>	Cape Blue Bell	CAMPANULACEAE

Appendix 3 – Vegetation Condition Scale

(Bush Forever Vol. 2 from Keighery B.J. (1994))

Pristine (1)

Pristine or nearly so, no obvious sign of disturbance.

Excellent (2)

Vegetation structure intact, disturbance affecting individual species and weeds are non aggressive species.

Very Good (3)

Vegetation structure altered, obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some aggressive weeds, dieback, logging and grazing.

Good (4)

Vegetation structure significantly altered by very obvious signs of multiple disturbance. Retains basic structure or ability to regenerate it. For example, disturbance to vegetation structure caused by frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.

Degraded (5)

Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition. Without intensive management. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing

Completely Degraded (6)

The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as "parkland cleared" with the flora comprising weed or crop species with isolated native trees or shrubs.

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Dell J., and Banyard J., (eds.) *Bush Forever (Keeping the Bush in The City)*, (Department of Environmental Protection, Perth 2000)

Hussey B.M.J, (et al), *Western Weeds*, (The Plant Protection Society of Western Australia, 1997)

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APPENDIX B

FAUNA LIST FOR HEPBURN HEIGHTS

Note: The fauna of Hepburn Heights Public Open Space may consist of a subset of this list.

FROG SPECIES

LEPTODACTYLIDAE: GROUND FROGS

Limnodynastes dorsalis: Banjo frog

REPTILE SPECIES

GEKKONIDAE: GECKOS

Diplodactylus polyophthalmus

Phyllodactylus marmoratus: Marbled gecko

PYGOPODIDAE: LEGLESS LIZARDS

Aprasia repens: Burrowing legless lizard

Lialis burtonis: Burton's legless lizard

AGAMIDAE: DRAGONS

Pogona minor minor: Bearded dragon

SCINCIDAE: SKINKS

Cryptoblepharus plagiocephalus: Sun skink

Ctenotus fallens: Striped skink

Ctenotus lesueurii

Hemiergus quadrilineatum: Yellow bellied skink

Lerista elegans: Burrowing skink

Lerista praepedita: Burrowing skink

Menetia greyii: Gray's skink

Morethia lineocellata

Morethia obscura

Tiliqua occipitalis: Western blue tongue

Tiliqua rugosa: Bobtail

VARANIDAE: MONITORS

Varanus gouldii: Sand monitor

ELAPIDAE: FRONT FANGED SNAKES

Pseudonaja affinis: Dugite

BIRD SPECIES

ACCIPITRIDAE

Elanus notatus: Black shouldered kite

Haliastur sphenurus: Whistling kite

FALCONIDAE

Falco peregrinus: Peregrine falcon

Falco cenchroides: Nankeen kestrel

COLUMBIDAE

Streptopelia chinensis: Spotted turtle dove

Streptopelia senegalensis: Laughing dove

CACATUIDAE

Calyptorhynchus baudini: White tailed black cockatoo

Cacatua roseicapilla: Galah

PLATYCERCIDAE

Barnadius zonarius: Ringneck parrot/28

CUCULIDAE

Cuculus pallidus: Pallid cuckoo

STRIGIDAE

Ninox novaeseelandiae: Boobook owl

ALCEDINIDAE

Dacelo gigas: Laughing kookaburra

Halcyon sancta: Sacred kingfisher

MEROPIDAE

Merops ornatus: Rainbow bee-eater

HIRUNDINIDAE

Hirundo neoxena: Welcome swallow

Petrochelidon nigricans: Tree martin

CAMPEPHAGIDAE

Corocina novaehollandiae: Black-faced cuckoo shrike

Lalage sueurii: White-winged triller

MUSCICAPIDAE

Petroica multicolor: Scarlet robin

Pachycephala pectoralis: Golden whistler

Pachycephala rufiventris: Rufous whistler

Rhipidura fuliginosa: Grey fantail

Rhipidura leucophrys: Willie wagtail

MALURIDAE:

Malurus splendens: Splendid wren

CORVIDAE

Corvus coronoides: Australian raven

MAMMAL SPECIES

Macropus fuliginosus: Western Grey Kangaroo

BIRD LIST

Hepburn Heights

- Domestic Pigeon
- Spotted Turtle-Dove
- Laughing Turtle-Dove
- Galah
- Port Lincoln Ringneck (Twenty eight Parrot)
- Pallid Cuckoo
- Shining Bronze-Cuckoo
- Southern Boobook
- Barn Owl
- Laughing Kookaburra
- Sacred Kingfisher
- Rainbow Bee-eater
- Welcome Swallow
- Black-faced Cuckoo-shrike
- Scarlet Robin
- Rufous Whistler
- Grey Shrike-thrush
- Grey Fantail
- Willie Wagtail
- Splendid Fairy-wren
- Weebill
- Western Gerygone (Western Warbler)
- Yellow-rumped Thornbill
- Red Wattlebird
- Singing Honeyeater
- Brown Honeyeater

New Holland Honeyeater

Western Spinebill

Striated Pardalote

Silvereye

Australian Magpie-lark

Black-faced Woodswallow

Grey Butcherbird

Australian Magpie

Australian Raven

LITTLE EAGLE

**CRAIGIE OPEN SPACE
URBAN BUSHLAND MANAGEMENT PLAN**

Submitted for Assessment as SCI 3451 Environmental Management
Project Edith Cowan University, Joondalup

November 1994

Prepared by:
Michael Allen
Caroline Mahoney
Tim Morald
Gary Ogden
Allan Pastega
Angela Stuart-Street

URBAN BUSHLAND MANAGEMENT
PLAN FOR CRAIGIE OPEN SPACE

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11. Establish educational facilities including species identification plaques along walk/cycle paths to enhance public appreciation of regional flora. Encourage public participation in both weed management and bush restoration programs.

5.3 Fauna

5.3.1 Mammals

Methodology

In consideration of the size of Craigie Open Space and the diversity of the vegetation communities present, sampling was conducted by stratifying the area into representative vegetation associations, with a sampling site established in each. (Refer Appendix 2)

At each of the sample sites a line of four pitfall traps (15 lt buckets) were set 7 metres apart, connected by a 28 metre long, 30 cm high fence of aluminium flywire mesh. The traps were established in the centre of the vegetation community, in order to sample small mammal species that may be present (modified from How & Dell, 1990). In conjunction with this two Elliot traps were placed 10 m to the left and right of the centre of the line of pitfall traps, baited with a pellet bait made up of a mixture of peanut paste, oats and sardines. Opportunistic sampling was conducted for larger mammals by spotlighting, the examination of tracks and scats and searching within each of the sample areas. Sampling was conducted during the month of September, 1994.

Results and Discussion

The presence of six species of mammals was confirmed within Craigie Open Space:

<u>Native mammals</u>		Conservation Status
Western Grey Kangaroo	<i>(Macropus fuliginosus)</i>	Abundant
Western Brush Wallaby	<i>(Macropus irma)</i>	Common
<u>Introduced mammals</u>		
House mouse	<i>(Mus musculus)</i>	N/A
Black Rat	<i>(Rattus rattus)</i>	"
Domestic and/or Feral Cat	<i>(Felis catus)</i>	"
European Rabbit	<i>(Oryctolagus cuniculus)</i>	"

This corresponds to a fauna survey of Hepburn Heights (Tingay, 1993) which confirmed the presence of five mammal species, with the exception being the Western Brush Wallaby which is present at Craigie Open Space.

Appendix 3 lists a further five species which may be present, based upon faunal studies of surrounding areas, but were not recorded during the sampling period.

A number of factors have adversely impacted upon the fauna of the Northern Swan Coastal Plain of which Craigie Open Space comprises part. How and Dell (1993) identify the fragmentation of native vegetation (as a result of urban and agricultural development), the alteration of fire regimes, the introduction of exotic species and the reclamation of wetlands, as having contributed to the decline of numerous indigenous fauna.

The populations of both the Western Grey Kangaroo and the Western Brush Wallaby within Craigie Open Space appear to be small and highly susceptible to any further modification of their habitat. In particular, the recreational use of the area is placing further pressure on the remaining individuals. On a number of occasions the exercising of dogs (unleashed) was observed to result in the pursuit of both kangaroos and wallabies by dogs, resulting in stress and potentially the predation of juveniles. Additionally, recreational use of vehicles in the area would also appear to pose a potential threat to both species, due to the speed at which vehicles were observed to travel along the unsealed roads.

Further modification of Craigie Open Space could potentially result in the loss of both the Western Grey Kangaroo and the Brush tailed Wallaby from the area. Either a reduction in the area of remnant bushland or the isolation of the remaining fauna (through the elimination of the corridor) pose the greatest threats. In terms of the carrying capacity of Craigie Open Space, the department for Conservation and Land Management recommend a kangaroo density of 1 animal for every 5 ha of native bushland. This indicates that in isolation, Craigie Open Space could only support an estimated 12 animals (Kangaroos or Wallabies).

Arnold et al., (1991) found that Western Grey Kangaroos commonly move 2km between remnants of vegetation in the wheatbelt. Currently it would appear possible for the present population of both kangaroos and wallabies to move along the corridor from Pinnaroo to the south to the Beenyup water treatment plant and adjacent reserve to the north. However, barriers such as Whitfords Avenue and the boundary fence between the Water Authority reserve and Craigie Open Space would appear to severely restrict this movement.

A result of the isolation of both populations would be a decline in genetic variability and therefore a loss in within species diversity. Usher (1987) details a range of genetic consequences that can occur as a result of habitat fragmentation and isolation : inbreeding, decreased heterozygosity, reduced effective population size, reduced gene flow and increased mutation rates.

The remnant mammalian fauna of Craigie Open Space includes a number of introduced pest species; the House Mouse, the Black Rat, the Feral Cat, the European Rabbit, and possibly the European Fox. The Feral Cat (or Domestic Cat) and European Fox are both efficient predators impacting upon a wide diversity of fauna including small mammals, birds, reptiles and invertebrates. The "average" domestic cat is believed to predate upon 25 native species annually. (Australian National Parks and Wildlife Service, 1992)

Rabbits can degrade remnant bushland in a variety of ways, through the digging of warrens disturbing soil, the prevention of the regeneration of native vegetation through intensive grazing and the distribution of weed seeds through their faeces (Tingay, 1993).

In terms of the fire regime employed, the use of a frequent, low intensity fire regime should be avoided. Catling (1991), in a study of the impact of frequent low intensity prescribed burns in Eucalypt forests in southeastern Australia, found that this type of regime advantaged many introduced mammals including; the House Mouse, the European Fox, the Feral Cat and the European Rabbit. Catling proposed that, where feasible, infrequent high intensity fires were generally more beneficial to native fauna. However, this would not appear to be a viable option in remnant bushland the size of Craigie Open Space, due to the need to protect adjacent residential areas. Overall fire management of Craigie Open Space is considered in section 7.

RECOMMENDATIONS

1. Retain Craigie Open Space as an urban bushland remnant for the conservation of flora and fauna and passive recreation.
2. If further development does occur, protect plant community diversity and fauna habitat by conserving the largest possible representative area of each vegetation community.
3. In order to maximise fauna habitat diversity retain habitat trees (for example the Tuart stags) and hollow logs.
4. Protect vegetation communities and fauna habitat from the introduction of diseases (for example dieback), inappropriate fire regimes, and human disturbance.
5. The sampling program conducted did not account for the temporal variability that may occur within the system. To verify and monitor the mammal species present, use established sample sites and methodology to monitor mammal populations on a regular basis (for example quarterly).
6. Access for residents wishing to exercise dogs should be permitted on the condition that the dogs are kept on a leash and under control at all times. Signs informing residents should be placed at all entrances and possibly a notice placed in the local paper advising residents of the reasons for the decision.
7. Recreational vehicle use should be prohibited. Signs and chain gates should be installed at the off road entrance to Craigie Open Space (near the roundabout).
8. Any future development proposals considered should ensure that Craigie Open Space remains part of the remnant bushland corridor between Pinnaroo and Beenyup Treatment Plant, to maximise the viability of the populations of Western Brush Wallaby and Western Grey Kangaroo.
9. Evidence to date does not indicate a large population of rabbits or foxes is present within Craigie Open Space. If populations do increase, concurrent baiting with 1080 may be a viable option, subject to extensive public consultation through the local media and if implemented, the use of on site signs. The Agriculture Protection

- EUPHORBIACEAE ~~/~~ *Phyllanthus calycinus*
~~/~~ *Ricinocarpos glaucus*
~~/~~ * *Ricinus communis*
- FABACEAE ~~/~~ *Bossiaea eriocarpa*
~~/~~ *Daviesia decurrens*
- ~~/~~ *D. divaricata*
~~/~~ *D. triflora*
~~/~~ *D. nudiflora*
~~/~~ *Gompholobium aristatum*
~~/~~ *G. tomentosum*
~~/~~ *Hovea trisperma*
~~/~~ # *Isotropis cuneifolia*
~~/~~ # *Jacksonia sericea*
~~/~~ *J. sternbergiana*
~~/~~ *Oxylobium capitatum*
- GERANIACEAE * ~~/~~ *Pelargonium capitatum*
- GOODENIACEAE ~~/~~ *Lechenaultia linarioides*
~~/~~ *Scaevola canescens*
~~/~~ # *S. crassifolia*
~~/~~ *S. paludosa*
~~/~~ *S. thesioides*
- LAMIACEAE ~~/~~ *Hemiandra pungens*
- MIMOSACEAE ~~/~~ *Acacia cyclops*
~~/~~ *A. pulchella*
~~/~~ *A. rostellifera*
~~/~~ # *A. willdenowiana*
~~/~~ *A. truncata*
- MYOPORACEAE ~~/~~ # *Eremophila glabra*
~~/~~ *Myoporum insulare*
- MYRTACEAE ~~/~~ *Hypocalymma robustum*
~~/~~ *Melaleuca acerosa*
~~/~~ # *M. huegelii*
~~/~~ # * *M. nesophila*
- ONAGRACEAE ~~/~~ # * *Oenothera mollissima*
- POLYGALACEAE ~~/~~ # *Comesperma calymega*

PROTEACEAE ~~Conospermum triplinervium~~
~~Dryandra nivea~~
~~D. sessilis~~
~~Grevillea crithmifolia~~
~~G. vestita~~
~~Hakea lissocarpha~~
~~H. prostrata~~
~~Persoonia saccata~~
~~Petrophile linearis~~
~~P. macrostachya~~
~~P. serruriae~~
~~Stirlingia latifolia~~
~~Synaphea spinulosa~~

RHAMNACEAE ~~Trymalium ledifolium~~

RUBIACEAE ~~Opercularia vaginata~~

SANTALACEAE ~~Exocarpos sparteus~~

SOLANACEAE ~~Anthocercis ilicifolia~~
* ~~Solanum nigrum~~

TYMELAEACEAE ~~Pimelea sulphurea~~

VIOLACEAE ~~Hybanthus calycinus~~

TWINING & PROSTRATE PLANTS

Monocotyledons ANTHERICACEAE ~~Thysanotus manglesianus~~
~~Tricoryne elatior~~

Dicotyledons AIZOAEAE * ~~Carpobrotus edulis~~
~~Galenia pubescens~~

DROSERACEAE ~~Drosera macrantha~~
~~D. pallida~~

FABACEAE ~~Hardenbergia comptoniana~~
✓ ~~Kennedia prostrata~~
* ~~Vicia sativa~~

LAURACEAE ~~Cassytha racemosa~~

RANUNCULACEAE ~~Clematis microphylla~~

HERBS

Monocotyledons

ANTHERICACEAE

- ~~Caesia parviflora~~
- ~~Lomandra maritima~~
- ~~Sowerbaea laxiflora~~
- ~~Thysanotus dichotomus~~ MISTAKE = SPARTAN
- ~~T. triandrus~~
- ~~Tricoryne elatior~~

ASPHODELACEAE * ~~Trachyandra divaicata~~

COLCHICACEAE ~~Burchardia umbellata~~

HAEMODORACEAE ~~Anigozanthos humilis~~
~~Conostylis auleata~~
~~C. candicans~~
~~Conostylis Hybrid~~
~~Haemodorum paniculatum~~

HYACINTHACEAE # ~~Lachenalia reflexa~~

IRIDACEAE *# ~~Chasmanthe floribunda~~

- * ~~Gladiolus caryophyllaceus~~
- * ~~Homeria flaccida~~
- ~~Orthrosanthus laxus~~
- * ~~Romulea rosea~~

PHORMIACEAE ~~Dianella divaricata~~

ORCHIDACEAE ~~Caladenia flava~~
~~C. huegelii~~
~~C. latifolia~~
~~C. menziesii~~
~~Diuris longifolia~~
~~Lyperanthus nigricans~~
~~Pterostylis vittata~~

Dicotyledons

AMARANTHACEAE ~~Ptilotus drummondii~~
~~P. manglesii~~
~~P. polystachyus~~

APIACEAE ~~Eryngium rostratum~~
~~Trachymene pilosa~~

- ASTERACEAE * ~~Arctotheca calendula~~
 * ~~Coryza bonariensis~~
 * ~~Cotula turbinata~~
 * ~~Hypochaeris glabra~~
 * ~~Lagenifera huegelii~~
 * ~~Podolepis gracilis~~
 * ~~Taraxacum officinale~~
 * ~~Urospermum picroides~~
 * ~~Ursinia anthemoides~~
 * ~~Waitzia suaveolens~~
- BRASSICACEAE * ~~Brassica tournefortii~~
 * ~~Diplotaxis tenuifolia~~
 * ~~Heliophila pusilla~~
 * ~~Raphanus raphanistrum~~
- CARYOPHYLLACEAE * ~~Cerastium glomeratum~~
- DROSERACEAE * ~~Drosera erythrorhiza~~
- EUPHORBIACEAE * ~~Euphorbia terracina~~
- FABACEAE * ~~Lupinus mutabilis~~
 * ~~L. consentinii~~
 * ~~Trifolium campestre~~
 * ~~T. campestre~~
 * ~~T. dubium~~
 * ~~T. subterraneum~~
- FUMARIACEAE * ~~Fumaria capreolata~~
- GERANIACEAE * ~~Erodium botrys~~
- ONAGRACEAE * ~~Oenothera drummondii~~
- OROBANCHACEAE * ~~Orobanche minor~~
- POLYGONACEAE * ~~Emex australis~~
- PRIMULACEAE * ~~Anagallis arvensis~~
- STYLIDIACEAE * ~~Stylidium brunonianum~~
 * ~~S. calcaratum~~

GRASSES/GRASSLIKE

Sedges CYPERACEAE
~~#~~ *Isolepis nodosa*
~~/~~ *Lepidosperma angustatum*
~~#~~ *L. gladiatum*
~~#~~ *L. costale*
~~/~~ *Mesomelaena stygia*
~~/~~ *Schoenus curvifolius*
~~/~~ *S. grandiflorus*
~~/~~ *S. latitans = clandestinus*
~~/~~ *Tetraria octandra*

Rushes JUNCACEAE
~~/~~ *Luzula meridionalis*

Grasses POACEAE
~~*~~ *Aira caryophyllea*
~~*~~ *Avena fatua*
~~*~~ *Briza maxima*
~~*~~ *Bromus diandrus*
~~#~~ *B. madritensis*
~~#~~ *Cortaderia selloana*
~~*~~ *Ehrharta calycina*
~~*~~ *E. longiflora*
~~#~~ *Hordeum leporinum*
~~#~~ *Lagurus ovatus*
~~#~~ *Lolium perenne*
~~#~~ *L. rigidum*
~~/~~ *Microlaene stipoides*
~~#~~ *Piptatherum miliaceum*
~~*~~ *Poa annua*
~~#~~ *P. porphyroclados*
~~#~~ *Polypogon monspeliensis*
~~/~~ *Stipa compressa*
~~/~~ *S. semibarbata*

Twine Rushes RESTIONACEAE
~~/~~ *Alexgeorgea arenicola nitens*
~~/~~ *A. nitens*
~~/~~ *Loxocarya fasciculata*
~~/~~ *L. flexuosa*
~~/~~ *L. pubescens* ??? not likely

KEY

* Alien Species

Priority Three - Poorly Known Taxa

Taxa which are known from several populations, at least some of which are not believed to be under immediate threat. Such taxa are under consideration for declaration as 'rare flora' but are in need of further survey. (CALM, 1992)

+ 12 natives
to Herbarium #5

+ 18 weeds

BFS303

FLORA AND VEGETATION OF PINNAROO CEMETERY BUSHLAND

Prepared for:
Ministry for Planning
Albert Facey House
469 Wellington Street
PERTH.

Prepared by:
Bennett Environmental Consulting Pty Ltd



Sollya heterophylla

21 Currawong Drive
GOOSEBERRY HILL 6076

February 2002

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i. SUMMARY

Bennett Environmental Consulting Pty Ltd was commissioned by the Ministry for Planning to undertake a flora and vegetation survey of Pinnaroo Cemetery bushland. Two surveys were undertaken in 2001 the first in July and the second in September. Eight permanent, 10m x 10m (100m²) quadrats, in accordance with Department of Environmental Protection policy, were established in the bushland in July and were re-surveyed for additional plant taxa in the September survey. A GPS reading and photograph were taken at the NW corner.

Two Floristic Community Types 28 and 29b were recorded in the bushland. Floristic Community Type 28 is included in the Vegetation Complex Karrakatta - Central and South of which less than 10%, a minimal requirement (Government of Western Australia, 2000), remains in the metropolitan area. Floristic Community Type 29b is representative of the Quindalup Vegetation Complex. The Quindalup Dune at Pinnaroo Cemetery is the furthest inland occurrence and is significant for conservation of the remaining 48% of the original Dune system is closer to the coast. The transitional vegetation between the Quindalup and Spearwood Dunes, a Low Closed Forest of *Banksia prionotes* over Tall Open Scrub dominated by *Melaleuca systema* is relatively uncommon in metropolitan Perth. This transitional vegetation has not been evaluated by English (2001), but as it so poorly represented within the Swan Coastal Plain it is recommended that the Quindalup Dune vegetation at Pinnaroo Cemetery be retained.

A total of 221 taxa in 156 genera and 58 vascular plant families were recorded for the bushland. Where plants collected were unknown in the field these were collected pressed and identified by comparison with specimens at the Western Australian Herbarium. No Declared Rare or Priority Flora were found, but five significant flora as listed in Bush Forever (Government of Western Australia, 2000) were located. These were:

- *Callitris preissii* – which occurred mainly on the eastern face of the Quindalup Dune. Some had been planted around the memorial areas.
- *Hibbertia cuneiformis* – a widespread species throughout most of the bushland, but not recorded in the *Banksia prionotes* community.
- *Lechenaultia linarioides* – was only recorded from the Woodland of *Eucalyptus gomphocephala* and *Banksia attenuata* over an Open Heath dominated by *Hakea lissocarpha*.
- *Ricinocarpus glaucus* – was widespread through most of the bushland.
- *Trymalium ledifolium* var. *ledifolium* – was only recorded from one area on the south eastern face of the Quindalup Dune.

The vegetation condition varied from Very Good to Good (Government of Western Australia, 2000). A total of 59 weed taxa representing 26.7% of the total number of taxa were recorded from the Pinnaroo Cemetery bushland. Two of the weed taxa were native taxa but not endemic to the Pinnaroo bushland, where they have been planted and become established in the bushland. Twelve of the weeds are listed by the Department of Conservation and Land Management as High, indicating that these are the weeds that should be targeted for removal. One-leaf cape tulip and *Lachenalia reflexa* were the dominant weeds throughout the bushland. Typically the understorey of the vegetation at Pinnaroo Cemetery is relatively degraded with large areas being replaced by weed taxa,

but often the shrub layer is in good to very good condition and the tree layer in excellent condition, common for many bushlands in metropolitan Perth.

The Pinnaroo Cemetery bushland adjoins Hepburn Heights Bushland on the south and Whitfords Avenue Bushland on the north. It is also part of Greenways 9 and 10 (Tingay, Alan and Associates, 1998) and part of a regionally significant fragmented bushland/wetland as illustrated in Bush Forever (2000).

The bushland is of sufficient size to continue even with the impact of weeds and fire. The vegetation community at most risk is Low Closed Forest of *Banksia prionotes*, one of the Transitional communities. The vegetation units of the Quindalup Dunes are also important although of a larger size than the above.

The threatening processes identified were:

- proliferation of walking tracks;
- wild fires;
- boundary plantings and dumping of garden waste by local residents;
- dumping of excess sand, grass, etc in the bushland by cemetery staff;
- inappropriate enhancement plantings in the bushland;
- heavy grazing of native vegetation by kangaroos and rabbits; and
- encroachment into the bushland by planted species around the Memorial Garden.

An assessment was made of the protection values of the Pinnaroo Cemetery bushland, using published information and that gathered during the field work. Important considerations included: presence of restricted vegetation units, presence of Vegetation Complex Karrakatta – Central and South, vegetation condition, presence of significant flora. Following on from this assessment a list was made of vegetation management issues to be considered to enhance and maintain the vegetation of Pinnaroo Cemetery bushland.

No whole area is
Whitford Ave Bushland

1. INTRODUCTION

1.1 General Introduction

The Ministry for Planning commissioned Bennett Environmental Consulting Pty Ltd to prepare a report on the flora and vegetation of the remnant vegetation at Pinnaroo Valley Memorial Park (Pinnaroo Cemetery). Pinnaroo Cemetery is included in Whitfords Avenue Bushland, Craigie/Padbury, the Bush Forever Site 303.

Planning for the cemetery requires the development of additional areas of the site for burials and memorials. As the undeveloped areas are bushland, this requires that a survey of these bushland areas be undertaken.

1.2 Location

Pinnaroo Cemetery is 18km north of the Perth Central Business District, 7km south of the City of Joondalup and about 9km from the Indian Ocean. The main entrance is at Whitford Avenue and an additional entrance is currently being built to provide access from Gibson Avenue. Due to development of the northern metropolitan area, the cemetery is now surrounded by suburban development on the west and across the freeway to the east. Hepburn Heights Open Space to the south, a bushland public reserve to the north and the Mitchell Freeway on the east.

1.3 Land Tenure

Pinnaroo Cemetery was reserved for cemetery purposes in 1962 and the first burials began in 1978. The original site covered 303ha but it has now been reduced to 111ha with some of the original reserve being taken for sewer easements, freeway construction and other urban amenities (Peter Cala and Associates, 1996).

1.4 Objectives of the Current Survey

There are several objectives for the current survey. These include:

- vegetation units and their associated flora;
- presence of any threatened ecological communities;
- regional assessment of the area;
- linkage to other bushland areas;
- any relevance to the Commonwealth Biodiversity Legislation;
- vegetation community viability;
- assessment of protection values and
- vegetation management issues.

The above information was to be obtained by undertaking a vegetation and flora survey of the area in June – July with a second survey to be undertaken during the spring. The second survey should record plants flowering, especially orchid species, many of which were observed in leaf during the first survey.

Each of the above topics will be discussed in the report.

2 PHYSICAL ENVIRONMENT

2.1 Climate

The area has a dry Mediterranean climate with an average rainfall of ± 740 mm per year, with about 80% occurring between May and August. The winters are mild with a mean maximum temperature of 18.7°C and a mean minimum of 9.9°C. The summers are warm to hot with a mean maximum temperature of 29.9°C and a mean minimum of 18.6°C.

Pinnaroo Cemetery is situated within a broad shallow valley and receives some shelter from the strong winds near the coast. The predominant wind patterns are typical of the Perth area with early morning easterlies becoming strong sea breezes in the afternoon, particularly in summer. During winter the site may occasionally experience wet stormy winds from the south-west.

2.2 Geology

Pinnaroo Cemetery is part of the Swan Coastal Plain. The Plain is of low relief, 20-30km wide and composed of aeolian and fluvial sediments. The aeolian deposits are arranged in age sequence with the oldest and furthest inland being the Bassendean Dunes, then the Spearwood Dunes and finally the Quindalup Dunes that are along the present coastline. These dunes are differentiated by their materials, topography and soil profile development.

Pinnaroo is on the boundary of the Quindalup and Spearwood Dune systems (Churchward and McArthur, 1980). The Spearwood Dunes consist of a core of limestone overlain by yellow sand. Due to differential wind erosion two distinctly different landscapes have been developed, the Cottesloe unit to the west and Karrakatta unit to the east. Pinnaroo occurs in the Karrakatta unit, which has deep yellow brown sands. The Quindalup unit consists of calcareous sands both as ridges and parabolic dunes.

2.3 Soils

The soil of the Karrakatta unit is leached sand closely associated with the Tamala limestone. It represents the decalcified elements of the Pleistocene lime sand dunes. The sand is moderately sorted and composed of fine to coarse quartz grains. Typically the sands are off-white to grey, grading through buff and pale brown to deep yellow close to limestone (Biggs and Wilde, 1980).

The Quindalup soil unit has the sand made up of shell fragments, a variable amount of quartz and minor amounts of feldspar. Generally the calcium carbonate content is greater than 50% and in places exceeds 80%.

A study by Foulds (1988) at three sites in the Karrakatta unit at Pinnaroo, indicated that the soils were neutral yellow sands varying in depth from 0-11metres over pinnacles of limestone. He found that the carbon content of these soils was low compared to the darker soils of the sand heaths. Also there was a paucity of nutrients particularly phosphorus and nitrate nitrogen as is common in all Australian soils. Compared to the Quindalup soils the potassium level was relatively high. A low chlorine level, compared to the foredunes, could be attributed to the distance from the sea and a decrease in the deposition of aerosol salt.

2.4 Landforms

Pinnaroo Cemetery is part of the wider dunal landscape of the Perth coastal plain. Located in a broad dunal valley the cemetery site gradually descends to the north to its lowest point adjacent to the Whitfords Avenue boundary. A slight ridge rises along the southern boundary and in the north east a broad ridge forms a flat area. These areas are the Karrakatta unit.

On the west side of the cemetery the natural dunal landforms rise steadily up to form a north-south escarpment. The dunal land is distinctly separated from the remainder of the site by small mounds on the top edge of the escarpment. This is the Quindalup unit.

2.5 Flora and Vegetation

The two major soil units support totally different vegetation units. The Karrakatta Vegetation Complex consists predominantly of a mosaic of woodland of *Eucalyptus gomphocephala* and open forest of *Eucalyptus gomphocephala* – *E. marginata* subsp. *marginata* – *Corymbia calophylla* with closed heath occurring on the limestone outcrops. Common tree species in the *Eucalyptus gomphocephala* – *E. marginata* subsp. *marginata* – *Corymbia calophylla*-open forest include *Banksia attenuata*, *B. menziesii*, *B. grandis* and *Allocasuarina fraseriana*. Shrub species include *Jacksonia sternbergiana*, *J. furcellata*, *Acacia cyclops*, *A. saligna*, *Hibbertia* spp., *Allocasuarina humilis*, *Calothamnus quadrifidus* and *Grevillea preissiana* (Heddle *et al.*, 1980).

The Quindalup Vegetation Complex is the coastal dune complex consisting of two alliances – the strand and fore dune alliance and the mobile and stable dune alliance. The mobile and stable dune alliance contains *Acacia cyclops*, *Anthocercis littorea*, *Lepidosperma gladiatum*, *Myoporum insulare*, *Nitraria schoberi*, *Olearia axillaris*, *Scaevola crassifolia*, *S. nitida* and *Spyridium globulosum* (Heddle *et al.*, 1980). Heddle *et al.*, (1980) did not map the Quindalup Vegetation Complex at Pinnaroo, possibly due to the scale of mapping (B.Keighery, pers. comm.) but prepared the above description from other areas.

In Bush Forever (Government of Western Australia, 2000) four Floristic Community Types are listed for the Whitfords Avenue Bushland. These are:

Northern Spearwood shrublands and woodlands (Floristic Community Type 24);

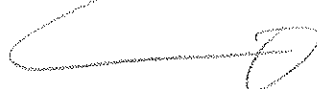
Woodland and mallees on limestone (Floristic Community Type 26b);

Spearwood *Banksia attenuata* or *Banksia attenuata* – *Eucalyptus* woodland (Floristic Community Type 28); and

Coastal shrubland on shallow soils (Floristic Community Type 29a).

Floristic Community Type 28 and 29a were identified at the Pinnaroo Cemetery Bushland. Floristic Community Type 24 and 26b were recorded from the Hepburn Heights Bushland where limestone is closer to the surface (B.Keighery, pers.comm.).

Keighery and Clarke (1999) mapped three major vegetation units, Spearwood Dune vegetation, Transitional vegetation and Quindalup Dune vegetation. They commented that the *Banksia prionotes* Open Woodland to Forest appeared to be a feature of the transitional zone between the Quindalup Dune and the lower lying Spearwood Sands.

 Joe report

3 SURVEY METHODOLOGY

The whole cemetery site, as defined in the information provided by the Ministry for Planning, was surveyed to assess the different vegetation units present. In each vegetation unit a permanent, 10m x 10m (100m²) quadrat was placed in a N,S,E,W orientation selecting the quadrat site for the best vegetation condition. This is consistent with the requirements of the Department of Environmental Protection. A star picket was placed at the NW corner and metal droppers placed at the remaining three corners. A metal tag with the quadrat number was attached to the star picket. A GPS reading was made and a photograph taken at the NW corner.

At Pinnaroo Cemetery there was marked variation within the Spearwood *Banksia attenuata* or *Banksia attenuata* – *Eucalyptus* woodland resulting in more than one quadrat being placed in this vegetation unit. The survey undertaken by Keighery and Clarke (1999) was used to assist with the definition of the vegetation units. Information about each quadrat was recorded on data forms (Appendix C).

In addition to the placement of each permanent quadrat the whole of the vegetation unit was traversed on foot to record additional taxa for the unit not represented in the quadrat. By recording these opportunistic species the total species list for each vegetation unit was increased considerably.

3.1 Vegetation

The vegetation of the area was defined for the whole unit, not just for the quadrat. The quadrat was placed in a characteristic section of the community but often it was only possible to include the dominant tree species within the 10m x 10m quadrat. Where tree taxa occurred outside of the quadrat these taxa were recorded separately and built into the vegetation classification. The descriptions were prepared using the vegetation layers as listed in Table 1.

Changes in vegetation structure at Pinnaroo included variation in the:

- tree layer, eg. Tuarts, *Banksia* spp, Jarrah;
- shrub layer, eg. *Melaleuca* sp., Papilionaceae species; and
- understorey layer, eg. sedges, herbs, grasses

Table 1. Vegetation layers. Adapted from: Bush Forever (Government of Western Australian, 2000)

Life Form/ Height Class	Canopy Cover			
	100-70%	70-30%	30-10%	10-2%
Trees over 30m	Tall Closed Forest	Tall Open Forest	Tall Woodland	Tall Open Woodland
Trees 10-30m	Closed Forest	Open Forest	Woodland	Open Woodland
Trees under 10m	Low Closed Forest	Low Open Forest	Low Woodland	Low Open Woodland
Tree mallee/Mallee	Closed Tree Mallee	Tree Mallee	Open Tree Mallee	Very Open Tree Mallee
Shrub mallee	Closed Shrub Mallee	Shrub Mallee	Open Shrub Mallee	Very Open Shrub Mallee
Shrubs over 2m	Closed Tall Scrub	Tall Open Scrub	Tall Shrubland	Tall Open Shrubland
Shrubs 1-2m	Closed Heath	Open Heath	Shrubland	Open Shrubland
Shrubs under 1m	Closed Low Heath	Open Low Heath	Low Shrubland	Low Open Shrubland
Grasses	Closed Grassland	Grassland	Open Grassland	Very Open Grassland

3.2 Taxa Present

For each quadrat all taxa were recorded, together, where applicable, with their flower colour, average height, percentage cover and if the taxa was rare or endangered. Time was spent locating additional species within the same vegetation unit but outside of the quadrat. Where the same vegetation unit occurred in different areas these were also searched to increase the taxa list for the unit. Taxa were recorded in the field, but where the identity was unknown or uncertain these were collected and pressed, then later identified using keys and by comparison with the specimens housed at the Western Australian Herbarium. Current nomenclature was checked using FloraBase (Western Australian Herbarium, 2001a) and MAX (Western Australian Herbarium, 2001b).

3.3 Vegetation Condition

The vegetation condition of each quadrat and the vegetation community as a whole was recorded using the 6-scale condition rating as appeared in Bush Forever Vol 2, p. 48 (Government of Western Australian, 2000).

Table 2: Condition rating scale (Bush Forever 2000)

Rating	Description	Explanation
1	Pristine	Pristine or nearly so, no obvious signs of disturbance.
2	Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.
3	Very Good	Vegetation structure altered, obvious signs of disturbance.
4	Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it.
5	Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management.
6	Completely Degraded	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species.

Table 3: Comparison between the Condition descriptions in Bush Forever and Trudgen (1991)

Description Bush Forever	Description Trudgen (1991)
Pristine	Excellent
Excellent	Very Good
Very Good	Good
Good	Poor
Degraded	Very Poor
Completely Degraded	Completely Degraded

If the description as given in Table 2 is used, it gives the impression that the bushland is in better condition than it really is. The classification after Trudgen (1991) gives a better indication of the true bushland condition. Categories 4 and above would be better described using the Trudgen method rather than Bush Forever. As an example category 4, where the bushland is significantly altered, often with many weeds, would be better

termed "Poor" rather than "Good". In this report the Condition Rating as given in Table 2 will be used

3.4 Significant Flora

Known Rare and Priority flora for the Whitfords Avenue Bushland are listed in Bush Forever, together with any other significant taxa.

Table 4. Rare and Priority Flora listed for Pinnaroo Cemetery in Bush Forever (Government of Western Australian, 2000)

Significant Flora	Comments
<i>Sarcozona bicarinata</i>	Priority 3 taxon
<i>Jacksonia sericea</i>	Priority 3 taxon
<i>Lechenaultia linarioides</i>	Not listed – but stated as significant
<i>Ricinocarpus glaucus</i>	Not listed – but stated as significant
<i>Callitris preissii</i>	Most northern population on Coastal Plain
<i>Grevillea preissii</i>	Tamala limestone taxon
<i>Diplopeltis huegelii</i> var. <i>huegelii</i>	Tamala limestone taxon
<i>Trymalium ledifolium</i> var. <i>ledifolium</i>	Tamala limestone taxon

Table 5. Code and description of Rare and Priority Flora categories

Code	Code Declared Rare and Priority Flora Categories
R	DRF (Declared Rare Flora) -Extant Taxa. Taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection.
X	DRF (Declared Rare Flora) -Presumed Extinct Taxa. Taxa which have not been collected, or otherwise verified, over the past 50 years despite thorough searching, or of which all known wild populations have been destroyed more recently.
1	Priority One -Poorly Known Taxa. Taxa which are known from one or a few (generally <5) populations which are under threat.
2	Priority Two -Poorly Known Taxa. Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat.
3	Priority Three -Poorly Known Taxa. Taxa which are known from several populations, at least some of which are not believed to be under immediate threat.
4	Priority Four -Rare Taxa. Taxa which are considered to have been adequately surveyed and which whilst being rare, are not currently threatened by any identifiable factors.

3.5 GPS Measurements

At the north west corner of each quadrat the GPS reading was recorded in UTM and latitude and longitude. In addition a photograph taken from this same corner recorded the quadrat. These measurements were used to locate the quadrats on the maps produced from the survey.

Where rare or priority flora were located outside the quadrat a GPS reading was recorded for each of these taxa.

3.6 Soil Assessment

A simple soil assessment was undertaken at each quadrat. This recorded the colour of the soil and its structure. Where rocks were observed these were also recorded.

3.7 Topography

The Ministry for Planning provided maps with contours for the area prior to undertaking the field work. Field notes also included the positions of the quadrats and vegetation units in relation to the topography.

Not
two
visits

4 RESULTS

Field work was undertaken on 4th and 5th July 2001. The perimeter roads were driven prior to undertaking any field work to determine the variation in vegetation present and the condition. This was compared to the vegetation map of Keighery and Clarke (1999). After all the quadrats had been placed the larger tracks through the cemetery were all driven to ensure there were no additional vegetation units and to determine the borders of the different mapped units.

All quadrats were placed as far away from tracks as was possible for two reasons. The first was to ensure that pegs would not be visible to the public using the many tracks and secondly to avoid the highly degraded verges along the track perimeters. Additional opportunistic taxa were recorded by walking the vegetation units, firstly that surrounding the quadrat, and then all the other areas with the same unit.

The second survey was undertaken on 12th September, 2001 when all permanent quadrats were resurveyed and the surrounding areas checked for additional plant taxa. The remnant "natural" areas within the developed Pinnaroo Cemetery were not surveyed during either field work as they were degraded and often planted with taxa alien to the bushland.

4.1 Vegetation and Flora

4.1.1 Quadrats

Eight permanent 10m x 10m quadrats, in accordance with the Department of Environmental Policy, were established in the bushland although Keighery and Clarke (1999) recorded three major landform vegetation units; Spearwood Dune vegetation (Karrakatta Complex – Central and South), Transitional vegetation and Quindalup Dune vegetation (Quindalup Complex).

The positions of the permanent quadrats are given in Table 6 and indicated in Appendix E Figure 1.

Table 6: GPS position of quadrats at Pinnaroo Cemetery

Quadrat Number	UTM Easting	UTM Northing	Latitude	Longitude
P1	50 384 560	684 1012	S 31°48'02.4"	E 115°46'49.9"
P2	50 384 542	649 1117	S 31°47'59.0"	E 115°46'49.2"
P3	50 384 673	648 0503	S 31°48'19.0"	E 115°46'54.0"
P4	50 384 307	648 0141	S 31°48'30.6"	E 115°46'39.9"
P5	50 384 147	648 1240	S 31°47'54.9"	E 115°46'34.3"
P6	50 384 048	648 1029	S 31°48'01.7"	E 115°46'30.4"
P7	50 384 238	647 9960	S 31°48'36.5"	E 115°46'37.2"
P8	50 384 193	648 0403	S 31°48'22.1"	E 115°46'35.7"

4.1.2 Vegetation

As mentioned above, Keighery and Clarke (1999) recorded three major vegetation units. This survey agreed with their findings and map. However this survey was able to map the area in finer detail and the main groupings of Keighery and Clarke (1999) were

divided into smaller component units. These are identified in Appendix E, Figure 1 and the taxa present listed in Appendix B. The Floristic Community Types are inferred from the species present in the vegetation unit and by comparison with the dominant taxa for each Floristic Vegetation Community listed in Gibson *et al.* (1994).

The dominant vegetation recorded was Floristic Community Type 28 (Gibson *et al.*, 1994) Spearwood *Banksia attenuata* or *Banksia attenuata* – *Eucalyptus* woodlands. The second most common was Floristic Community Type 29b *Acacia* shrublands on taller dunes. The third, referred to by Keighery and Clarke (1999) as Transitional vegetation included characteristics of both the other two. The different vegetation units are described below followed by the abbreviations used on the vegetation map (Appendix D, Figure 1). Appendix C has the information gathered for each quadrat.

Floristic Community Type 28

This Floristic Community Type was located on the north, east and southern sides of the Pinnaroo Cemetery. From the current survey Community Type 28 is further subdivided as described below.

- **Woodland of *Eucalyptus gomphocephala* and *Banksia attenuata* over an Open Heath dominated by *Hakea lissocarpha* and Closed Herbland. (EgHl) (Quadrat P1)**

Dominant trees: *Eucalyptus gomphocephala*, *Banksia attenuata*. Cover 40%

Dominant shrubs: *Acacia saligna*, *Acanthocarpus preissii*, *Hakea lissocarpha*, *Hibbertia hypericoides*, *Rhagodia baccata* subsp. *baccata*, *Xanthorrhoea preissii*. Cover 81%

Dominant herbs: **Carpobrotus edulis*, **Euphorbia terracina*, **Homeria flaccida*, **Lachenalia reflexa*, **Medicago* spp. Cover 87%

This vegetation unit occurred in only a small area towards the north eastern edge of the cemetery. It did extend through the cemetery to the main road, but up to 20m on the internal road the edge was degraded due to clearing of vegetation, invasion of weeds and planting of inappropriate taxa for the vegetation unit.

- **Open Forest of *Eucalyptus gomphocephala*, *Nuytsia floribunda* and *Allocasuarina fraseriana* over an Open Shrubland of *Xanthorrhoea preissii* and Herbland. (EgXp) (Quadrat P2)**

Dominant trees: *Allocasuarina fraseriana*, *Eucalyptus gomphocephala*, *Nuytsia floribunda* Cover 55%

Dominant shrubs: *Acacia cyclops*, *Rhagodia baccata* subsp. *baccata*, *Xanthorrhoea preissii*. Cover 4%

Dominant herbs: **Ehrharta longiflora*, **Euphorbia terracina*, **Homeria flaccida*, **Lachenalia reflexa*. Cover 73%

This vegetation unit adjoined the preceding unit and was of even smaller size. However the understorey was completely different to that of the preceding.

- **Open Forest of *Eucalyptus marginata* subsp. *marginata* and *Banksia attenuata* over a Shrubland dominated by *Xanthorrhoea preissii* and Sedgeland. (EmBa) (Quadrat P3)**
 Dominant trees: *Banksia attenuata*, *Eucalyptus marginata* subsp. *marginata* with scattered *Eucalyptus gomphocephala*. Cover 53%
 Dominant shrubs: *Hakea lissocarpa*, *Hibbertia hypericoides*, *Hovea trisperma* var. *trisperma*, *Petrophile macrostachya*, *Xanthorrhoea preissii*. Cover 20%
 Dominant herbs: *Drosera erythrorhiza*, *Homeria flaccida*, *Trifolium campestre*. Cover 18%
 Dominant sedges: *Desmodium flexuosum*, *Lepidosperma leptostachyum*, *Mesomelaena pseudostygia*. Cover 50%

This vegetation unit occurred along the eastern and southern edge of the cemetery. In some sections *Eucalyptus marginata* was the dominant tree in others *B. attenuata* was dominant but throughout the understorey had several shrub taxa.

- **Low Open Forest of *Banksia attenuata*, *B. menziesii*, *Eucalyptus marginata* subsp. *marginata* and *Allocasuarina fraseriana* over an Open Heath dominated by *Xanthorrhoea preissii* and Herbland/Sedgeland. (EmBaBmAf). (Quadrat P5)**
 Dominant trees: *Acacia saligna*, *Allocasuarina fraseriana*, *Banksia attenuata*, *B. menziesii*, *Corymbia calophylla*, *Eucalyptus marginata* subsp. *marginata*. Cover 58%
 Dominant shrubs: *Eremaea asterocarpa* subsp. *asterocarpa*, *Hakea lissocarpa*, *H. prostrata*, *Hibbertia racemosa*, *Xanthorrhoea preissii*. Cover 20%
 Dominant herbs: **Homeria flaccida*, *Lagenifera huegelii*, **Ursinia anthemoides*. Cover 70%
 Dominant sedges: *Desmocladius flexuosus*, *Mesomelaena pseudostygia*. Cover 15%.

This vegetation unit occurred on the northern edge of the cemetery and was separated from the preceding unit by the relative dominance of *B. menziesii* whereas this taxon was only scattered through the Open Forest of *Eucalyptus marginata* subsp. *marginata* and *Banksia attenuata*.

Floristic Community Type 29b

This Floristic Community Type was located in the Quindalup Dune on the western side of the Pinnaroo Cemetery. Two permanent quadrats were established in this community, one on the eastern slope, the other on top of the dune. Although both contained similar species they are separated in this study as the vegetation on the slope was of low shrubs but on the top of the dune trees of *Eucalyptus gomphocephala* and/or *Banksia prionotes* occurred in groups. Only occasionally were these trees recorded on the dune slope.

- **Open Low Heath dominated by *Melaleuca systema* and *Acacia lasiocarpa* over Herbland and Grassland. (MsAl) (Quadrat P6)**
 Dominant shrubs: *Acacia lasiocarpa*, *Acanthocarpus preissii*, *Exocarpos sparteus*, *Melaleuca systema*, *Santalum acuminatum*. Cover 70%
 Dominant herbs: *Brassica tournefortii*, *Conostylis candicans*, *Conostylis juncea*, **Pelargonium capitatum*, **Petrorhagia velutinea*, **Romulea rosea*. Cover 27%
 Dominant grasses: **Lagurus ovatus*. Cover 10%,

This community unit occurred on the eastern slope of the Quindalup Dune. Towards the sheltered base, trees of *Eucalyptus gomphocephala* occasionally occurred in groups. *Banksia prionotes* trees were scattered occasionally through the Low Heath.

- **Woodland of *Eucalyptus gomphocephala* and/or *Banksia prionotes* over Shrubland dominated by *Acacia lasiocarpa* and Open Sedgeland/Grassland/Herbland. (EgBp) (Quadrat P8)**
 Dominant trees: *Banksia prionotes*, *Eucalyptus gomphocephala*. Cover 0-50%
 Dominant shrubs: *Acacia lasiocarpa*, *Acanthocarpus preissii*, *Melaleuca systema*. Cover 40%
 Dominant herbs: **Carpobrotus edulis*, *Dianella revoluta*, **Romulea rosea*. Cover 27%
 Dominant grasses: **Avena barbata*, **Lagurus ovatus*. Cover 15%
 Dominant sedges: *Desmocladius flexuosus*. Cover 45%

This vegetation unit occurred on the western side, on the flat ground above the dune. *Eucalyptus gomphocephala* trees occurred in groups scattered through the Shrubland and groups of *Banksia prionotes* occurred in sheltered swales.

Transitional Vegetation

Two permanent quadrats were placed in the transitional vegetation (Keighery and Clarke, 1999) which included the stands of *Banksia prionotes* at the base of the Quindalup Dune.

- **Low Closed Forest of *Banksia prionotes* over Tall Open Scrub dominated by *Melaleuca systema* over a Closed Grassland. (BpMs) (Quadrat P7)**
 Dominant trees: *Banksia prionotes*, *Callitris preissii*. Cover 80-95%
 Dominant shrubs: *Acacia saligna*, *A. cyclops*, *Acanthocarpus preissii*, *Melaleuca huegelii* subsp. *huegelii*, *M. systema*. Cover 50%
 Dominant grasses: **Avena barbata*. Cover 85%

This vegetation unit was very small as indicated on Appendix E Figure 1. However the tree and shrub strata were in very good to excellent condition. It abutted the Quindalup Dune at the base and the following vegetation unit on the east.

Low Closed Forest of *Banksia attenuata*, *B. prionotes* with emergent *Eucalyptus gomphocephala* over a Shrubland dominated by *Xanthorrhoea preissii* and Sedgeland – Grassland. (BaBpEg) (Quadrat P4)

Dominant trees: *Banksia attenuata*, *B. menziesii*, *B. prionotes*, *Eucalyptus gomphocephala*, *E. marginata* subsp. *marginata*. Cover 75%

Dominant shrubs: *Acacia cyclops*, *Daviesia triflora*, *Dryandra lindleyana* subsp. *lindleyana*, *Hakea lissocarpha*, *Xanthorrhoea preissii*. Cover 18%

Dominant sedges: *Desmocladius flexuosus*, *Lepidosperma leptostachyum*, *Mesomelaena pseudostygia*. Cover 45%

Dominant grasses: **Avena barbata*, **Ehrharta calycina*, **Ehrharta longiflora*. Cover 12%

The above vegetation unit was the overlap between the communities of the Spearwood *Banksia attenuata* or *Banksia attenuata* – *Eucalyptus* woodlands and Quindalup Dune vegetation. It occurred between the Low Closed Forest of *Banksia prionotes* and Hovea Court.

4.1.3 Vegetation Condition

Keighery and Clarke (1999) mapped the vegetation condition of the area. The current survey was in agreement. For each quadrat a condition assessment was made and these are indicated in Table 7 and illustrated in Appendix E Figure 2.

Table 7. Vegetation condition of the 8 quadrats at Pinnaroo Cemetery (Government of Western Australia, 2000)

Quadrat Number	Vegetation Condition	Keighery and Clarke	Area
P1	3-4	4.5 / 5-4	
P2	4-5	5-4 / 4-5	
P3	occasionally 2 (although area generally 3-4)	4-3 4	
P4	2 (generally 3-4)	4-3 3-4	
P5	4	5-4-4-5	
P6	3	5-4-4-5 3-4	
P7	4-5	3-4 4-3	
P8	3	3-4	

*Government of Western Australia
Pinnaroo Cemetery
near lake*

Plot 3/2000

area seal

The vegetation condition of the whole area is mapped in Appendix E Figure 2. Typically the coastal plain is degraded, often quite severely by the introduction of weeds and this was found to be the case at Pinnaroo Cemetery bushland. Extensive development of the coastal plain, and in particular the development of residences close to the Pinnaroo Cemetery has seen several tracks developed through the bushland from the surrounding houses. Staff of the cemetery dump grass and sand in the bushland, generally out of sight of the public. This will increase the number of unwanted plants through the bushland. A buffer zone should be maintained between the bushland and the developed areas and an area(s) should be set aside for the dumping of soil and grass etc.

The edges of the roads were typically degraded by clearing, weed invasion and inappropriate plantings. The main road from the Administration building to the lake has the natural vegetation degraded for nearly 20m from the road edge.

The section of the cemetery where the Low Closed Forest of *Banksia prionotes* over Tall Open Scrub dominated by *Melaleuca systena* occurred had several *Eucalyptus caesia* trees planted. It would appear from the age of some of these trees that several may have self seeded and could extend further into this vegetation unit. Although the vegetation unit did record a high percentage of weed cover the tree and shrub layers were in excellent condition and unusual for the area. The *Eucalyptus caesia* trees should be removed to ensure they do not penetrate any further into this restricted vegetation unit. The dominant weeds recorded from the cemetery will be discussed in detail in Section 4.5.

4.1.4 Flora

A total of 301 taxa (including weeds) have been recorded from the Whitfords Avenue Bushland (Government of Western Australia, 2000) whilst a total of 221 taxa (including weed taxa) in 58 vascular plant families and 156 genera were recorded from these surveys (Appendix A and B). The taxa from these surveys at Pinnaroo Cemetery represent 73% of the total flora for the Whitfords Avenue Bushland. The Whitfords Avenue Bushland is 215.5ha in area, whereas Pinnaroo Cemetery is 111ha.

Table 8 records the dominant families together with the number of genera and species.

Table 8. Dominant Plant families (≥ 10 taxa) recorded from Pinnaroo Cemetery

Family	Number of Genera	Number of Native Taxa	Number of Weed Taxa	Total Number of Taxa
Asteraceae	16	6	10	16
Proteaceae	8	16	0	16
Papilionaceae	10	11	4	15
Poaceae	11	3	11	14
Cyperaceae	5	11	0	11
Orchidaceae	7	11	0	11
TOTAL	57	48	25	83

These 6 vascular plant families represent 10% of the number of families, 36.5% of the genera and 37.5% of the total taxa recorded from Pinnaroo Cemetery bushland.

Appendix B lists the taxa alphabetically under taxa for each vegetation unit. The Open Forest of *Eucalyptus marginata* subsp. *marginata* and *Banksia attenuata* recorded 124 taxa, the highest number of taxa. The Low Closed Forest of *Banksia attenuata*, *B. prionotes* with emergent *Eucalyptus gomphocephala* and the Low Open Forest of *Banksia attenuata*, *B. menziesii*, *Eucalyptus marginata* subsp. *marginata* and *Allocasuarina fraseriana* recorded both recorded 90 taxa. Both the Open Forest of *Eucalyptus marginata* subsp. *marginata* and *Banksia attenuata* and the Low Open Forest of *Banksia attenuata*, *B. menziesii*, *Eucalyptus marginata* subsp. *marginata* and *Allocasuarina fraseriana* are in the Spearwood system and typical of Community type 28 (Gibson *et al*, 1994). The Low Closed Forest of *Banksia attenuata*, *B. prionotes* with emergent *Eucalyptus gomphocephala* is in the Transitional vegetation. The Open Forest of *Eucalyptus gomphocephala*, *Nuytsia floribunda* and *Allocasuarina fraseriana* and Low Closed Forest of *Banksia prionotes* recorded the least number of taxa, 37 and 41 respectively. The Open Forest of *Eucalyptus gomphocephala*, *Nuytsia floribunda* and

Allocasuarina fraseriana is in the Spearwood system and Low Closed Forest of *Banksia prionotes* is an example of the transitional vegetation. Low Closed Forest of *Banksia prionotes* had a dense tree canopy dominated by *Banksia prionotes*, which would reduce considerably the potential for a large number of taxa in the shrub and herb canopy. Open Forest of *Eucalyptus gomphocephala*, *Nuytsia floribunda* and *Allocasuarina fraseriana* recorded very low shrub cover but a high herb cover, predominantly of weed taxa.

4.1.5 Rare, Priority and Significant Flora

No Declared Rare flora or Priority flora were recorded. Two significant flora taxa, *Lechenaultia linarioides* and *Trymalium ledifolium* var. *ledifolium* were located during the surveys. These are listed as occurring at the Whitfords Avenue Bushland in Bush Forever (Government of Western Australia, 2000). Taxa located during the surveys are listed in Table 9 and located on Appendix E Figure 3.

Table 9. Significant Flora recorded for Pinnaroo Cemetery (Bush Forever, 2000)

Taxon	Significance Code	Community Unit	Quadrat Number
<i>Callitris preissii</i>	s, E	*EgHl; BpMs; EgBp	*P1, P7, P8
<i>Hibbertia cuneiformis</i>	r,s	EgHl; EmBa; EmBa; EmBaBmAf;	P1, P3, P4, P5
<i>Lechenaultia linarioides</i>	p	EgHl	P1
<i>Ricinocarpus glaucus</i>	not provided	EgHl; EmBa; EmBa; EmBaBmAf; BpMs	P1, P3, P4, P5, P7
<i>Trymalium ledifolium</i> var. <i>ledifolium</i>	not provided	MsAl	Not recorded in a quadrat

* Planted in this community unit

Geographical variation

r = populations at the northern or southern limit of their known geographical range

s = significant populations

p = considered to be poorly reserved

Regional Ecological Preferences

E = taxa endemic to the Swan Coastal Plain in the Perth Metropolitan Region

No - e
Cris's
off

Not all the *Callitris preissii* trees at Pinnaroo Cemetery are natural; several have been planted in the bushland, especially beside the lawn and garden areas. The natural stands of *Callitris preissii* at Pinnaroo represent the most northern populations on the Swan Coastal Plain and therefore those occurring in the natural vegetation are extremely significant. *Hibbertia cuneiformis* is predominantly a taxon located around the southwest corner the State but is widespread through the Pinnaroo Cemetery bushland. *Trymalium ledifolium* var. *ledifolium* and *Ricinocarpus glaucus* are taxa restricted to the sandy soils close to the coast. *Ricinocarpus glaucus* was common in the Pinnaroo Cemetery bushland but *Trymalium ledifolium* var. *ledifolium* was only recorded from the Quindalup Dune.

4.1.6 Weed Taxa

A total of 59 weed taxa were recorded from the cemetery bushland representing 26.7% of all taxa recorded. This is comparable to the 26% of alien taxa recorded in the Flora of the Perth Region (Marchant *et al.*, 1987). There were 10 weeds recorded in the family

Asteraceae, 11 in the Poaceae, 5 in the Iridaceae and 4 in the Papilionaceae, totalling 30 taxa. These four families represent 50.8% of the weed taxa recorded.

The 59 weeds except 2, have all been determined as weeds by Department of Conservation and Land Management (1999) and the Western Australian Herbarium (2001a,b) and their rating is given below in Table 10. The rating allocated to each weed by CALM is based on three criteria:

- **Invasiveness** – ability to invade natural bushland in good to excellent condition or ability to invade waterways.
- **Distribution** – wide current or potential distribution including consideration of known history of wide spread distribution elsewhere in the world.
- **Environmental impacts** – Ability to change the structure, composition and function of ecosystems. In particular an ability to form a monoculture in a vegetation community.

Ratings indicate the following:

- **High** indicates this weed is prioritised for control and/or research ie prioritising funding to it.
- **Moderate** indicates control or research effort should be directed to it if funds are available, however it should be monitored (possibly a reasonably high level of monitoring).
- **Mild** indicates monitoring of the weed and control where appropriate.
- **Low** indicates that this species would require a low level of monitoring.

Table 10. Weeds recorded during the survey classified according to CALM (1999)

Scientific Name	Common Name	CALM Category		
		Rating	Invasiveness	Impact
* <i>Brassica tournefortii</i>	Wild turnip	High	✓	✓
* <i>Bromus diandrus</i>	Great brome	High	✓	✓
* <i>Ehrharta calycina</i>	Perennial veldt grass	High	✓	✓
* <i>Eragrostis curvula</i>	African love grass	High	✓	✓
* <i>Euphorbia terracina</i>	Geraldton carnation weed	High	✓	✓
* <i>Freesia hybrid</i>	Freesia	High	✓	✓
* <i>Homeria flaccida</i>	One leaf cape tulip	High	✓	✓
* <i>Lachenalia reflexa</i>	Lachenalia	High	✓	✓
* <i>Lagurus ovatus</i>	Hare's tail grass	High	✓	✓
* <i>Lupinus consentinii</i>	Blue lupin	High	✓	✓
* <i>Pelargonium capitatum</i>	Rose pelargonium	High	✓	✓
* <i>Romulea rosea</i>	Guildford grass	High	✓	✓
* <i>Aira caryophyllea</i>	Silvery hairgrass	Moderate	✓	
* <i>Anagallis arvensis</i>	Pimpernel	Moderate	✓	
* <i>Arctotheca calendula</i>	Cape weed	Moderate	✓	
* <i>Avena ?sp.</i>	Wild oats	Moderate	✓	
* <i>Avena barbata</i>	Bearded oat	Moderate	✓	
* <i>Briza maxima</i>	Blowfly grass	Moderate	✓	
* <i>Briza minor</i>	Shivery grass	Moderate	✓	
* <i>Carpobrotus edulis</i>	Hotentot fig	Moderate	✓	
* <i>Dischisma arenaria</i>		Moderate	✓	
* <i>Ehrharta longiflora</i>	Annual veldt grass	Moderate	✓	
* <i>Erodium cicutarium</i>	Common storksbill	Moderate	✓	
* <i>Euphorbia peplus</i>	Petty spurge	Moderate	✓	
* <i>Gladiolus caryophyllaceus</i>	Pink gladiolus	Moderate	✓	
* <i>Heliophila pusilla</i>		Moderate	✓	

Scientific Name	Common Name	CALM Category		
		Rating	Invasiveness	Impact
* <i>Hypochaeris glabra</i>	Flatweed	Moderate	✓	
* <i>Melilotus indica</i>	Common melilot	Moderate	✓	
* <i>Orobanche minor</i>	Lesser broomrape	Moderate	✓	
* <i>Lolium rigidum</i>	Annual ryegrass	Moderate	✓	
* <i>Solanum nigrum</i>	Blackberry nightshade	Moderate	✓	
* <i>Sonchus oleraceus</i>	Sowthistle	Moderate	✓	
* <i>Trifolium arvense</i>	Hares foot clover	Moderate	✓	
* <i>Trifolium campestre</i>	Hop clover	Moderate	✓	
* <i>Trifolium dubium</i>	Suckling clover	Moderate	✓	
* <i>Trifolium glomeratum</i>	Cluster clover	Moderate	✓	
* <i>Ursinia anthemoides</i>	Ursinia	Moderate	✓	
* <i>Vigna myuros</i>	Vetch	Moderate	✓	
* <i>Vulpia</i> sp.	Fescue	Moderate	✓	
* <i>Medicago polymorpha</i>	Medic	Mild		
* <i>Osteospermum clandestinum</i>	Stinking roger	Mild		
* <i>Oxalis pes-caprae</i>	Soursob	Mild		
* <i>Petrorhagia velutina</i>	Velvet pink	Mild		
* <i>Trachyantra divaricata</i>	Strapweed	Mild		
* <i>Agave americana</i>	Centuary plant	Low		
* <i>Arctotis stoechadifolia</i>	Arctotis	Low		
* <i>Cerastium glomeratum</i>	Mouse-ear chickweed	Low		
* <i>Conyza bonariensis</i>	Flaxleaf fleabane	Low		
* <i>Cotula turbinata</i>	Funnel weed	Low		
* <i>Dimorphotheca ecklonis</i>	Veldt daisy	Low		
* <i>Erodium botrys</i>	Corkscrews	Low		
* <i>Gaazania linearis</i>	Gazania	Low		
* <i>Marrubrium vulgare</i>	Horehound	Low		
* <i>Silene gallica</i>	French catchfly	Low		
* <i>Stellaria media</i>	Common chickweed	Low		
* <i>Brassica rapa</i>	Turnip	To Be Assessed		
* <i>Minuartia mediterraneum</i>	Sandwort	To Be Assessed		
* <i>Casuarina obesa</i>	Bullock	Not listed - taxon native to WA		
* <i>Chamelaucium uncinatum</i>	Geraldton wax	Not listed - taxon native to WA		

The distribution of the weeds within the different vegetation units is given in Appendix B. Twelve of the weed taxa are recorded as High, indicating that these are the weeds that should be targeted for removal.

**Homeria flaccida* and **Lachenalia reflexa* were the dominant weeds found in most of the bushland. Both are rated as High, considered to have an impact on the bushland and are invasive. **Homeria flaccida* is in the family Iridiaceae and reproduces by corms and seeds. **Lachenalia reflexa* is in the family Hyacinthaceae and reproduces by bulbs and seeds. In Hussey *et al.* (1997) *Lachenalia reflexa* is recorded as a potentially serious bushland weed naturalised in the tuart or banksia woodland and heath in the Perth area.

Casuarina obesa was planted on the western boundary opposite the residences, and now some seedlings appear to have become established in the bushland of that area.

Chamelaucium uncinatum has been planted in the bushland adjacent to the Memorial Park and subsequently become established.

4.2 Restricted Ecological Communities

In Bush Forever (Government of Western Australia, 2000) six factors are listed for consideration when selecting areas in the Quindalup Dunes for conservation. These are:

1. Quindalup Dune types. Inclusion of a series of Quindalup Dune types related to distance from the coastline, age and formation process,
2. Continuing natural processes. Sufficient size to allow for natural processes,
3. Shoreline.
4. Linkages. Include Quindalup, Spearwood and Bassendean Dune systems,
5. Vegetation. Variety of typical associations in good condition that encompass the north-south variation and
6. Habitats. A variety of habitats of sufficient area to provide for diverse reptilian and bird fauna of the coastal dunes.

It is proposed to protect 20% of the remaining 48% of the original area of the Quindalup Dunes (Government of Western Australia, 2000) within the Perth Metropolitan Region. Most of this vegetation complex currently protected is within 500 metres of the coastline. Pinnaroo Cemetery is about 9km from the ocean so it meets a very important distance criterion for conservation. Considering the six conservation factors listed above Pinnaroo Cemetery bushland meets the 1st, 2nd, 4th, 5th and 6th considerations. The Quindalup Dune at Pinnaroo Cemetery is of sufficient size for the natural processes to continue. Most of the remnant Quindalup Dune vegetation complex is classified as Condition 3-6 (Government of Western Australia, 2000) as is the case at Pinnaroo. It must be close to being, or actually be, the most distant occurrence from the coast of a Quindalup Dune in the Perth area, making it worthy of conservation.

The Quindalup Dune vegetation is Floristic Community Type 29b (Gibson *et al*, 1994), which is poorly reserved with a conservation status of susceptible. Typically the vegetation units on the Swan Coastal Plain are degraded but Keighery and Clarke (1999) recorded the vegetation of the Quindalup Dune at Pinnaroo Cemetery as good to very good (categories 3-4). Therefore, although Floristic Community Type 29 has not been evaluated by English (2001) it is recommended that the Quindalup Dune vegetation at Pinnaroo Cemetery be retained.

The Low Closed Forest of *Banksia prionotes* over Tall Open Scrub dominated by *Melaleuca systema* over a Closed Grassland is relatively uncommon in the Perth metropolitan area. There are very few such examples of this vegetation type in Metropolitan Perth (Government of Western Australia, 2000). The other two sites of reasonable size are the NW corner of Kings Park bushland and Underwood Avenue, Shenton Park, however at these two sites the vegetation more closely resembles the Low Closed Forest of *Banksia attenuata*, *B. prionotes* with emergent *Eucalyptus gomphocephala*.

Keighery and Clarke (1999) state the *Banksia prionotes* Open Woodland to Forest appears to be the transitional zone between the Quindalup Dune to the west and the low lying Spearwood sand to the east. In general, the other examples of this vegetation unit are highly disturbed due to the severe impacts which have resulted from weed taxa dominating the under storey. In the *Banksia prionotes* Open Woodland to Forest at

Pinnaroo Cemetery there is disturbance, predominantly as a result of repetitive fires followed by invasion of weeds, generally the understorey is in good to very good condition. This vegetation unit has not been evaluated by English (2001), but as it so poorly represented within the Swan Coastal Plain it is recommended that the Quindalup Dune vegetation at Pinnaroo Cemetery be retained.

~~There are two dominant Floristic Community Types 28 and 29b recorded from Pinnaroo Cemetery bushland. Floristic Community Type 29b *Acacia* shrublands on taller dunes is in the Cottesloe Complex - Central and South which exceeds the 10% target (Government of Western Australia, 2000).~~

Floristic Community Type 28 Spearwood *Banksia attenuata* or *Banksia attenuata* – *Eucalyptus* Woodland is in the Karakatta Vegetation Complex – Central and South of which less than the target of 10% is in conservation (Government of Western Australia, 2000). It is therefore important that this Floristic Community Type be conserved and maintained in a reasonable condition. Some of this Floristic Community Type is a vegetated buffer between the Quindalup Dunes communities and the *Banksia prionotes* vegetation types.

The location of the restricted ecological communities is provided in Appendix E, Figure 4.

4.3 Regional Assessment

Within the near vicinity of the Whitfords Avenue Bushland, Bushplan site 303 extends across Whitfords Avenue to form one relatively large bushland area. The whole area encompasses Spearwood and Quindalup Dunes. The landscape features include a limestone ridge as well as a tall ridge and vegetated uplands but there are no wetland communities. The structural units recorded from the area by several researchers (Government of Western Australia, 2000) include:

Quindalup Dunes

- *Melaleuca systena* and *Acacia lasiocarpa* Open Low Heath,
- *Eucalyptus gomphocephala* Woodland, and
- *Banksia prionotes* Woodland.

Spearwood Dunes

On sand derived from Tamala Limestone

- Open Forest to Woodland dominated by *Eucalyptus marginata*, *Corymbia calophylla* or *E. gomphocephala*,
- Low Woodland to Open Low Woodland dominated by *Banksia attenuata*, *B. menziesii*, *B. prionotes* or *Allocasuarina fraseriana* and combinations of these,
- *Acacia saligna* shrubland, and
- *Acacia rostellifera* shrubland.

Tamala Limestone

- *Eucalyptus decipiens* Low Woodland,
- *Acacia rostellifera* Shrubland,
- *Acacia truncata* Shrubland,
- *Dryandra sessilis* var. *cygnorum* Closed Heath, and
- *Lepidosperma gladiatum* Sedgeland.

The variation in the total Bush Forever (Government of Western Australian, 2000) site 303 is much more extensive that at Pinnaroo Cemetery. However the 3 vegetation units described above for the Quindalup Dune were mapped as one unit at Pinnaroo Cemetery

as the *Eucalyptus gomphocephala* and *Banksia prionotes* Woodlands occupied very small remnants within the total. On the sands derived from the Tamala limestone the first two structural units were mapped at Pinnaroo Cemetery. The other structural units occur in the larger area of Bush Forever site 303.

At the north east of Bush Forever Site 303 it adjoins Bush Forever site 407, Woodvale Nature Reserve. This bushland is included in the Spearwood Dunes, being represented by Floristic Community Type 28 (as in the Whitfords Avenue Bushland), "Spearwood *Banksia attenuata* or *B. attenuata* – *Eucalyptus* woodlands". The structural units recorded (Government of Western Australia, 2000) include:

- Low Woodland dominated by *Banksia attenuata*, *B. menziesii* and *Allocasuarina fraseriana* which is at times dominated by *Eucalyptus gomphocephala* Open Woodland, and
- *Eucalyptus gomphocephala* Open Woodland.

Both these structural units are represented in the Whitfords Avenue Bushland.

Therefore it would appear that the vegetation units on the Spearwood Dune are well represented outside of and near to the Whitfords Avenue Bushland. The closest Bush Forever site that includes vegetation units of the Quindalup Dune is Site 325, "Coastal strip from Burns Beach to Hillarys" which is nearly 5km west of the Pinnaroo Cemetery bushland.

By definition BF NOT.
= KC-S NOT well rep.

4.4 Linkage to Other Bushland Areas

Linkages between Whitfords Avenue Bushland and other areas are:

- the linkage to the north as described above to Bush Forever site 407, Whitfords Avenue bushland,
- Whitfords Avenue Bushland is also part of the regionally significant fragmented bushland/wetland linkage as illustrated in Bush Forever (2000). This linkage starts at Lake Goollelal and continues north to Bush Forever site 406, connecting in the north with another linkage to Gingin, and north of Joondalup with another linkage to the east, and
- part of Greenways 9 and 10 (Tingay, Alan and Associates 1998). One extends from the City of Perth along the Mitchell Freeway, the other from the east of Lake Goollelal to Hillary's Boat Harbour.

The natural vegetation in Pinnaroo Cemetery on the eastern side along Mitchell Freeway and the north along Whitfords Avenue is important to maintain bushland linkages. It is important that these bushland areas be retained to act as a buffer for the cemetery and as a bushland linkage. The proposed cemetery development plan (Peter Cala and Associates, 1996) intended to develop some additional areas near to Whitfords Avenue. During the field work it was noted that some of this area had been cleared and that another had signs suggesting that it was intended to become car parks etc.

4.5 Commonwealth Biodiversity Legislation

No threatened plant species or threatened ecological communities or wetlands as listed under the Commonwealth Biodiversity Legislation occur in Pinnaroo Cemetery.

Whitfords Avenue Bushland is entered in the Interim List of the Register of the National Estate (Australian Heritage Commission, 2001). The Australian Heritage Commission, established by the Commonwealth Government in 1975, compiles this Register. Being included in the Interim Register indicates that the area has heritage value so any

development within the cemetery should consider the conservation of the area. Listing does not directly affect the way the area is managed; it confers a moral rather than a legal obligation on the owners.

4.6 Vegetation Community Viability

Pinnaroo Cemetery bushland includes a restricted example of transitional vegetation between the Quindalup and Spearwood Dunes. This community has been recorded from other areas but the tree canopy at Pinnaroo Cemetery is excellent and extremely worthy of conserving. In addition being so far inland adds to the restricted status of this Quindalup Dune vegetation and it should be conserved.

4.6.1 Important Vegetation units

Most of the vegetation units on the Swan Coastal Plain are degraded and those at Pinnaroo Cemetery are no exception. There are four communities indicated above that are important for conservation. These are both those occurring on the Quindalup Dune:

- Open Low Heath dominated by *Melaleuca systema* and *Acacia lasiocarpa* over Herbland and Grassland, and
- Woodland of *Eucalyptus gomphocephala* and/or *Banksia prionotes* over Shrubland dominated by *Acacia lasiocarpa* and Open Sedgeland –Grassland – Herbland,

and the two that included *Banksia prionotes*:

- Low Closed Forest of *Banksia attenuata*, *B. prionotes* with emergent *Eucalyptus gomphocephala* over a shrubland dominated by *Xanthorrhoea preissii* and Sedgeland – Grassland, and
- Low Closed Forest of *Banksia prionotes* over Tall Open Scrub dominated by *Melaleuca systema* over a Closed Grassland.

4.6.2 Size of Communities

The Quindalup Dune communities and the Open Forest of *Eucalyptus marginata* subsp. *marginata* and *Banksia attenuata* over a Shrubland were both of sufficient size to continue to survive even with the impact of fire and weeds. However the Low Closed Forest of *Banksia prionotes* is very small and is nestled between the Quindalup Dune face and the Low Closed Forest of *Banksia attenuata*, *B. prionotes* with emergent *Eucalyptus gomphocephala*. These last two communities act as a buffer for the Low Closed Forest of *Banksia prionotes* and it will be essential to maintain these buffer communities to ensure the continued viability of this restricted community. Provided no further development or clearing occurs within these vegetation units they should continue to survive.

The other two vegetation units occupying a small area, The Woodland of *Eucalyptus gomphocephala* and *Banksia attenuata*, and the Open Forest of *Eucalyptus gomphocephala*, *Nuytsia floribunda* and *Allocasuarina fraseriana* are already quite degraded and occur in a part of the cemetery where the road edges have been cleared up to 20m in width and where several, non-endemic trees have been planted.

In Bush Forever (Government of Western Australia, 2000) a minimum of 10% of each Vegetation Complex is to be retained as bushland. Karrakatta – Central and South, which

includes Floristic Community Type 28, has less than 10% remaining. Therefore the presence and conservation of this Community Type is important.

12/10/05 = 15/10/05 p 21

4.6.3 Condition of Communities

Referring to Appendix E Figure 2 the condition of these communities varies between 3-4(5), that is they are Very Good to Good with occasional sections degraded. Several weed species were recorded from all of these communities, but although some of the weeds had a High rating they were not abundant. Weeds commonly associated with the Spearwood and Quindalup Dunes communities eg **Pelargonium capitatum*, **Ehrharta calycina*, **Freesia* hybrid were not abundant. Although weed control would be a time consuming task it would not be impossible, especially in the two Quindalup Dune communities. Under the *Banksia prionotes* trees there were several plants of **Homeria flaccida*, a weed taxon which is more difficult to control as it reproduces by underground corms and seeds.

4.6.4 Threatening Processes

As indicated above weeds will continue to threaten all the vegetation units at Pinnaroo Cemetery. Two common weeds, **Homeria flaccida* and **Lachenalia reflexa* were common through much of the bushland, especially that on the eastern side of the cemetery. To ensure these weeds are not spread further through the bushland it is essential that machinery driven into these areas is not then driven into the better bushland areas. Similarly it will be essential to ensure that soil from one area is not removed and dumped on another area.

There are several walking tracks through the bushland and it is along these that the weeds were densest. Generally along the roads through the cemetery the weeds have been controlled. There are many traversing the bushland, especially on the western side where it appears that residents walk their dogs. Although there are access points provided from the roads, some access holes have been broken through the fences and new trails commenced which eventually join with the older ones. People pressure will continue to be a problem for the cemetery as during the time the field work was undertaken several people were observed walking along the tracks and through the bushland.

At the second survey a large cubby was found in the Low Closed Forest of *Banksia prionotes* but far enough away from the tracks for it not to be readily visible. To build this structure many *Banksia prionotes* trees had been cut down in this important vegetation community. Cemetery staff were notified and it was removed.

Fires have been through the bushland at regular intervals. The northern end of the Quindalup Dune face had been burnt within the last 5 years as the wattles had regrown and several had died. Further south from this area there had been a fire in the *Banksia* woodland near the Quindalup Dune face. This area was recovering but many weeds had germinated. Opening the area through fire allows weeds to germinate and aggressively invade the bushland. Often fires are beyond the control of the Pinnaroo Cemetery staff, but where possible these should be prevented. If wildfires occur they need to be contained immediately.

Cemetery staff dump sand, clods of lawn and lawn clippings on the bushland. This practice must stop and a dump be developed within the cemetery. By dumping lawn

clippings it raises the potential for these grasses to become established and grow into the bushland.

Plantings by cemetery staff have occurred within the bushland areas. This is particularly apparent where the lawn areas adjoin the bushland. Here there have been amenity plantings, which are not of local taxa but taxa from other areas of Western Australia and Australia as a whole (listed by Keighery and Clarke, 1999). In the Low Closed Forest of *Banksia prionotes* there were several trees of *Eucalyptus todtiana* and *Eucalyptus caesia*. They may be aesthetically pleasing, where they occurred along a fire break / walk track, but care must be taken to ensure only plants native to the bushland and to that particular vegetation type are planted. Seed should be collected from the bushland plants to ensure that the genotype of the plants within the vegetation type is maintained. There are many aesthetically appealing plants within the bushland which would enhance any proposed plantings.

Grazing by kangaroos and rabbits is affecting the quality of the vegetation. The vegetation of the Quindalup Dune was heavily grazed and kangaroos were common through the Spearwood Dune, especially in the northern section in the Woodland of *Eucalyptus gomphocephala* (Tuart) and *Banksia attenuata* and Open Forest of *Eucalyptus gomphocephala* (Tuart), *Nuytsia floribunda* (Christmas tree) and *Allocasuarina fraseriana* (Sheoak).

No signs of dieback was recorded in the cemetery during this survey.

Fertiliser drift from the grassed areas is penetrating into the surrounding bushland increasing the number of weeds, in particular the invasion by grass. This is an obvious problem on the western side of the Memorial Park where the grassed areas run up to the edge of the Quindalup Dune's eastern slope. In addition some non-natural taxa planted in the area eg Japanese Peppercorn trees (*Schinus teberinthifolia*) are now becoming established in the adjoining bushland. This can also be a problem species in a public place as it has been recorded as causing skin problems for some people (Hussey *et al.*, 1997).

There needs to be buffer areas developed between the conserved bushland and the memorial areas. Along Eremaea Court the lawn area comes up and abuts the eastern edge of the Quindalup Dune. This section is becoming degraded due to many of the conditions mentioned above, but the weeds have penetrated further into this area than in other sections of the same vegetation type.

4.7 Assessment of Protection Values

Pinnaroo Cemetery is part of the larger Bush Forever site 303, Whitfords Avenue Bushland. Any further development within the cemetery must consider this and ensure that no current bushland linkages are broken. This is possibly the most important consideration for protection of the bushland. To ensure a linkage is maintained all future development must occur as at present, within the centre of the Memorial Park.

The protection values within Pinnaroo Cemetery are:

- the presence of Threatened Ecological Communities,
- the presence of restricted flora,
- the maintenance of bushland corridors,
- ensuring that the transitional vegetation between the Quindalup and Spearwood Dunes is maintained,

- ensuring a natural vegetation buffer is maintained between the lawned areas and the natural bushland, especially to the east of the Quindalup Dune where the lawn has already started to encroach,
- bushland condition – it is important to protect the better quality vegetation as determined by the field work, and
- the maintenance of the variation in the vegetation as determined during the field work.

The Protection values are described in Table 11 and illustrated in Appendix E, Figure 5.

Table 11. Assessment of Protection Values for Vegetation at Pinnaroo Cemetery

SCALE	DESCRIPTION
1	Includes restricted vegetation units, ensures the transitional vegetation between the Quindalup and Spearwood Dunes is maintained; vegetation in good or better Condition.
2	Vegetation Complex, Karakatta – Central and South in very good vegetation condition.
3	Vegetation Complex, Karakatta – Central and South but vegetation condition good to degraded. Important as a vegetated buffer to Protection Value 1 and 2 areas.
4	Vegetation Complex, Karakatta – Central and South but understorey has been altered considerably by burning.
5	Developed. Vegetation severely altered.

4.7.1 Protection Value 1

Development on the Quindalup Dune should not occur, or at least ensure that the values of this area are maintained. This will ensure the protection of vegetation unit, Open Low Heath dominated by *Melaleuca systema* and *Acacia lasiocarpa* and Woodland of *Eucalyptus gomphocephala* and/or *Banksia prionotes* over Shrubland dominated by *Acacia lasiocarpa*. As mentioned earlier this is the furthest east occurrence of this particular Floristic Community Type and as such should be conserved.

The Low Closed Forest of *Banksia prionotes* over Tall Open Scrub dominated by *Melaleuca systema* is a priority area for protection. This vegetation unit with a dense upper canopy is unusual in metropolitan Perth, it is also a transitional vegetation unit between the Quindalup and Spearwood dunes. For these reasons it should be maintained.

4.7.2 Protection Value 2 – *2 boundary K & C 197*

Vegetation units included in the Vegetation Complex, Karakatta – Central and South of which less than 10% remains in metropolitan Perth. Also the Low Closed Forest of *Banksia attenuata*, *B. prionotes* with emergent *Eucalyptus gomphocephala* over a Shrubland dominated by *Xanthorrhoea preissii* acts as a buffer between the developed areas and the Low Closed Forest of *Banksia prionotes* over Tall Open Scrub dominated by *Melaleuca systema*. There are very few examples of this latter vegetation unit within suburban Perth and therefore it is important that it is conserved. It is also important for ensuring the transitional vegetation between the Quindalup and Spearwood Dunes is maintained.

4.7.3 Protection Value 3

Includes the vegetation units included in the Vegetation Complex, Karakatta – Central and South where the vegetation condition was good to degraded. To ensure the maintenance of the vegetation linkage through the bushland and with the surrounding bushland areas a bushland perimeter of at least 50m should be maintained around the Memorial Park. This natural vegetated area will act as a buffer between the Memorial Park and the higher protection value areas.

4.7.4 Protection Value 4

None of the bushland is of low protection value as it is included in Vegetation Complex, Karakatta – Central and South but the understorey has been altered considerably by frequent burning.

4.7.5 Protection Value 5

Developed areas within Pinnaroo Cemetery.

4.8 Vegetation Management Issues

Any further development within Pinnaroo Cemetery should consider the management of the bushland areas, including the remnants within the Memorial Park itself.

4.8.1 General Issues

- Ensure that all future enhancement plantings are of taxa natural to the particular vegetation unit as per Appendix E Figure 1.
- Ensure that seeds collected for propagation of plants come from plants growing in the Pinnaroo Cemetery Bushland.

Develop or retain a vegetated buffer between the developed lawn areas and the natural vegetation. This is particularly important on the western edge beside the Quindalup Dune, but it will also be essential for any planned future development. By ensuring a vegetated buffer is present it should maintain the vegetation integrity of the bushland.

4.8.2 Short Term Issues

- Remove all the non-native trees from the bushland areas, particularly *Eucalyptus caesia* and *E. todtiana* growing in the Low Closed Forest of *Banksia prionotes* over Tall Open Scrub. This is a vegetation unit that must be conserved in as natural a condition as is possible.
- Reduce the number of kangaroos grazing the vegetation by relocation and commence the eradication of the rabbits.
- Commence the removal of weeds, especially the encroaching grass from the “natural” beds in the Memorial Park.
- Develop one dumping area for sand, lawn clippings, prunings and clods of turf. This must not be established next to the *Banksia prionotes* area to ensure there is no further degradation of this vegetation unit..
- Remove the clods of turf and lawn clippings from the bushland areas where they have been dumped into the above dumping area.

- If additional area is required for burials then only utilise the area indicated on Appendix E Figure 5.
- Educate adjoining households on the problems with the dumping of garden rubbish and reasons for removal of non-native trees from the bushland.

4.8.3 Medium Term Issues

- Continue the removal of weeds from the "natural" beds in the Memorial Park. Develop a distinct edge between the lawn and these areas.
- Continue the removal of non-native trees from the bushland areas, after advising local households of the reason.
- Remove historically dumped rubbish from the bushland areas, especially the area on the western side.
- Check and repair perimeter fences. Relocate entry points after the rationalising of tracks.
- Determine which are the popular walk trails through the bushland and reduce their number, closing those used the least. An education program for users will be an important precursor.
- Commence rehabilitation of the closed walk trails with seeds and seedlings collected from the area and taxa correct for the particular vegetation unit.
- Develop a Friends of Pinnaroo Cemetery Bushland voluntary group to assist with bushland care and bushland advice

4.8.4 Long Term Issues

- Undertake a weed removal program from the bushland, commencing with the Low Closed Forest of *Banksia prionotes* over Tall Open Scrub, followed by Open Low Heath dominated by *Melaleuca systema* and *Acacia lasiocarpa*, then Woodland of *Eucalyptus gomphocephala* and/or *Banksia prionotes* over Shrubland dominated by *Acacia lasiocarpa*.
- Commence rehabilitation of the bushland area with plantings of native taxa correct for each vegetation unit.
- Maintain the 'natural' areas by ensuring weeds are removed and grass trimmed to the edge.
- Monitor kangaroo numbers and reduce when necessary by relocation.
- Develop information leaflets for the bushland and the Memorial Park so that the public can appreciate the natural history of the area. Give consideration to informative signs through the bushland. Special consideration will need to be given to the potential for vandalism.

5 DISCUSSION

The bushland areas of Pinnaroo Cemetery include some restricted vegetation units. The cemetery has the requirement to expand, but consideration should be given to protecting the restricted vegetation units identified during this survey.

Typically the understorey of the vegetation at Pinnaroo Cemetery is relatively degraded with large areas being replaced by weed taxa, but often the shrub layer is in good to very good condition and the tree layer in excellent condition. This is not uncommon in metropolitan Perth, but at Pinnaroo Cemetery the tree and shrub layers are generally in excellent to very good condition (Government of Western Australia, 2000). In some areas the understorey is still in relatively good condition. As the Pinnaroo Cemetery bushland is also included in Bush Forever as part of the Whitfords Avenue Bushland it increases the size and therefore the viability of this bushland reserve.

The Low Closed Forest of *Banksia prionotes* over Tall Open Scrub dominated by *Melaleuca systema* is a vegetation unit relatively restricted and certainly not recorded in as good a condition elsewhere as at Pinnaroo Cemetery. This vegetation unit should be retained for the restrictedness of its vegetation. The understorey is slightly degraded but with time and effort in removing the weed taxa it could, at a cost, be restored to an acceptable level. However if this vegetation unit is to be restored it will be essential to rehabilitate at the same time the surrounding vegetation to provide a buffer, otherwise the vegetation will degrade back to the present level. More important with this vegetation unit is to remove the exotic trees that have been planted through the area in particular *Eucalyptus caesia* and *E. todtiana*.

The Quindalup Dune on the western side of the cemetery should be retained with a buffer around its eastern edge where limited, sympathetic development could occur. As this is the furthest inland example of this vegetation unit within the Perth Metropolitan Area it is important that its integrity be assured.

Rabbits and possibly kangaroos heavily graze large areas of this vegetation unit. Reducing the number of these animals will be required to ensure its long term survival. Similarly an education of the local land owners and the staff of City of Wanneroo, should be undertaken to ensure they also understand the importance of this vegetation unit and that dumping of rubbish and planting of "pretty" plants does not continue.

Kangaroos are also common in the vegetation on the eastern and southern areas of the cemetery. They are a draw card for visitors to the cemetery but consideration should be given to reducing their numbers. Monitoring of their numbers should indicate the total number there at present. With the ongoing conversion of the bushland for burials and the increase in lawns the area of their natural food will continue to decrease.

Due to the nature of the vegetation through the cemetery bushland only a limited area of the bushland should be developed. This is indicated on Appendix E Figure 5. To ensure the continued structure of the vegetation it is essential that a buffer be retained between the natural vegetation and the developed areas.

With the planning of additional lawn burials and the retention of nodes of bushland amongst the lawn burials, additional plantings should be of taxa native to that particular vegetation unit. This can now be done by using the map of the vegetation within the cemetery and the species list provided. Where incorrect taxa have been planted,

particularly along the road verges and into the bushland these should be replaced by taxa compatible with that vegetation unit.

Care must be taken with the application of fertiliser and water to the developed areas where these abut onto the natural bushland. The retention of sufficient sized buffers will assist with ensuring drift of fertiliser into the bushland does not occur.

An area must be developed for the dumping of excess sand, prunings, lawn and lawn clippings away from the Low Closed Forest of *Banksia prionotes*, vegetation unit. At present these are just dumped away from the public eye, often in bushland areas quite close to this vegetation unit. Only the area indicated for potential extension or the areas currently developed or being developed should be considered.

6 RECOMMENDATIONS

The following recommendations for the protection of the Pinnaroo Cemetery bushland and future development for burials are:

- protect the two restricted vegetation units, the Quindalup Dune and Low Closed Forest of *Banksia prionotes* over Tall Open Scrub dominated by *Melaleuca systema*;
- leave the Low Closed Forest of *Banksia attenuata*, *B. prionotes* with emergent *Eucalyptus gomphocephala* over a shrubland as a buffer between the developed cemetery and the Low Closed Forest of *Banksia prionotes* over a Tall Open Scrub dominated by *Melaleuca systema*;
- leave at least 15m of natural bushland between the protected vegetation and the lawn burial areas or other developments;
- when enhancing the natural vegetation nodes in the lawned areas plant only taxa of the appropriate vegetation unit;
- remove all non-natural trees from the buffer zones between the roads and the natural vegetation;
- reduce the number of walk trails and mark/map the approved ones;
- educate the Town Council workers and the local residents on the importance of the vegetation and how they can assist in its maintenance;
- develop an area for dumping of sand, prunings, lawn and lawn clippings;
- eradicate rabbits;
- monitor the number of kangaroos and maintain at a viable level for the food available.

Action plans should be developed and regularly reviewed for;

- fire prevention and management, in conjunction with the local Fire Brigade and CALM,
- weed control techniques and methods in conjunction with a professional practitioner to ensure the correct spray and/or techniques are applied,
- rehabilitation methods, including ground preparation, seeding and planting techniques,
- seed collection and storage as well as
- monitoring and accepted treatment methods for dieback.

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APPENDIX A

List of taxa recorded from Pinnaroo Cemetery

FAMILY	TAXON	COMMON NAME
ZAMIACEAE	<i>Macrozamia riedlei</i>	Zamia
CUPRESSACEAE	<i>Callitris preissii</i> subsp. <i>preissii</i>	Rottneest island pine
JUNCAGINACEAE	<i>Triglochin calcitrapa</i>	
POACEAE	* <i>Aira caryophyllea</i>	
	<i>Austrodanthonia occidentalis</i>	
	<i>Austrostipa</i> sp.	
	* <i>Avena barbata</i>	Wild oats
	* <i>Briza maxima</i>	Blowfly grass
	* <i>Briza minor</i>	
	* <i>Bromus diandrus</i>	
	* <i>Ehrharta calycina</i>	Perennial veldt grass
	* <i>Ehrharta longiflora</i>	Annual veldt grass
	* <i>Eragrostis curvula</i>	African love grass
	* <i>Lagurus ovatus</i>	Hare's tail grass
	* <i>Lolium rigidum</i>	
	<i>Poa serpentum</i>	
	* <i>Vulpia</i> sp.	Fescue
CYPERACEAE	<i>Isolepis marginatus</i>	
	<i>Isolepis nodosa</i>	Knotted club rush
	<i>Lepidosperma angustatum</i>	
	<i>Lepidosperma gladiatum</i>	Coast sword-sedge
	<i>Lepidosperma leptostachyum</i>	
	<i>Lepidosperma squamatum</i>	
	<i>Lepidosperma tenue</i>	
	<i>Mesomelaena pseudostygia</i>	
	<i>Schoenus clandestinus</i>	
	<i>Schoenus grandiflorus</i>	Large flowered bog-rush
	<i>Tetraria octandra</i>	
RESTIONACEAE	<i>Desmocladius flexuosus</i>	
CENTROLEPIDACEAE	<i>Centrolepis drummondii</i>	
PHORMIACEAE	<i>Dianella revoluta</i>	Blue flax-lily
ANTHERICACEAE	<i>Corynotheca micrantha</i>	Sand lily
	<i>Sowerbaea laxiflora</i>	
	<i>Thysanotus arbuscula</i>	
	<i>Thysanotus manglesianus</i>	Fringed lily
	<i>Thysanotus multiflorus</i>	
	<i>Tricoryne elatior</i>	Autumn lily
ASPHODELACEAE	* <i>Trachyandra divaricata</i>	Dune onion weed
DASYPOGONACEAE	<i>Acanthocarpus preissii</i>	
	<i>Lomandra caespitosa</i>	Tufted mat-rush
	<i>Lomandra hermaphrodita</i>	
	<i>Lomandra maritima</i>	
	<i>Lomandra preissii</i>	
	<i>Lomandra suaveolens</i>	
HYACINTHACEAE	* <i>Lachenalia reflexa</i>	Soldiers
XANTHORRHOEACEAE	<i>Xanthorrhoea brunonis</i> subsp. <i>brunonis</i>	
	<i>Xanthorrhoea preissii</i>	Gras-tree
COLCHICACEAE	<i>Burchardia umbellata</i>	

FAMILY	TAXON	COMMON NAME
HAEMODORACEAE	<i>Anigozanthos humilis</i> subsp. <i>humilis</i>	Cats paw
	<i>Conostylis aculeata</i> subsp. <i>bracteata</i>	Prickly conostylis
	<i>Conostylis candicans</i>	Grey cottonhead
	<i>Conostylis juncea</i>	
AGAVACEAE	<i>Haemodorum laxum</i>	Bloodroot
	* <i>Agave americana</i>	
IRIDACEAE	* <i>Freesia</i> hybrid	Freesia
	* <i>Gladiolus caryophyllaceus</i>	Pink gladiolus
	* <i>Homeria flaccida</i>	One leaf cape tulip
	<i>Orthrosanthus laxus</i>	Morning iris
	<i>Patersonia occidentalis</i>	Purple flag
	* <i>Romulea rosea</i>	Guildford grass
	<i>Caladenia flava</i>	Cowslip orchid
ORCHIDACEAE	<i>Caladenia georgei</i>	
	<i>Caldenia latifolia</i>	
	<i>Caladenia</i> sp.	
	<i>Cyanicula deformis</i>	Blue orchid
	<i>Diuris corymbosus</i>	
	<i>Diuris magnifica</i>	
	<i>Elythranthera brunonis</i>	
	<i>Prasophyllum hians</i>	
	<i>Pterostylis vittata</i>	Greenhood orchid
	<i>Pyrorchis nigricans</i>	Potato orchid
	CASUARINACEAE	<i>Allocasuarina fraseriana</i>
<i>Allocasuarina humilis</i>		Scrub sheoak
* <i>Casuarina obesa</i>		Bulloak
PROTEACEAE	<i>Banksia attenuata</i>	Narrow leaf banksia
	<i>Banksia grandis</i>	Bull banksia
	<i>Banksia menziesii</i>	Firewood banksia
	<i>Banksia prionotes</i>	Acorn banksia
	<i>Dryandra lindleyana</i> subsp. <i>lindleyana</i>	Couch honeypot
	<i>Dryandra sessilis</i>	
	<i>Grevillea crithmifolia</i>	
	<i>Grevillea vestita</i>	
	<i>Hakea lissocarpa</i>	Honey bush
	<i>Hakea prostrata</i>	Harsh hakea
	<i>Hakea trifurcata</i>	
	<i>Persoonia saccata</i>	Snottygobble
	<i>Petrophile linearis</i>	Pixie mops
	<i>Petrophile macrostachya</i>	
<i>Stirlingia latifolia</i>	Blueboy	
SANTALACEAE	<i>Synaphea spinulosa</i> subsp. <i>spinulosa</i>	Pinda
	<i>Exocarpos sparteus</i>	Broom ballart
LORANTHACEAE	<i>Santalum acuminatum</i>	Quandong
CHENOPODIACEAE	<i>Nuytsia floribunda</i>	Christmas tree
AMARANTHACEAE	<i>Rhagodia baccata</i> subsp. <i>baccata</i>	Berry saltbush
	<i>Ptilotus drummondii</i>	
GYROSTEMONACEAE	<i>Ptilotus polystachyus</i>	Green mullamulla
	<i>Gyrostemon ramulosus</i>	Camel poison

FAMILY	TAXON	COMMON NAME
	<i>Tersonia cyathiflora</i>	
AIZOACEAE	* <i>Carpobrotus edulis</i>	Hottentot fig
PORTULACACEAE	<i>Calandrinia cryptrata</i>	
CARYOPHYLLACEAE	* <i>Cerastium glomeratum</i>	
	* <i>Minuartia mediterraneum</i>	
	* <i>Petrorhagia velutina</i>	Velvet pink
	* <i>Silene gallica</i>	French catchfly
	* <i>Stellaria media</i>	Common chickweed
RANUNCULACEAE	<i>Clematis linearifolia</i>	Slender clematis
LAURACEAE	<i>Cassytha flava</i>	Dodder laurel
	<i>Cassytha racemosa</i>	
FUMARIACEAE	<i>Fumaria capreolata</i>	
BRASSICACEAE	* <i>Brassica rapa</i>	
	* <i>Brassica tournefortii</i>	Wild turnip
	* <i>Heliophila pusilla</i>	
DROSERACEAE	<i>Drosera erythrorhiza</i>	Red ink sundew
	<i>Drosera macrantha</i>	
	<i>Drosera menziesii</i>	Pink rainbow
	<i>Drosera pallida</i>	Pale rainbow
	<i>Drosera</i> sp.	Sundew
CRASSULACEAE	<i>Crassula colorata</i> subsp. <i>colorata</i>	
	<i>Crassula glomerata</i>	
MIMOSACEAE	<i>Acacia cyclops</i>	Coastal wattle
	<i>Acacia lasiocarpa</i>	
	<i>Acacia pulchella</i> subsp. <i>glaberrima</i>	
	<i>Acacia rostellifera</i>	Summer scented wattle
	<i>Acacia saligna</i>	Orange wattle
	<i>Acacia willdenowiana</i>	Grass wattle
PAPILIONACEAE	<i>Daviesia divaricata</i>	Mano
	<i>Daviesia incrassata</i> subsp. <i>incrassata</i>	
	<i>Daviesia nudiflora</i>	
	<i>Daviesia triflora</i>	
	<i>Gompholobium tomentosum</i>	Hairy yellow pea
	<i>Hardenbergia comptoniana</i>	Native wisteria
	<i>Hovea trisperma</i> var. <i>trisperma</i>	Common hovea
	<i>Isotropis cuneifolia</i>	Grannys bonnets
	<i>Jacksonia furcellata</i>	Grey stinkwood
	<i>Jacksonia sternbergiana</i>	Stinkwood
	<i>Kennedia prostrata</i>	Running postman
	* <i>Lupinus consentinii</i>	Western Australian blue lupin
	* <i>Medicago polymorpha</i>	Medic
	* <i>Melilotus indica</i>	
	<i>Nemcia capitata</i>	
	<i>Templetonia retusa</i>	Cocky's tongues
	* <i>Trifolium arvense</i>	
	* <i>Trifolium campestre</i>	Hopclover
	* <i>Trifolium dubium</i>	
	* <i>Trifolium glomeratum</i>	
	* <i>Vigna sativa</i> .	Vetch

FAMILY	TAXON	COMMON NAME
GERANIACEAE	<i>*Erodium botrys</i>	Corkscrews
	<i>*Erodium cicutarium</i>	
	<i>Geranium retrorsum</i>	
	<i>*Pelargonium capitatum</i>	Rose pelargonium
	<i>Pelargonium littorale</i>	
OXALIDACEAE	<i>*Oxalis pes-caprae</i>	Soursob
RUTACEAE	<i>Philotheca spicatus</i>	Pepper and salt
EUPHORBIACEAE	<i>*Euphorbia peplus</i>	
	<i>*Euphorbia terracina</i>	Geraldton carnation weed
	<i>Monotaxis grandiflora</i>	
	<i>Phyllanthus calycinus</i>	False boronia
	<i>Poranthera microphylla</i>	
STACKHOUSIACEAE	<i>Ricinocarpus glaucus</i>	Wedding bush
RHAMNACEAE	<i>Tripterococcus brunonis</i>	
	<i>Spyridium globulosum</i>	Basket bush
	<i>Stenanthemum notiale</i> subsp. <i>chamelum</i>	
DILLENIACEAE	<i>Trymalium ledifolium</i> subsp. <i>ledifolium</i>	
	<i>Hibbertia cuneiformis</i>	Cutleaf hibbertia
	<i>Hibbertia hypericoides</i>	Yellow buttercups
	<i>Hibbertia racemosa</i>	Stalked guinea flower
	<i>Hibbertia subvaginata</i>	
VIOLACEAE	<i>Hybanthus calycinus</i>	Wild violet
THYMELAEACEAE	<i>Pimelea leucantha</i>	Banjine
	<i>Pimelea sulphurea</i>	Yellow banjine
MYRTACEAE	<i>Calothamnus quadrifidus</i>	One-sided bottlebrush
	<i>*Chamelaucium uncinatum</i>	Geraldton wax
	<i>Eremaea fimbriata</i>	
	<i>Eucalyptus gomphocephala</i>	Tuart
	<i>Eucalyptus marginata</i> subsp. <i>marginata</i>	Jarrah
	<i>Eucalyptus todtiana</i>	Prickly bark
	<i>Hypocalymma robustum</i>	Swan River myrtle
	<i>Melaleuca huegelii</i> subsp. <i>huegelii</i>	Chenille honeymyrtle
	<i>Melaleuca systema</i>	Coast honeymyrtle
	<i>Daucus glochidiatus</i>	Australian carrot
APIACEAE	<i>Erygium pinnatifidum</i> subsp. <i>pinnatifidum</i>	Blue devils
	<i>*Foeniculum vulgare</i>	
	<i>Trachymene pilosa</i>	
EPACRIDACEAE	<i>Xanthosia huegelii</i>	
	<i>Astroloma pallidum</i>	Kickbush
	<i>Conostephium pendulum</i>	Pearl flower
	<i>Leucopogon parviflorus</i>	Coast beardheath
	<i>Leucopogon propinquus</i>	
PRIMULACEAE	<i>*Anagallis arvensis</i>	Pimpernel
LAMIACEAE	<i>Hemiantra pungens</i>	Snake bush
	<i>*Marrubium vulgare</i>	
SOLANACEAE	<i>Anthocercis littorea</i>	Slender tail flower
	<i>*Solanum nigrum</i>	Blueberry nightshade
SCROPHULARIACEAE	<i>*Dischismus arenarius</i>	
OROBANCHACEAE	<i>*Orobanche minor</i>	Lesser Broomrape

FAMILY	TAXON	COMMON NAME
MYOPORACEAE	<i>Eremophila glabra</i>	Tar bush
	<i>Myoporum insulare</i>	Boobialla
RUBIACEAE	<i>Opercularia vaginata</i>	Dogweed
GOODENIACEAE	<i>Lechenaultia linarioides</i>	Yellow leschenaultia
	<i>Scaevola repens</i> subsp. <i>repens</i>	Grey scaevola
	<i>Scaevola canescens</i>	
	<i>Scaevola thesioides</i> subsp. <i>thesioides</i>	
STYLIDIACEAE	<i>Levenhookia stipitata</i>	Common stylewort
	<i>Stylidium amoenum</i>	Lovely triggerplant
	<i>Stylidium brunonianum</i>	
	<i>Stylidium calcaratum</i>	
ASTERACEAE	* <i>Arctotheca calendula</i>	Capeweed
	* <i>Arctotis stoechadifolia</i>	White arctotis
	* <i>Conyza bonariensis</i>	Flaxleaf fleabane
	* <i>Cotula turbinatas</i>	
	* <i>Dimorphotheca ecklonis</i>	Veldt daisy
	* <i>Gazania linearis</i>	Gazania
	<i>Helichrysum cordatum</i>	
	* <i>Hypochaeris glabra</i>	Flatweed
	<i>Lagenifera huegelii</i>	Coarse lagenifera
	<i>Olearia axillaris</i>	Coastal daisybush
	* <i>Osteospermum clandestinum</i>	Stinking roger
	<i>Podolepis gracilis</i>	
	<i>Quinetia urvellei</i>	
	<i>Senecio lautus</i>	
* <i>Sonchus oleraceus</i>	Sowthistle	
* <i>Ursinia anthemoides</i>	Ursinia	

APPENDIX B

Total taxa recorded for the different vegetation units

Abbreviation	Vegetation Description
EgHl	Woodland of <i>Eucalyptus gomphocephala</i> and <i>Banksia attenuata</i> over an Open Heath dominated by <i>Hakea lissocarpa</i> and Closed Herbland.
EgXp	Open Forest of <i>Eucalyptus gomphocephala</i> , <i>Nuytsia floribunda</i> and <i>Allocasuarina fraseriana</i> over an Open Shrubland of <i>Xanthorrhoea preissii</i> and Herbland
EmBa	Open Forest of <i>Eucalyptus marginata</i> subsp. <i>marginata</i> and <i>Banksia attenuata</i> over a Shrubland dominated by <i>Xanthorrhoea preissii</i> and Sedgeland
EmBaBmAf	Low Open Forest of <i>Banksia attenuata</i> , <i>B. menziesii</i> , <i>Eucalyptus marginata</i> subsp. <i>marginata</i> and <i>Allocasuarina fraseriana</i> over an Open Heath dominated by <i>Xanthorrhoea preissii</i> and Herbland/Sedgeland.
MsAl	Open Low Heath dominated by <i>Melaleuca systema</i> and <i>Acacia lasiocarpa</i> over Herbland and Grassland.
EgBp	Woodland of <i>Eucalyptus gomphocephala</i> and/or <i>Banksia prionotes</i> over Shrubland dominated by <i>Acacia lasiocarpa</i> and Open Sedgeland/Grassland/Herbland
BpMs	Low Closed Forest of <i>Banksia prionotes</i> over Tall Open Scrub dominated by <i>Melaleuca systema</i> over a Closed Grassland
BaBpEg	Low Closed Forest of <i>Banksia attenuata</i> , <i>B. prionotes</i> with emergent <i>Eucalyptus gomphocephala</i> over a shrubland dominated by <i>Xanthorrhoea preissii</i> and Sedgeland/Grassland.

TAXA	FLORISTIC COMMUNITY TYPES								
	28			29b			Transitional		
	EgHl	EgXp	EmBa	EmBaBm	AfMsAl	EgBp	BpMs	BaBp	Eg
<i>Acacia cyclops</i>	✓	✓	✓				✓	✓	✓
<i>Acacia lasiocarpa</i>			✓			✓	✓	✓	✓
<i>Acacia pulchella</i> var. <i>glaberrima</i>			✓						
<i>Acacia rostellifera</i>		✓		✓					✓
<i>Acacia saligna</i>	✓		✓	✓	✓	✓	✓	✓	✓
<i>Acacia willdenowiana</i>			✓						✓
<i>Acanthocarpus preissii</i>	✓		✓	✓	✓	✓	✓	✓	✓
* <i>Agave americana</i> var. <i>americana</i>						✓			
* <i>Aira caryophyllea</i>	✓	✓	✓	✓					
<i>Allocasuarina fraseriana</i>		✓	✓	✓					
<i>Allocasuarina humilis</i>			✓						
* <i>Anagallis arvensis</i> var. <i>arvensis</i>	✓		✓	✓		✓	✓	✓	
<i>Anigozanthos humilis</i> subsp. <i>humilis</i>				✓					
<i>Anthocercis littorea</i>				✓	✓	✓			
* <i>Arctotheca calendula</i>		✓	✓			✓		✓	✓
* <i>Arctotis stoechadifolia</i>						✓			
<i>Astroloma pallidum</i>			✓						
<i>Austrodanthonia occidentalis</i>			✓						
<i>Austrostipa</i> sp.					✓	✓			
* <i>Avena barbata</i>					✓	✓	✓	✓	
<i>Banksia attenuata</i>	✓		✓	✓					✓
<i>Banksia grandis</i>	✓	✓	✓	✓					
<i>Banksia menziesii</i>			✓	✓					✓
<i>Banksia prionotes</i>					✓	✓	✓	✓	
* <i>Brassica rapa</i>		✓							
* <i>Brassica tournefortii</i>	✓				✓	✓			
* <i>Briza maxima</i>			✓	✓					✓
* <i>Briza minor</i>			✓	✓					
* <i>Bromus diandrus</i>					✓	✓			
<i>Burchardia umbellata</i>			✓	✓					
<i>Caladenia flava</i>			✓	✓			✓		
<i>Caladenia georgei</i>			✓	✓					✓
<i>Caladenia latifolia</i>			✓	✓	✓	✓	✓	✓	
<i>Caladenia longicauda</i> subsp. <i>calcigena</i>				✓					
<i>Caladenia</i> sp.			✓				✓		
<i>Calandrinia calyptrata</i>						✓			
<i>Callitris preissii</i> subsp. <i>preissii</i>	✓					✓	✓	✓	
<i>Calothamnus quadrifidus</i>				✓					
* <i>Carpobrotus edulis</i>	✓		✓	✓	✓	✓	✓	✓	✓
<i>Cassylia flava</i>					✓	✓			
<i>Cassylia racemosa</i>					✓	✓			
* <i>Casuarina obesa</i>						✓			
<i>Centropis drummondii</i>			✓						
* <i>Cerastium glomeratum</i>			✓						
* <i>Chamaelucium uncinatum</i>		✓				✓			
<i>Clematis linearifolia</i>						✓			
<i>Conostephium pendulum</i>			✓						
<i>Conostylis aculeata</i> subsp. <i>bracteata</i>			✓	✓		✓	✓	✓	

TAXA	FLORISTIC COMMUNITY TYPES							
	28				29b		Transitional	
	EgHl	EgXp	EmBa	EmBaBmAf	MsAl	EgBp	BpMs	BaBpEg
<i>Conostylis candicans</i>			✓			✓	✓	
<i>Conostylis juncea</i>						✓	✓	
* <i>Conyza bonariensis</i>			✓	✓			✓	✓
<i>Corynotheca micrantha</i>	✓		✓	✓				
* <i>Cotula turbinata</i>				✓				
<i>Crassula colorata</i> var. <i>colorata</i>			✓	✓		✓		
<i>Crassula glomerata</i>					✓			
<i>Cyanicula deformis</i>				✓				
<i>Daucus glochidiatus</i>			✓			✓		✓
<i>Daviesia divaricata</i>			✓	✓			✓	
<i>Daviesia incrassata</i> subsp. <i>incrassata</i>			✓					✓
<i>Daviesia nudiflora</i>			✓					✓
<i>Daviesia triflora</i>			✓		✓		✓	✓
<i>Desmocladius flexuosus</i>	✓	✓	✓	✓	✓	✓		✓
<i>Dianella revoluta</i>			✓			✓	✓	✓
* <i>Dimorphotheca ecklonis</i>							✓	✓
* <i>Dischismus arenarium</i>						✓		✓
<i>Diuris corymbosa</i>			✓	✓				✓
<i>Diuris magnifica</i>				✓				
<i>Drosera erythrorhiza</i>		✓	✓	✓				✓
<i>Drosera macrantha</i>			✓	✓				
<i>Drosera menziesii</i>				✓				
<i>Drosera pallida</i>	✓		✓	✓				✓
<i>Drosera</i> sp.								✓
<i>Dryandra lindleyana</i> subsp. <i>lindleyana</i>	✓				✓			
<i>Dryandra sessilis</i>					✓			
* <i>Ehrharta calycina</i>			✓					✓
* <i>Ehrharta longiflora</i>	✓	✓	✓		✓	✓		✓
<i>Elythranthera brunonis</i>			✓					
* <i>Eragrostis curvula</i>						✓		
<i>Eremaea asterocarpa</i> subsp. <i>asterocarpa</i>				✓				
<i>Eremophila glabra</i>					✓	✓		
* <i>Erodium botrys</i>		✓		✓				✓
* <i>Erodium cicutarium</i>						✓		
<i>Eryngium pinnatifidum</i> subsp. <i>pinnatifidum</i>			✓					
<i>Eucalyptus gomphocephala</i>	✓	✓	✓	✓	✓	✓		✓
<i>Eucalyptus marginata</i> subsp. <i>marginata</i>		✓	✓	✓				✓
<i>Eucalyptus todtiana</i>							✓	
* <i>Euphorbia pepplus</i>						✓		✓
* <i>Euphorbia terracina</i>	✓	✓			✓	✓		
<i>Exocarpos sparteus</i>	✓			✓	✓	✓		
* <i>Foeniculum vulgare</i>						✓		
* <i>Freesia hybrid</i>			✓			✓		✓
* <i>Fumaria capreolata</i>						✓		
* <i>Gazania linearis</i>						✓		
<i>Geranium retrorsum</i>	✓					✓		
* <i>Gladiolus caryophyllaceus</i>			✓					✓
<i>Gompholobium tomentosum</i>			✓	✓	✓	✓		✓
<i>Grevillea crithmifolia</i>					✓	✓	✓	✓

TAXA	FLORISTIC COMMUNITY TYPES							
	28				29b		Transitional	
	EgHl	EgXp	EmBa	EmBaBmAf	MsAl	EgBp	BpMs	BaBpEg
<i>Grevillea vestita</i> subsp. <i>vestita</i>			✓	✓	✓			✓
<i>Gyrostemon ramulosus</i>						✓		
<i>Haemodorum paniculatum</i>								✓
<i>Hakea lissocarpa</i>	✓	✓	✓	✓	✓			✓
<i>Hakea prostrata</i>			✓	✓	✓		✓	✓
<i>Hakea trifurcata</i>								✓
<i>Hardenbergia comptoniana</i>		✓	✓	✓	✓	✓		✓
* <i>Heliophila pusilla</i>	✓	✓		✓	✓	✓	✓	
<i>Hemiandra pungens</i>					✓	✓		
<i>Hibbertia cuneiformis</i>	✓		✓	✓				✓
<i>Hibbertia hypericoides</i>	✓		✓	✓				
<i>Hibbertia racemosa</i>		✓	✓	✓	✓			
<i>Hibbertia subvaginata</i>				✓	✓			
* <i>Homeria flaccida</i>	✓	✓		✓	✓		✓	✓
<i>Hovea trisperma</i> var. <i>trisperma</i>			✓	✓				✓
<i>Hybanthus calycinus</i>	✓		✓	✓	✓			
<i>Hypocalymma robustum</i>			✓					
* <i>Hypochaeris glabra</i>		✓	✓	✓				✓
<i>Isolepis marginata</i>	✓							✓
<i>Isotropis cuneifolia</i>			✓	✓	✓			
<i>Jacksonia furcellata</i>				✓				✓
<i>Jacksonia sternbergiana</i>			✓	✓				
<i>Kennedia prostrata</i>			✓	✓	✓	✓	✓	✓
* <i>Lachenalia reflexa</i>	✓	✓	✓	✓				✓
<i>Lagenophora huegelii</i>			✓	✓				✓
* <i>Lagurus ovatus</i>					✓	✓		✓
<i>Lechenaultia linarioides</i>	✓							
<i>Lepidosperma gladiatum</i>					✓	✓		
<i>Lepidosperma leptostachyum</i>			✓					
<i>Lepidosperma squamatum</i>			✓		✓	✓		
<i>Lepidosperma tenue</i>								✓
<i>Leucopogon parviflorus</i>					✓	✓	✓	
<i>Leucopogon propinquus</i>	✓	✓	✓	✓				✓
<i>Levenhookia stipitata</i>					✓			
* <i>Lolium rigidum</i>					✓			
<i>Lomandra caespitosa</i>	✓		✓			✓		
<i>Lomandra hermaphrodita</i>						✓		
<i>Lomandra maritima</i>			✓		✓	✓	✓	
<i>Lomandra preissii</i>			✓	✓				✓
<i>Lomandra suaveolens</i>	✓		✓		✓			
* <i>Lupinus consentinii</i>	✓			✓		✓		
<i>Macrozamia riedlei</i>	✓	✓	✓			✓		✓
* <i>Marrubium vulgare</i>					✓			
* <i>Medicago polymorpha</i>	✓	✓			✓			
<i>Melaleuca huegelii</i> subsp. <i>huegelii</i>					✓		✓	
<i>Melaleuca systema</i>			✓	✓	✓	✓	✓	✓
* <i>Melilotus indicus</i>	✓							
<i>Mesomelaena pseudostygia</i>	✓		✓	✓				✓
* <i>Minuartia mediterranea</i>						✓		

TAXA	FLORISTIC COMMUNITY TYPES									
	28					29b		Transitional		
	EgHl	EgXp	EmBa	EmBaBmAf	MsAl	EgBp	BpMs	BaBp	Eg	
<i>Monotaxis grandiflora</i>						✓				
<i>Myoporum insulare</i>					✓	✓				
<i>Nemcia capitata</i>			✓	✓						
<i>Nuytsia floribunda</i>		✓								
<i>Olearia axillaris</i>			✓		✓	✓				
<i>Opercularia vaginata</i>					✓	✓				
<i>Prasophyllum</i> sp.			✓			✓				
<i>Orobanche minor</i>						✓				
<i>Orthrosanthos laxus</i> var. <i>laxus</i>	✓			✓						
* <i>Osteospermum clandestinum</i>		✓					✓			
* <i>Oxalis pes-caprae</i>			✓							
<i>Ozothamnus cordatum</i>			✓							
<i>Patersonia occidentalis</i>				✓						
* <i>Pelargonium capitatum</i>			✓	✓	✓	✓	✓	✓		
<i>Pelargonium littorale</i>	✓									
<i>Persoonia saccata</i>			✓						✓	
<i>Petrophile linearis</i>			✓							
<i>Petrophile macrostegia</i>			✓						✓	
* <i>Petrorhagia velutina</i>	✓	✓	✓	✓	✓	✓	✓	✓	✓	
<i>Philotheca spicatus</i>			✓							
<i>Phyllanthus calycinus</i>		✓	✓			✓				
<i>Pimelea leucantha</i>	✓		✓							
<i>Pimelea sulphurea</i>									✓	
<i>Poa serpentum</i>						✓				
<i>Podolepis gracilis</i>			✓							
<i>Poranthera microphylla</i>						✓				
<i>Prasophyllum hians</i>			✓							
<i>Pterostylis vittata</i>			✓		✓				✓	
<i>Ptilotus drummondii</i>			✓							
<i>Ptilotus polystachyus</i>			✓				✓	✓		
<i>Pyrorchis nigricans</i>			✓	✓				✓		
<i>Quinetia urvillei</i>			✓							
<i>Rhagodia baccata</i> subsp. <i>baccata</i>	✓	✓		✓	✓	✓	✓			
<i>Ricinocarpus glaucus</i>	✓		✓	✓			✓	✓		
* <i>Romulea rosea</i>	✓				✓	✓	✓	✓		
<i>Santalum acuminatum</i>					✓	✓				
<i>Scaevola canescens</i>			✓	✓					✓	
<i>Scaevola repens</i> var. <i>repens</i>					✓					
<i>Scaevola thesioides</i> var. <i>thesioides</i>					✓	✓				
<i>Schoenus clandestinus</i>			✓	✓					✓	
<i>Schoenus grandiflorus</i>					✓	✓	✓	✓		
<i>Senecio lautus</i>						✓				
* <i>Silene gallica</i>			✓	✓						
* <i>Solanum nigrum</i>	✓			✓					✓	
* <i>Sonchus oleraceus</i>	✓		✓	✓		✓	✓	✓		
<i>Sowerbaea laxiflora</i>		✓	✓						✓	
<i>Spyridium globulosum</i>						✓			✓	
* <i>Stellaria media</i>				✓		✓			✓	
<i>Stenanthemum notiale</i> subsp. <i>chamelum</i>			✓							

TAXA	FLORISTIC COMMUNITY TYPES							
	28				29b		Transitional	
	EgHl	EgXp	EmBa	EmBaBmAf	MsAl	EgBp	BpMsBaBpEg	
<i>Stenanthemum tridentatum</i>			✓					
<i>Stirlingia latifolia</i>								✓
<i>Stylidium amoenum</i>				✓				
<i>Stylidium brunonianum</i>			✓	✓				
<i>Stylidium calcaratum</i>			✓					
<i>Synaphea spinulosa</i> subsp. <i>spinulosa</i>			✓					
<i>Templetonia retusa</i>						✓		
<i>Tersonia cyathiflora</i>					✓	✓		
<i>Tetraria octandra</i>			✓					✓
<i>Thysanotus arbuscula</i>					✓			
<i>Thysanotus manglesianus</i>			✓	✓		✓		✓
<i>Thysanotus multiflorus</i>			✓					
* <i>Trachyandra divaricata</i>				✓	✓	✓		
<i>Trachymene pilosa</i>			✓	✓		✓		✓
<i>Tricoryne elatior</i>			✓					✓
* <i>Trifolium arvense</i>		✓						
* <i>Trifolium campestre</i>	✓	✓	✓	✓			✓	✓
* <i>Trifolium dubium</i>			✓					✓
* <i>Trifolium glomeratum</i>				✓				
<i>Triglochin calcitrapum</i>						✓		
<i>Tripterococcus brunonis</i>			✓					
<i>Trymalium ledifolium</i> var. <i>ledifolium</i>					✓			
* <i>Ursinia anthemoides</i>		✓	✓	✓	✓		✓	
* <i>Vigna sativa</i>		✓	✓	✓	✓		✓	✓
* <i>Vulpia myuros</i>		✓	✓	✓				
<i>Waitzia suaveolens</i>			✓					
<i>Xanthorrhoea brunonis</i>				✓				
<i>Xanthorrhoea preissii</i>	✓	✓	✓	✓				✓
<i>Xanthosia huegelii</i>			✓					
Total	47	37	124	90	69	87	41	90

APPENDIX C

Quadrat Data

Cover (1) = data from the first survey, 4th and 5th July 2001
Cover (2) = data from the second survey, 12th September 2001

FLORA DATA SHEETS

Project: MFP -	Date: 4 th July 2001	Surveyors: EB & JB
Location: To the east of Myles Road at northern end of Midland Cemetery SITE P1		
Aerial Photograph: N/A		
DATUM: Site 1 Site 2 Site 3 Site 4 Site 5 Site 6	Easting 50 384 560	Northing 648 1012
Soil type: Sand <input checked="" type="checkbox"/> :silt : clay Colour Grey, yellow below	Rocks: (average size) N/A	Outcropping Type and percentage N/A
Litter Bark %; Leaves 5 % Twigs 5 %; Logs 5 %	Topography: Br; R; US; MS; LS; DL; MIC; MAC Aspect: NE	Film No: Photo No. 1
Percentage cover of strata (for quadrat) Trees 40 %; Shrubs >2m %; Shrubs 1-2m 81 %; Shrubs <1m %; Herbs 87 %; Grasses %; Bare Ground 5 %		
Vegetation Description: Open Woodland of Eucalyptus gomphocephala, Banksia attenuata over Hakea lissocarpha and other shrubs		
Condition: 3-4		
Rare or Priority Flora:		
Other Notes: Dieback/Age since fire/ Predators/Erosion/Weeds/Tracks/Position in cemetery. Very weedy. Difficult to find a good site in which to put the quadrat. Weeds about 50%. Near the interzone to the jarrah woodland but no jarrah in this area. Cape Tulip is the dominant weed. Edge of road around cemetery has been cleared at least 10m into the bushland area. Exotic trees also planted.		

Colln No	Taxon	Fl Colour	Ht (cm)	% Cover(1)	% Cover (2)
P1-7	<i>Acacia cyclops</i>		20	<1	<1
	<i>Acacia saligna</i>	Bright yellow	300	5	5
	<i>Acanthocarpus preissii</i>	Pale yellow	100	15	15
	* <i>Anagallis arvensis</i> var. <i>arvensis</i>	Blue	15		<1
	<i>Banksia attenuata</i>		600	5	5
	* <i>Brassica tournefortii</i>	Yellow	45		<1
	* <i>Carpobrotus edulis</i>	Wellow-pink	10	20	20
	<i>Desmocladius flexuosus</i>	Brown	15	<1	<1
	<i>Drosera pallida</i>	White	T	<1	<1
	* <i>Ehrharta longiflora</i>	Green	30		1
	<i>Eucalyptus gomphocephala</i>		2000	35	35
	* <i>Euphorbia terracina</i>	Yellow	70	15	45
	<i>Hakea lissocarpa</i>		150	40	40
	* <i>Heliophila pusilla</i>	White	20		4
	<i>Hibbertia hypericoides</i>	Yellow	35	5	5
P1-1	* <i>Lachenalia reflexa</i>	Yellow	15	15	15
	<i>Lechenaultia linarioides</i>	Yellow/red	35	<1	<1
	* <i>Lupinus consentinii</i>		5	2	0
	* <i>Medicago polymorpha</i>	Yellow	3	10	10
	* <i>Melilotus indica</i>	Yellow	30		2
P1-2	* <i>Homeria flaccida</i>	Orange	30	15	30
P1-4	<i>Pelargonium littorale</i>		10	1	1
	* <i>Petrorhagia velutina</i>	Pink	15		2
	<i>Pimelea leucantha</i>	White	70	3	3
	<i>Rhagodia baccata</i> subsp. <i>baccata</i>	white	100	5	5
	<i>Ricinocarpus glaucus</i>	White	40		1
	* <i>Romulea rosea</i>	Pink	20		1
	* <i>Solanum nigrum</i>	White	5	<1	<1
	* <i>Sonchus oleraceus</i>		25		<1
	<i>Xanthorrhoea preissii</i>		90	8	8

12th September 2001 Survey - Lower storey cover 100% weeds



Quadrat P1

FLORA DATA SHEETS

Project: MFP -		Date: 4 th July 2001	Surveyors: EB & JB
Location: SITE P2			
Aerial Photograph: N/A			
DATUM:	Easting	Northing	
Site 1	50 384 542	648 1117	
Site 2			
Site 3			
Site 4			
Site 5			
Site 6			
Soil type:	Rocks: (average size)	Outcropping	
Sand <input checked="" type="checkbox"/> : silt : clay	N/A	Type and percentage N/A	
Colour Yellow brown			
Litter	Topography: Br; R; US; MS;	Film No:	
Bark %; Leaves 10 %	LS; DL; MIC; MAC	Photo No. 2	
Twigs 5 %; Logs 5 %	Aspect: NE		
Percentage cover of strata (for quadrat)			
Trees 55 %; Shrubs >2m %; Shrubs 1-2m 4 %; Shrubs <1m %;			
Herbs 73 %; Grasses %; Bare Ground 5 %			
Vegetation Description:			
Open woodland of tuart, <i>Allocasuarina fraseriana</i> , <i>Nuytsia floribunda</i> over <i>Xanthorrhoea preissii</i>			
Condition:			
4-5			
Rare or Priority Flora:			
Other Notes: Dieback/Age since fire/ Predators/Erosion/Weeds/Tracks/Position in cemetery. Adjacent to a shed on the NE side.			

Colln No	Taxon	Fl Colour	Ht (cm)	% Cover(1)	% Cover (2)
	<i>Acacia cyclops</i>		40	<1	<1
	<i>Allocasuarina fraseriana</i>		1100	10	10
	<i>Desmocladius flexuosus</i>	Brown	15		1
	* <i>Ehrharta longiflora</i>	Green	15	40	10
	<i>Eucalyptus gomphocephala</i>		1000	25	25
	* <i>Euphorbia terracina</i>	Yellow	70	3	5
P1-2	* <i>Homeria flaccida</i>	Orange	30	10	10
P1-1	* <i>Lachenalia reflexa</i>	Yellow	15	20	40
	<i>Macrozamia riedlei</i>		15		<1
	<i>Nuytsia floribunda</i>		1000	20	20
	* <i>Petrorhagia velutina</i>	Pink	15		1
	<i>Rhagodia baccata</i> subsp. <i>baccata</i>	White/red berry	60	1	1
	* <i>Trifolium campestre</i>	Yellow	20		5
	* <i>Ursinia anthemoides</i>	Yellow	25	<1	1
	<i>Xanthorrhoea preissii</i>		120	2	2

12th September 2001 Survey – Quadrat had been heavily grazed



Quadrat P2

FLORA DATA SHEETS

Project: MFP -	Date: 4 th July 2001	Surveyors: EB & JB
Location: SITE P3		
Aerial Photograph: N/A		
DATUM: Site 1 Site 2 Site 3 Site 4 Site 5 Site 6	Easting 50 384 674	Northing 648 0503
Soil type: Sand <input checked="" type="checkbox"/> :silt : clay Colour Yellow	Rocks: (average size) N/A	Outcropping Type and percentage N/A
Litter Bark %; Leaves 85 % Twigs 3 %; Logs %	Topography: Br; R; US; MS; LS; DL; MIC; MAC Aspect: W	Film No: Photo No. 5
Percentage cover of strata (for quadrat) Trees 53 %; Shrubs >2m %; Shrubs 1-2m 20%; Shrubs <1m %; Herbs 18 %; Grasses %; Bare Ground %		
Vegetation Description: Eucalyptus marginata, Banksia attenuata Woodland over shrubs and sedges with occasional tuart		
Condition: 2 Area mainly 3-4 with occasional areas of condition 2		
Rare or Priority Flora:		
Other Notes: Dieback/Age since fire/ Predators/Erosion/Weeds/Tracks/Position in cemetery Several banksias germinating.		

Colln No	Taxon	Fl Colour	Ht (cm)	% Cover(1)	% Cover (2)	
P1-7	<i>Acacia cyclops</i>		40	<1	<1	
	* <i>Aira caryophylla</i>	Straw	15		2	
	<i>Astroloma pallidum</i>	White	10	1	1	
	<i>Austrodanthonia occidentalis</i>		50	1	1	
	<i>Banksia attenuata</i>		600	<1	2	
	<i>Banksia grandis</i>		350	0.5	0.5	
	* <i>Briza maxima</i>	Green	40	1	8	
	<i>Caladenia flava</i>	Yellow	2	<1	20	
	<i>Caladenia latifolia</i>		8	<1	<1	
	<i>Conostylis candicans</i>	Yellow	15	<1	0	
	P3-4	* <i>Conyza bonariensis</i>	Straw	30	<1	<1
		<i>Daucus glochidiatus</i>	Green	2	<1	4
		<i>Desmocladus flexuosus</i>	Brown	20	25	25
<i>Drosera erythrorhiza</i>			5	15	10	
<i>Drosera sp.</i>			10	<1	<1	
* <i>Ehrharta calycina</i>		Green	20	<1	<1	
* <i>Ehrharta longiflora</i>		Green	15	1	<1	
<i>Elythranthera brunonis</i>			20	<1	<1	
<i>Eryngium rostratum</i>			25		<1	
<i>Eucalyptus marginata</i> subsp. <i>marginata</i>			1000	45	45	
<i>Gompholobium tomentosum</i>		Yellow	35		<1	
<i>Hakea lissocarpha</i>		White	40	<1	<1	
<i>Hardenbergia comptoniana</i>		Purple	T	1	1	
* <i>Heliophila pusilla</i>		White	15		<1	
<i>Hibbertia cuneiformis</i>		Yellow	150	1	1	
<i>Hibbertia hypericoides</i>		Yellow	20	1	1	
<i>Hibbertia racemosa</i>		Yellow	20	<1	<1	
<i>Hovea trisperma</i> var. <i>trisperma</i>		Purple	20	8	8	
<i>Kennedia prostrata</i>		Red	5	<1	<1	
<i>Lagenophora huegelii</i>			2	<1	<1	
P3-1		<i>Lepidosperma leptostachyum</i>	Black	50	5	5
P3-2		<i>Lomandra caespitosa</i>	Yellow	20	<1	<1
		<i>Lomandra preissii</i>	Cream	40	<1	<1
	<i>Mesomelaena pseudostygia</i>	Black	70	20	20	
P1-2	* <i>Homeria flaccida</i>	Orange	50	<1	<1	
	<i>Petrophile macrostachya</i>		40	<1	<1	
	* <i>Petrorhagia velutina</i>	PInk	20		<1	
	<i>Pterostylis vittata</i>	Green	10	<1	<1	
	<i>Pyrorchis nigricans</i>		2	<1	<1	
	<i>Ricinocarpus glaucus</i>	White	25	<1	<1	
	* <i>Romulea rosea</i>	Pink	15		1	
	<i>Schoenus clandestinus</i>		2	<1	<1	
	<i>Sowerbaea laxiflora</i>	Purple	20		5	
	P3-3	<i>Stenanthemum notiale</i> subsp. <i>chamelum</i>	Yellow	20	<1	<1
<i>Thysanotus manglesianus</i>		Mauve	T	<1	<1	
* <i>Trifolium campestre</i>		Yellow	5	1	1	
* <i>Vulpia bromoides</i>		Green	15		1	
<i>Xanthorrhoea preissii</i>			140	15	15	



Quadrat P3

FLORA DATA SHEETS

Project: MFP -	Date: 4 th July 2001	Surveyors: EB & JB
Location: To the east of Myles Road at northern end of Midland Cemetery SITE P4		
Aerial Photograph: N/A		
DATUM: Site 1 Site 2 Site 3 Site 4 Site 5 Site 6	Easting 50 384 307	Northing 648 0141
Soil type: Sand <input checked="" type="checkbox"/> : silt : clay Colour Grey/brown	Rocks: (average size) N/A	Outcropping Type and percentage N/A
Litter Bark %; Leaves 95 % Twigs 1 %; Logs 2 %	Topography: Br; R; US; MS; LS; DL; MIC; MAC Aspect: Mid slope	Film No: Photo No. 6
Percentage cover of strata (for quadrat) Trees 58 %; Shrubs >2m %; Shrubs 1-2m 20 %; Shrubs <1m %; Herbs 70 %; Grasses /sedges 15 %; Bare Ground %		
Vegetation Description: Banksia prionotes, jarrah, tuart over shrubs including Xanthorrhoea preissii. Varying from dense to open Banksia prionotes.		
Condition: 2		
Rare or Priority Flora:		
Other Notes: Dieback/Age since fire/ Predators/Erosion/Weeds/Tracks/Position in cemetery Tree layer in very good condition but lower layer consisting predominantly of weeds.		

Colln No	Taxon	Fl Colour	Ht (cm)	% Cover (1)	% Cover (2)
	<i>Banksia attenuata</i>		800	30	30
	<i>Banksia prionotes</i>		800	30	30
	* <i>Briza maxima</i>	Green	50	1	1
	<i>Caesia micrantha</i>		50		1
	<i>Caladenia flava</i>	Yellow	15		<1
	<i>Caladenia latifolia</i>	Pink	20		<1
	<i>Conostylis aculeata</i> subsp. <i>bracteata</i>		20		<1
	<i>Daviesia divaricata</i>	Yellow/red	50		<1
	<i>Desmocladius flexuosus</i>	Brown	15	8	8
	<i>Drosera erythrorhiza</i>		3	2	2
	* <i>Ehrharta calycina</i>	Green	40	5	1
	<i>Eucalyptus gomphocephala</i>		1800	15	15
	* <i>Freesia</i> hybrid		20	1	10
	* <i>Gladiolus caryophyllaceus</i>		15	<1	<1
	<i>Gompholobium tomentosum</i>	Yellow	70	5	5
	<i>Haemodorum laxum</i>		15	<1	<1
	<i>Hakea lissocarpha</i>	White	40	2	2
	<i>Hakea trifurcata</i>		80	<1	<1
	* <i>Homeria flaccida</i>	Orange	50		<1
	<i>Hovea trisperma</i> var. <i>trisperma</i>	Purple	50	1	1
	<i>Lepidosperma leptostachyum</i>	Brown	70	5	5
	<i>Lomandra preissii</i>	Cream	50	2	2
	<i>Mesomelaena pseudostygia</i>	Black	70	30	30
	* <i>Pelargonium capitatum</i>		30		<1
	<i>Petrophile macrostachya</i>		50	<1	<1
	<i>Scaevola canescens</i>	White	10	1	1
	<i>Sowerbaea laxiflora</i>	Purple	40		2
	<i>Stirlingia latifolia</i>	Orange	30	<1	<1
	<i>Tetraria octandra</i>		45	2	1
	<i>Thysanotus manglesianus</i>	Purple	T	<1	<1
	<i>Tricoryne elatior</i>		90	<1	<1
	<i>Xanthorrhoea preissii</i>		150	10	10



Quadrat P4

FLORA DATA SHEETS

Project: MFP -	Date: 4 th July 2001	Surveyors: EB & JB
Location: SITE P5		
Aerial Photograph: N/A		
DATUM: Site 1 Site 2 Site 3 Site 4 Site 5 Site 6	Easting 50 384147	Northing 6481241
Soil type: Sand <input checked="" type="checkbox"/> :silt : clay Colour Yellowish brown	Rocks: (average size) N/A	Outcropping Type and percentage N/A
Litter Bark %; Leaves 50 % Twigs 2 %; Logs 1 %	Topography: Br; R; US; MS; LS; DL; MIC; MAC Aspect: Mid slope	Film No: Photo No. 7
Percentage cover of strata (for quadrat) Trees 75 %; Shrubs >2m %; Shrubs 1-2m 18 %; Shrubs <1m %; Herbs %; Grasses 12% sedges 45 %; Bare Ground 2 %		
Vegetation Description: Banksia menziesii, B. attenuata, jarrah with occasional tuart Woodland over Xanthorrhoea preissii and shrubs		
Condition: 4		
Rare or Priority Flora:		
Other Notes: Dieback/Age since fire/ Predators/Erosion/Weeds/Tracks/Position in cemetery Quadrat placed near the northern edge of the park just before the Quindalup Dune. On opposite side of track the area has signs marking areas for parking etc.		

Colln No	Taxon	Fl Colour	Ht (cm)	% Cover (1)	% Cover (2)
	<i>Acacia saligna</i>	Bright yellow	10	<1	<1
	<i>Allocasuarina fraseriana</i>		750	2	2
	<i>Banksia attenuata</i>		800	20	20
	<i>Banksia menziesii</i>		900	25	25
	* <i>Briza maxima</i>	Green	15		2
	<i>Caladenia flava</i>	Yellow	10	<1	<1
	* <i>Conyza bonariensis</i>	Straw	10	<1	<1
	<i>Daucus glachidiatus</i>	Green	5		3
	<i>Desmocladius flexuosus</i>	Yellow	15	10	10
	<i>Drosera erythrorhiza</i>		2	<1	<1
	<i>Drosera menziesii</i>	Pink	T	<1	<1
	<i>Drosera pallida</i>	White	T	<1	<1
P5-2	<i>Eremaea asterocarpa</i> subsp. <i>asterocarpa</i>	Orange	50	2	2
	<i>Eucalyptus marginata</i> subsp. <i>marginata</i>		850	8	8
P1-1	<i>Hakea lissocarpa</i>	White	110	1	1
	<i>Hibbertia hypericoides</i>	Yellow	40	2	2
	<i>Hibbertia racemosa</i>	Yellow	40	2	2
P1-2	* <i>Homeria flaccida</i>	Orange	35	<1	15
	<i>Hovea trisperma</i> var. <i>trisperma</i>	Purple	20	1	1
	* <i>Hypochoeris glabra</i>		3	2	20
	* <i>Lachenalia reflexa</i>	Yellow/green	30	40	1
	<i>Lagenifera huegelii</i>	White	2	5	5
	<i>Leucopogon propinquus</i>	White	45	2	2
	<i>Lomandra preissii</i>	Cream	30	<1	<1
	<i>Mesomelaena pseudostygia</i>	Black	50	5	5
	* <i>Petrorhagia velutina</i>	Pink	25		<1
	<i>Podolepis gracilis</i>	White	25		2
	<i>Ricinocarpus glaucus</i>	White	55	<1	<1
	* <i>Romulea rosea</i>	Pink	15		10
	<i>Scaevola canescens</i>	White	10	<1	2
	<i>Schoenus clandestinus</i>		5	<1	<1
	<i>Sowerbaea laxiflora</i>	Purple	30		3
	* <i>Stellaria media</i>	White	5	3	3
	<i>Stylidium brunonianum</i>	Pink	20	<1	<1
	<i>Thysanotus manglesianus</i>	Mauve	T	<1	<1
	* <i>Trifolium campestre</i>	Yellow	20	3	5
	* <i>Trifolium dubium</i>	Yellow	15		5
	* <i>Ursinia anthemoides</i>	Cream	15	20	20
	<i>Xanthorrhoea brunonis</i> subsp. <i>brunonis</i>		60	3	3
	<i>Xanthorrhoea preissii</i>		150	15	15

12th September 2001 Survey. Large amount of litter on the ground. Several *Banksia* seedlings.



Quadrat P5

FLORA DATA SHEETS

Project: MFP -	Date: 5 th July 2001	Surveyors: EB & JB
Location: Near where erecting a new building SITE P6		
Aerial Photograph: N/A		
DATUM:	Easting	Northing
Site 1	50 384048	648 1028
Site 2	50 384229 (2 nd area)	647 9961
Site 3		
Site 4		
Site 5		
Site 6		
Soil type: Sand <input checked="" type="checkbox"/> : silt : clay Colour Pale yellowish cream	Rocks: (average size) N/A	Outcropping Type and percentage N/A
Litter Bark %; Leaves 5 % Twigs 3 %; Logs %	Topography: Br; R; US; MS; LS; DL; MIC; MAC Aspect: East	Film No: Photo No. 8
Percentage cover of strata (for quadrat)		
Trees %; Shrubs >2m %; Shrubs 1-2m 70 %; Shrubs <1m %; Herbs 27 %; Grasses 10 %; Bare Ground 30 %		
Vegetation Description: Heath of <i>Melaleuca systema</i> and other shrubs etc		
Condition: 3		
Rare or Priority Flora:		
Other Notes: Dieback/Age since fire/ Predators/Erosion/Weeds/Tracks/Position in cemetery. Edge of Quindalup Dune. Several dead <i>Acacia lasiocarpa</i> . Scattered young plants of <i>Banksia prionotes</i> . On the higher slopes occasional <i>B. prionotes</i> and <i>Eucalyptus gomphocephala</i> .		

Colln No	Taxon	Fl Colour	Ht (cm)	% Cover (1)	% Cover (2)
	<i>Acacia lasiocarpa</i>	Yellow	40	5	5
	<i>Acanthocarpus preissii</i>	Cream	70	20	20
	<i>Anthocercis littorea</i>	Yellow	120	<1	<1
	* <i>Arctotheca calendula</i>	Yellow	5	<1	<1
P6-5	<i>Austrostipa</i> sp.		120	<1	<1
P6-7	* <i>Brassica tournfortii</i>	White	5	5	5
	* <i>Bromus diandrus</i>	Green	25		10
	<i>Calandrinia linifolia</i>	Pink	5		3
P6-1	<i>Cassutha flava</i>		T	1	1
	<i>Conostylis candicans</i>	Bright yellow	25	5	5
P6-3	<i>Conostylis juncea</i>		25	5	5
	* <i>Cotula turbinata</i>	White	10		<1
	<i>Crassula glomerata</i>	White	2		<1
	<i>Desmocladus flexuosus</i>	Brown	15	1	1
	* <i>Dischisma arenarium</i>	Green/brown	10		<1
	* <i>Erodium botrys</i>	White	5		1
	<i>Gompholobium tomentosum</i>	Yellow	40	2	2
	<i>Hibbertia subvaginata</i>	Yellow	70	<1	<1
	* <i>Lagurus ovatus</i>	White/green	25	10	1
	* <i>Lolium rigidum</i>	Green	40		1
P6-2	<i>Lomandra suaveolens</i>	Yellow	20	1	1
	<i>Melaleuca systema</i>	Cream	70	40	40
	<i>Opercularia vaginata</i>	Green	50	<1	<1
	* <i>Pelargonium capitatum</i>	Pink	5	2	2
	* <i>Petrorhagia velutina</i>	Pink	5	2	2
	* <i>Romulea rosea</i>	Pink	25	8	15
	<i>Santalum acuminatum</i>		100	4	4
	<i>Schoenus grandiflorus</i>	Brown	50	1	1
	* <i>Sonchus oleraceus</i>	Yellow	20		<1
P6-4	<i>Thysanotus arbuscula</i>		25	<1	<1
	* <i>Trachyandra divaricata</i>	White	20	<1	<1
	<i>Trachymene pilosa</i>	White	10		2

12th September 2001 Survey. Heavily grazed



Quadrat P6

FLORA DATA SHEETS

Project: MFP -		Date: 5 th July 2001	Surveyors: EB & JB	
Location: SITE P7 On lower slopes of Quindalup Dune Aerial Photograph: N/A				
DATUM: Site 1 Site 2 Site 3 Site 4 Site 5 Site 6	Easting 50 384 238		Northing 647 9960	
Soil type: Sand <input checked="" type="checkbox"/> : silt : clay Colour Yellowish grey		Rocks: (average size) N/A		Outcropping Type and percentage N/A
Litter Bark %; Leaves 80 % Twigs 5 %; Logs %		Topography: Br; R; US; MS; LS; DL; MIC; MAC Aspect: East		Film No: Photo No. 9
Percentage cover of strata (for quadrat) Trees 80-95%; Shrubs >2m %; Shrubs 1-2m 50 %; Shrubs <1m %; Herbs %; Grasses 85 %; Bare Ground %				
Vegetation Description: Dense Banksia prionotes forest.				
Condition: 4-5 but excellent and should be retained				
Rare or Priority Flora:				
Other Notes: Dieback/Age since fire/ Predators/Erosion/Weeds/Tracks/Position in cemetery Some of the best and most restricted area but there are several Eucalyptus caesia planted and appear to be germinating from seed. Occurs at the base of the Quindalup Dune escarpment ca 20m wide.				

Colln No	Taxon	Fl Colour	Ht (cm)	% Cover (1)	% Cover (2)
	<i>Acanthocarpus preissii</i>	Cream	50	2	2
	* <i>Avena barbata</i>	Green	70	85	2
	<i>Banksia prionotes</i>		900	95	95
	* <i>Briza maxima</i>	Green	10		5
	<i>Conostylis aculeata</i> subsp. <i>bracteata</i>	Yellow	15		<1
	* <i>Ehrharta longiflora</i>	Green	20		80
	<i>Grevillea crithmifolia</i>	White	45	<1	<1
	<i>Lomandra maritima</i>	Cream	40	<1	<1
P7-1	<i>Melaleuca systema</i>	Cream	200	40	40
P1-1	* <i>Homeria flaccida</i>	Orange	70	5	15
	* <i>Pelargonium capitatum</i>	Pink	15	<1	<1
	<i>Ricinocarpus glaucus</i>	White	50	1	1
	<i>Schoenus grandiflorus</i>	Rusty brown	70	<1	<1
	<i>Trachymene pilosa</i>	White	5		3



Quadrat P7

FLORA DATA SHEETS

Project: MFP -		Date: 5 th July 2001	Surveyors: EB & JB
Location: SITE P8 On western edge of cemetery Aerial Photograph: N/A			
DATUM: Site 1 Site 2 Site 3 Site 4 Site 5 Site 6	Easting 50 384 193		Northing 6480403
Soil type: Sand <input checked="" type="checkbox"/> : silt : clay Colour Yellowish brown	Rocks: (average size) N/A	Outcropping Type and percentage N/A	
Litter Bark %; Leaves 10 % Twigs 5 %; Logs 8 %	Topography: Br; R; US; MS; LS; DL; MIC; MAC Aspect: Top of slope	Film No: Photo No. 12	
Percentage cover of strata (for quadrat) Trees 0-50 %; Shrubs >2m %; Shrubs 1-2m 40 %; Shrubs <1m %; Herbs 27 %; Grasses 15% sedges 45 %; Bare Ground %			
Vegetation Description: Heath with occasional dense to open clumps of tuart or Banksia prionotes. Quindalup Dune.			
Condition: 3			
Rare or Priority Flora:			
Other Notes: Dieback/Age since fire/ Predators/Erosion/Weeds/Tracks/Position in cemetery Star pickets and pots, remnants of Cannabis site. Lot of grazing by rabbits and kangaroos(?)			

Colln No	Taxon	Fl Colour	Ht (cm)	% Cover (1)	% Cover (2)
	<i>Acacia cyclops</i>		200	8	8
	<i>Acacia lasiocarpa</i>	Yellow	50	20	20
	<i>Acanthocarpus preissii</i>	Cream	110	10	10
	<i>Anagallis arvensis</i> var. <i>arvensis</i>	Blue	5	<1	<1
	<i>Austrostipa</i> sp.		110	<1	<1
	* <i>Avena barbata</i>	Green	15	5	8
	* <i>Brassica tournefortii</i>	Yellow	50		1
	* <i>Bromus diandrus</i>	Green	35		1
	<i>Caladenia latifolia</i>	Pink	5	<1	2
	* <i>Carpobrotus edulis</i>	Cream	10	10	10
	<i>Conostylis aculeata</i> subsp. <i>bracteata</i>	Yellow	20	1	1
	<i>Conostylis candicans</i>	Bright yellow	15		2
	<i>Daucus glochidiatus</i>	Green	5	2	2
	<i>Desmocladus flexuosus</i>	Brown	20	45	45
	<i>Dianella revoluta</i>		45	2	2
	* <i>Erodium cicutarium</i>	White	5		<1
	<i>Eucalyptus gomphocephala</i>		1800	30	30
	<i>Gompholobium tomentosum</i>	Yellow	25	1	1
	<i>Grevillea crithmifolia</i>	White	50	1	1
	<i>Hardenbergia comptoniana</i>	Purple	T	<1	<1
	* <i>Heliophylla pusilla</i>	White	15		1
	<i>Kennedia prostrata</i>	Red	T		<1
	* <i>Lagurus ovatus</i>	White/green	25	10	10
	<i>Lepidosperma squamatum</i>	Brown	20		<1
	<i>Leucopogon parviflorus</i>	White	45	1	1
	* <i>Lolium rigidum</i>	Green	30		<1
	<i>Lomandra caespitosa</i>	Cream	25	3	3
	<i>Melaleuca systema</i>	Cream	120	10	10
	* <i>Melilotus indica</i>	Yellow	10		1
	<i>Olearia axillaris</i>	White	150	5	5
	<i>Pelargonium capitatum</i>	Pink	20	1	1
	* <i>Petrorhagia velutina</i>	Pink	5	1	8
	<i>Rhagodia baccata</i> subsp. <i>baccata</i>	White/red fruit	45	5	5
	* <i>Romulea rosea</i>	Pink	20	15	15
	* <i>Sonchus oleraceus</i>	Yellow	15	<1	1
	* <i>Stellaria media</i>	White	5	3	3
	<i>Thysanotus manglesianus</i>	Mauve	T	<1	<1
	* <i>Trachyantra divaricata</i>	White	25	1	1



Quadrat P8

APPENDIX D

Figures

- Figure 1. Vegetation units**
- Figure 2. Vegetation Condition**
- Figure 3. Significant Plant Taxa**
- Figure 4. Threatened Ecological Communities**
- Figure 5. Protection Value**

WESTERN POWER CORPORATION

**VEGETATION SURVEY
AND *PHYTOPHTHORA CINNAMOMI*
ASSESSMENT,**

**HEPBURN HEIGHTS AND
LILBURNE RESERVE**

FEBRUARY 2003



WOODMAN ENVIRONMENTAL CONSULTING PTY LTD

A.C.N. 088 055 903

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APPENDICES

Appendix A: Vascular Plant Species Recorded within the Survey Area, October 2003

Appendix B: Vascular Plant Species Recorded within each Plant Community, October 2003

Appendix C: GPS locations of Sites (GDA 94)

Appendix D: Photographic Record of Plant Communities

FIGURES

Figure 1: Plant Communities, Hepburn Heights and Lilburne Reserve

EXECUTIVE SUMMARY

In October 2003 Woodman Environmental Consulting Pty Ltd undertook a vegetation survey and *Phytophthora cinnamomi* assessment of a Western Power-owned block of land north of Hepburn Avenue, the adjoining property to the west (previously owned by FESA), and Lilburne Reserve, situated to the south of Hepburn Avenue. Western Power need to construct a new sub-station, to supply the increased demand for electricity that has been created through growth in the region.

The vegetation of the survey area was assessed on foot on the 21st October 2003, with plant communities mapped and a Declared Rare and Priority Flora search undertaken. Plant communities mapped are shown on Figure 1. Information gathered from sites has been used to describe the plant communities mapped, and to create a vascular plant species list.

A total of 76 native taxa and 22 introduced taxa were recorded from the survey area. The high number of introduced taxa gives an indication of the disturbed nature of the survey area in general. Of these taxa, one Priority 4 species, *Jacksonia sericea*, was recorded scattered throughout Lilburne Reserve. This species has already been determined to be present within the Hepburn Heights Conservation Park (Alan Tingay and Associates 1993). One Declared Plant, **Moraea flaccida*, was also recorded from both within the Lilburne Reserve, and the block of ex-FESA-designated land, north of Hepburn Avenue.

Three plant communities were mapped through the survey area. These were:

W1: Very Open Woodland of *Eucalyptus gomphocephala* over Low Woodland of *Banksia attenuata* over Open Shrubland of *Xanthorrhoea preissii* over Low Shrubland of mixed species dominated by *Hibbertia hypericoides*, *Mesomelaena pseudostygia* and *Grevillea vestita* subsp. *vestita* on yellow sand

W2: Low Woodland of *Eucalyptus marginata*, *Banksia attenuata* and *Banksia menziesii* over Open Shrubland of *Hakea lissocarpha*, *Xanthorrhoea preissii* and *Allocasuarina humilis* over Open Low Heath dominated by *Hibbertia hypericoides* and *Orthrosanthus laxus* var. *laxus* on yellow sand

W3: Low Woodland of *Banksia attenuata* and *Allocasuarina fraseriana* with occasional *Eucalyptus gomphocephala* over Shrubland of *Calothamnus quadrifidus*, *Xanthorrhoea preissii* and *Hakea lissocarpha* over Low Shrubland dominated by *Hibbertia hypericoides* on yellow sand

None of these plant communities are listed as Threatened Ecological Communities (TECs).

The vegetation within the Lilburne Reserve is in a generally poorer condition in comparison to the blocks of land north of Hepburn Avenue. Although *Jacksonia sericea* is present within the reserve, there is a high level of weed infestation throughout this reserve as a result of recent fire and edge effects from the surrounding residential development. Lilburne Reserve is isolated from other, larger areas of

bushland due to the presence of Hepburn Avenue, and other roads and housing developments, reducing its long term viability and function as flora and fauna habitat. In comparison, the bushland within the Hepburn Heights Conservation Area comprises a large continuous piece of native vegetation stretching to the north and east.

The following recommendations are given:

- The boundaries of the proposed sub-station and access road be pegged in the field to determine the number of *Jacksonia sericea* individuals within this area;
- A *P. cinnamomi* and weed-management plan be developed for construction of the proposed sub-station to prevent the introduction of *P. cinnamomi* and further weed infestation of areas near the sub-station; and
- Should no development take place prior to October 2004, the areas should be re-surveyed for the presence of *P. cinnamomi*.

1. INTRODUCTION

A parcel of land within the Hepburn Heights Conservation Area and owned by Western Power Corporation, located north of the intersection of Hepburn Avenue and Lilburne Road in the suburb of Padbury, is currently reserved for the installation of a sub-station. The establishment of this sub-station is now required due to the higher demand for electricity as a result of increased growth in the region. Due to conservation values of the Hepburn Heights Conservation Area, Western Power are also assessing the options of placing the sub-station within Hepburn Heights Conservation Area, and also within Lilburne Reserve, located south of Hepburn Avenue. Woodman Environmental Consulting was contracted by Western Power to undertake a vegetation survey and *Phytophthora cinnamomi* assessment of all three areas, including a search for Declared Rare Flora (DRF), Priority Flora and Threatened Ecological Communities (TECs).

1.1 Background

The survey area is located within the Drummond Botanical Subdistrict of the Swan Coastal Plain Subregion, within the Southwest Province as defined by Beard (1990). The survey area also lies on the Cottesloe Complex as mapped by Churchward and McArthur (1980), near a boundary with the Quindalup Complex. The Cottesloe complex is described as a low hilly landscape with shallow brown sands over limestone, with much exposed limestone, and the Quindalup Complex is described as dunes and beach ridges composed of calcareous sand.

Hedde *et. al.* (1980) mapped the survey area as being of the Cottesloe Complex – Central and South, which is described as a mosaic of woodland of *Eucalyptus gomphocephala* and open forest of *Eucalyptus gomphocephala* – *Eucalyptus marginata* – *Corymbia calophylla*; closed heath on the limestone outcrops. This vegetation complex supports heaths on limestone outcrops, with woodlands on deeper sands.

Alan Tingay and Associates produced a management plan for the Hepburn Heights Conservation Area in 1993. This report states that the predominant vegetation type throughout the conservation park is *Banksia attenuata* Low Woodland on deep sandy soils, with other tree species including *Banksia menziesii* and *Allocasuarina fraseriana* co-dominating, with scattered *Eucalyptus marginata* and *Eucalyptus gomphocephala*. Three vegetation types were mapped over the parcels of land owned by Western Power and previously by FESA, north of Hepburn Avenue:

- *Eucalyptus decipiens* Woodland
- *Eucalyptus marginata* Woodland
- *Banksia attenuata* Woodland

A total of 58 native taxa were recorded by Alan Tingay and Associates (1993) as occurring within the Hepburn Heights Conservation Park, however due to the timing of the survey ephemeral species such as orchids and annuals were not identified. Within the Hepburn Heights Conservation Park three taxa were of note: *Carpobrotus* c.g. *modestus* (now *Sarcozona bicarinata*), a Priority 3 (P3) species; *Jacksonia sericea*, now a Priority 4 (P4) species, and *Cartonema phylidroides*, which is no

longer on the Priority Flora List (Department of Conservation and Land Management 2003a).

No description of presence or possible impact of *Phytophthora cinnamomi* on the vegetation in the Hepburn Heights Conservation Park was reported in the Management Plan (Alan Tingay and Associated 1993).

Bush Forever listed a description of the landforms and vegetation of the Hepburn Heights Conservation Park area, as a compilation of previous work (Government of Western Australia 2000). Vegetation complexes present on the area include Karakatta Complex – Central and South, and Cottesloe Complex – Central and South. Floristic Community Types (FCTs) include: 24 - Northern Spearwood shrublands and woodlands; 26b - Woodlands and mallees on limestone; 28 - Spearwood *Banksia attenuata* or *Banksia attenuata* – *Eucalyptus* woodlands; and 29a - Coastal Shrublands on shallow sand. In total, >70% is in Very Good to Excellent condition, with <30% being in Good to Degraded condition, with areas of severe localized disturbance (Government of Western Australia 2000). Hepburn Heights Conservation Park is situated within Bush Forever Site Number 303 under the name of 'Whitfords Avenue Bushland, Craigie/Padbury. The Bush Forever Site encompasses 139.5 ha of bushland including the Hepburn Heights Conservation Park and adjoining areas through the Pinnaroo Cemetery north to the Ocean Reef Road adjacent to the Mitchell Freeway. The Hepburn Heights Conservation Park has been entered in the Interim List of the Register of the National Estate.

2. AIMS AND OBJECTIVES

The aims of this project were to:

- Map and describe all plant communities in the survey area;
- Produce a vascular plant species list for the survey area;
- Identify Declared Rare Flora (DRF) and Priority Flora in the survey area;
- Identify Threatened Ecological Communities (TECs) in the survey area;
- Provide information regarding the regional significance of plant communities mapped;
- Describe the distribution of *Phytophthora cinnamomi* within the study area and discuss management implications of this to the proposed development.

3. METHODOLOGY

3.1 Flora and Vegetation

On the 21st of October one experienced botanist assessed the survey area. The survey area consisted of the Western Power property located on the northern side of Hepburn Avenue, and the adjacent property (previously owned by FESA) located adjacent to the western boundary of the Western Power property. The Western Power property covers approximately 1.0 ha, with the ex-FESA property covering approximately 0.3 ha. The southern half of the Lilburne Reserve, as delineated by a track running approximately east north-east – west south-west was also surveyed. This area covers approximately 2.7 ha.

The entire survey area was assessed on foot, with sites established in the field for each plant community. The following information was recorded at each site:

- Personnel
- Date
- GPS (GDA 94) (Appendix C)
- Soil type
- Slope
- Fire History
- Brief Description of Vegetation
- Condition of Vegetation
- Vascular Plant Species present (including height and cover)

All vascular plant species within the site area were recorded, including all introduced (weed) species. Samples of species that were unable to be identified in the field were taken to the Western Australian Herbarium (WAHerb) for identification. Opportunistic species identified between sites were also recorded. This information was used to describe the plant communities mapped, and also to provide lists of species recorded within the three blocks. Descriptions of plant communities were undertaken using the vegetation structural classes described in Government of Western Australia (2000).

All names were checked for currency using the MAX database, and for status using the latest CALM DRF and Priority Flora listing (Department of Conservation and Land Management 2003a). Plant communities mapped were also checked against the Threatened Ecological Communities (TEC) list (Department of Conservation and Land Management 2003b), and against Gibson *et. al.* (1994) to identify any TECs present within the survey area.

3.2 *Phytophthora cinnamomi* Assessment

The survey area was traversed on foot by personnel accredited in the detection and mapping of *Phytophthora cinnamomi*. Samples of soil and vegetation material were collected from dead or dying indicator plant species and analysed for the presence of *P. cinnamomi*. Any disease boundaries within the survey area were marked in the field using day-glo pink (*P. cinnamomi* infested) or white (uninterpretable) flagging tape.

Disease Interpretation and Mapping Terminology

***P. cinnamomi* free (Uninfested areas)**

Areas of native vegetation that an accredited interpreter has determined to be free of plant disease symptoms which would indicate the presence of the pathogen *P. cinnamomi*.

These areas need not be sampled for the presence of *P. cinnamomi*, however if samples are collected, analysis results must not show the presence of *P. cinnamomi*.

P. cinnamomi infested (Infested areas)

Areas of native vegetation that an accredited interpreter has determined have plant disease symptoms consistent with the presence of the pathogen *P. cinnamomi*.

Samples of plant tissue and/or soil should be collected within these areas to confirm the presence of the pathogen. Sample analysis results should provide a recovery of the pathogen from within each area to confirm the interpretation.

Uninterpretable

Areas in which indicator plants are absent or too few to determine the presence or absence of disease caused by *P. cinnamomi*.

Areas that have suffered significant disturbance to reduce the number of indicator plants or mask disease symptoms may be included in this category. Fire is a common factor that will cause normally interpretable areas to become uninterpretable. Cleared land is placed in the uninterpretable category, however these areas will never regain their status as interpretable.

Areas of vegetation that do not include indicator plants such as wetlands and some swamps should be placed in this category unless sampling confirms the presence of *P. cinnamomi*. These areas must then be placed in the infested category.

4. RESULTS**4.1 Flora**

A total of 76 native taxa and 22 introduced taxa from 30 families were recorded within the survey area at time of survey. The high number of introduced taxa gives an indication of the disturbed nature of the survey area in general. Table 1 below lists the number of native and introduced taxa recorded in each area surveyed.

Table 1: Native and Introduced Taxa Recorded in the Surveyed Areas

	Native Taxa	Introduced Taxa
Lilburne Reserve	54	20
Western Power/ex-FESA	58	11

Although Lilburne Reserve was of a larger size than the blocks owned by Western Power and ex-FESA, the number of native taxa recorded was lower than the number recorded in the Western Power block. Lilburne Reserve was considerably more weed infested, and areas have been affected by bushfire.

No Declared Rare Flora (DRF) pursuant to the Wildlife Conservation Act (1950) were recorded in the survey area during this survey. One Priority Flora species, *Jacksonia sericea* (P4) was recorded from Lilburne Reserve. It was widely scattered throughout the surveyed area in this reserve, especially in the southern and eastern sections, where it forms dense clumps. This species was recorded from Sites 2 and 3, and from near Site 1 (Figure 1). This species has previously been recorded from within the Hepburn Heights Conservation Park (Alan Tingay and Associates 1993). *Jacksonia*

sericea is endemic to the Swan Coastal Plain, and grows on calcareous and sandy soils (Marchant *et. al.* 1987).

Only one Declared Plant (Department of Agriculture 2003) was recorded during the survey, **Moraea flaccida* (one leaf cape tulip). There is a legislative requirement for landowners to control or eradicate Declared Plants where they are found on their land. Currently, within Perth **Moraea flaccida* is a Declared P1 plant, where the movement of plants or seeds of the species are prohibited within the State, and where the movement of contaminated machinery and produce is prohibited (Department of Agriculture 2003). This species was recorded scattered throughout Lilburne Reserve, and within the block of land previously designated for FESA.

4.2 Vegetation

Three plant communities were mapped over the survey area as part of this survey.

W1: Very Open Woodland of *Eucalyptus gomphocephala* over Low Woodland of *Banksia attenuata* over Open Shrubland of *Xanthorrhoea preissii* over Low Shrubland of mixed species dominated by *Hibbertia hypericoides*, *Mesomelaena pseudostygia* and *Grevillea vestita* subsp. *vestita* on yellow sand

Plant community W1 was mapped over the portion of Lilburne Reserve included in this survey. *Eucalyptus gomphocephala*, whilst present throughout this area, was more prevalent along the southern boundary of the reserve. Likewise, *Allocasuarina fraseriana* was recorded in the north-western section of this area, *Banksia prionotes* was recorded in the south-western corner of this area, and a small pocket of *Eucalyptus marginata* was present along the track on the northern boundary. *Xanthorrhoea preissii* and *Mesomelaena pseudostygia* are present throughout the surveyed area of Lilburne Reserve, however was most common in the north-western corner. Other common species in the understorey were *Corynotheca micrantha* and *Jacksonia sericea*, a P4 species.

This area has been impacted upon by past clearing, bushfires, tracks and other human disturbances. Burn scars are visible on aerial photography of the reserve, and some changes in density of *Banksia attenuata* can be attributed to past fire history. Although some areas of the reserve surveyed have not been impacted upon by weeds to a large extent, especially near the western boundary, the majority of the reserve is infested by pockets of species such as **Euphorbia terracina*, **Ehrharta calycina*, **Lupinus* sp., **Pelargonium capitatum*, **Erodium botrys*, **Trachyandra divaricata* and **Fumaria capreolata*. **Moraea flaccida*, a Declared Plant species, was recorded scattered throughout this area.

A total of 54 native taxa, and 20 introduced taxa were recorded from this plant community.

W2: Low Woodland of *Eucalyptus marginata*, *Banksia attenuata* and *Banksia menziesii* over Open Shrubland of *Hakea lissocarpha*, *Xanthorrhoea preissii* and *Allocasuarina humilis* over Open Low Heath dominated by *Hibbertia hypericoides* and *Orthrosanthus laxus* var. *laxus* on yellow sand

Plant community W2 was mapped in the parcel of land owned by Western Power on the northern side of Hepburn Avenue, and the northern half of the parcel of land previously designated for FESA. The overstorey was dominated by *Eucalyptus marginata* and *Banksia attenuata*, with *Banksia menziesii* and *Banksia grandis* also present. A sparse to moderately dense mid-storey was present, overlying an understorey dominated by *Hibbertia hypericoides* and *Orthrosanthus laxus* var. *laxus*. Other species in the understorey included *Calothamnus quadrifidus*, *Hypocalymma robustum*, *Leucopogon capitellatus*, *Acacia pulchella* and *Mesomelaena pseudostygia*.

In general this plant community was in very good condition, with very few introduced species present. Common introduced species included **Ursinia anthemoides*, **Hypochaeris glabra*, **Ehrharta calycina*, **Briza* spp., **Gladiolus* sp. and **Silene gallica*. More invasive species, including **Pelargonium capitatum*, **Fumaria capreolata* and **Lupinus* sp. were not recorded. A total of 52 native taxa and 10 introduced taxa were recorded from within this plant community. *Eucalyptus decipiens* was noted just outside of the survey area, on the north-eastern corner.

W3: Low Woodland of *Banksia attenuata* and *Allocasuarina fraseriana* with occasional *Eucalyptus gomphocephala* over Shrubland of *Calothamnus quadrifidus*, *Xanthorrhoea preissii* and *Hakea lissocarpha* over Low Shrubland dominated by *Hibbertia hypericoides* on yellow sand

Plant community W3 was mapped over the southern half of the parcel of land previously designated for FESA. It differed from plant community W2 by the differing overstorey composition, and from W1 by the increased presence of *Allocasuarina fraseriana* in the overstorey, and *Calothamnus quadrifidus* in the understorey. This area had a moderate weed infestation, especially closer to Hepburn Avenue. **Moraea flaccida* was also recorded in this area. Also, there was a large patch of old dead *Eucalyptus gomphocephala* and *Banksia attenuata* to the north-west of the survey area. A total of 28 native taxa and five introduced taxa were recorded in this plant community.

The plant communities mapped have been correlated with their corresponding Floristic Community Types (FCTs) as described by Gibson *et. al.* (1994). Plant community W2 is representative of FCT 28 – Spearwood *Banksia attenuata* or *Banksia attenuata* – *Eucalyptus* woodlands, with typical species such as *Xanthorrhoea preissii*, *Hibbertia hypericoides*, *Conostephium pendulum*, *Acacia pulchella*, *Petrophile linearis*, *Gompholobium tomentosum* and *Mesomelaena pseudostygia*. The overstorey of this FCT is comprised of a mix of *Banksia attenuata*, *Banksia attenuata* – *Corymbia calophylla* or *Banksia attenuata* – *Eucalyptus marginata*.

Plant communities W1 and W2 have affinities with both FCT 28, with the presence of *Banksia attenuata* in the overstorey and *Hibbertia hypericoides*, *Xanthorrhoea preissii* and *Mesomelaena pseudostygia* in the understorey, and with FCT 24 – Northern Spearwood shrublands and woodlands. This FCT is comprised of heaths or heaths with scattered *Eucalyptus gomphocephala* on deeper soils within the Cottesloe unit of the Spearwood System. However, the understorey composition for FCT 24 is different, with species such as *Melaleuca acerosa*, *Hardenbergia comptoniana*, *Lomandra maritima*, *Dianella revoluta*, or *Phyllanthus calycinus* (in W3) recorded

during the survey, although species such as *Xanthorrhoea preissii* and *Conostylis aculeata* were present.

Neither FCT 28 nor FCT 24 are listed TECs (Department of Conservation and Land Management 2003).

4.3 *Phytophthora cinnamomi* Assessment

The assessment of the survey area found no symptoms of the presence of the pathogen within the vegetation. The vegetation of the Lilburne Reserve was displaying symptoms of stress associated with a recent fire and the ongoing tree and understorey death that normally follows due to fire damage. Similarly, some recent death of *Banksia* species was noted within the Hepburn Heights area, due to water stress associated with shallow soil profiles around limestone outcropping. This is a common feature of such areas where tree deaths occur near the edge of limestone heaths on the western side of the Swan Coastal Plain.

Two samples of plant and soil material were collected for analysis for the presence of *P. cinnamomi*. The sample analysis results are presented in Table 2.

Table 2: *P. cinnamomi* Sample Analysis Results

Sample Number	Sample Location	Sample Material	Species Sampled	Analysis Result
1	Lilburne Reserve 383673 E 6478820 N Corner of 2 tracks	Root collar Soil	<i>Banksia attenuata</i>	Negative
2	Hepburn Heights 383477 E 6479110 N Death on edge of shallow soil at limestone outcrop	Root collar Soil	<i>Banksia attenuata</i>	Negative

The entire survey area was interpreted as being Uninfested with *P. cinnamomi* at the time of the assessment.

5. DISCUSSION AND RECOMMENDATIONS

No TECs have been mapped within the survey area, and no DRF have been recorded from the survey area. One Priority 4 species, *Jacksonia sericea*, was recorded scattered throughout the Lilburne Reserve, forming some dense patches. Priority 4 (Rare Taxa) are defined as 'Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors' (Department of Conservation and Land Management 2003).

The block owned by Western Power and previously designated for FESA on the north side of Hepburn Avenue have inherently higher conservation values than the Lilburne Reserve, south of Hepburn Avenue. Although the Priority 4 species *Jacksonia sericea* is present within the Lilburne Reserve, the vegetation of the surveyed area in

Lilburne Reserve is generally of poorer quality due to the higher levels of weed infestation within the area. This parcel of remnant vegetation has also been isolated from the much larger Hepburn Heights Conservation Park area by Hepburn Avenue, and is surrounded by other roads and housing developments. The surveyed blocks north of Hepburn Avenue are in excellent condition, with minor weed invasion, and have direct links to other remnant bushland areas within the Hepburn Heights Conservation Park and Bush Forever Site 303.

The soils of the survey area are predominantly underlain by limestone, producing an environment that is not very conducive to the establishment, survival and proliferation of *P. cinnamomi*. However the vegetation present on the site contains many susceptible species therefore a clean on entry policy should apply to any proposed construction activities in the area. Should the proposed development proceed within any portion of the areas surveyed for this report, it is recommended that hygiene measures are implemented to protect the vegetation from the introduction of *P. cinnamomi* and/or additional weed species.

The following recommendations are given:

- The boundaries of the proposed sub-station and access road be pegged in the field to determine the number of *Jacksonia sericea* individuals within this area;
- A *P. cinnamomi* and weed-management plan be developed for construction of the proposed sub-station to prevent the introduction of *P. cinnamomi* and further weed infestation of areas near the sub-station; and
- Should no development take place prior to October 2004, the areas should be re-surveyed for the presence of *P. cinnamomi*.

6. REFERENCES

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APPENDIX A: VASCULAR PLANT SPECIES RECORDED WITHIN THE SURVEY AREA, OCTOBER 2003

FAMILY	SPECIES
Zamiaceae	<i>Macrozamia riedlei</i>
Poaceae	<i>Austrostipa macalpinei</i> * <i>Briza maxima</i> * <i>Briza minor</i> * <i>Ehrharta calycina</i>
Cyperaceae	<i>Lepidosperma squamatum</i> <i>Mesomelaena pseudostygia</i> <i>Schoenus clandestinus</i> <i>Tetraria octandra</i>
Restionaceae	<i>Alexgeorgea nitens</i> <i>Desmocladius fascicularis</i> <i>Acanthocarpus preissii</i> <i>Lomandra hermaphrodita</i> <i>Xanthorrhoea preissii</i> <i>Corynotheca micrantha</i> <i>Sowerbaea laxiflora</i> <i>Thysanotus manglesianus</i> <i>Tricoryne elatior</i> * <i>Trachyandra divaricata</i> <i>Burchardia umbellata</i>
Haemodoraceae	<i>Anigozanthos humilis</i> subsp. <i>humilis</i> <i>Conostylis aculeata</i> <i>Haemodorum spicatum</i>
Iridaceae	* <i>Gladiolus</i> sp. * <i>Moraea flaccida</i> <i>Orthosanthus laxus</i> var. <i>laxus</i>
Orchidaceae	* <i>Disa bracteata</i>
Casuarinaceae	<i>Allocasuarina fraseriana</i> <i>Allocasuarina humilis</i>
Proteaceae	<i>Banksia attenuata</i> <i>Banksia grandis</i> <i>Banksia menziesii</i> <i>Banksia prionotes</i> <i>Calothamnus quadrifidus</i> <i>Calothamnus sanguineus</i> <i>Dryandra lindleyana</i> <i>Dryandra sessilis</i> <i>Grevillea bipinnatifida</i> <i>Grevillea vestita</i> subsp. <i>vestita</i> <i>Hakea lissocarpha</i>

**APPENDIX A: VASCULAR PLANT SPECIES RECORDED WITHIN THE
SURVEY AREA, OCTOBER 2003**

FAMILY	SPECIES
Proteaceae (Contd.)	<i>Hakea prostrata</i> <i>Jacksonia furcellata</i> <i>Petrophile linearis</i> <i>Stirlingia latifolia</i> <i>Synaphea spimulosa</i>
Amaranthaceae	<i>Ptilotus manglesii</i> <i>Ptilotus polystachyus</i> <i>Ptilotus stirlingii</i> var. <i>stirlingii</i>
Aizoaceae	* <i>Carpobrotus edulis</i>
Caryophyllaceae	* <i>Silene gallica</i>
Fumariaceae	* <i>Fumaria capreolata</i>
Mimosaceae	<i>Acacia pulchella</i> * <i>Acacia iteaphylla</i> <i>Acacia saligna</i>
Papilionaceae	<i>Daviesia divaricata</i> subsp. <i>divaricata</i> <i>Daviesia nudiflora</i> subsp. <i>nudiflora</i> <i>Daviesia triflora</i> <i>Gompholobium tomentosum</i> <i>Hardenbergia comptoniana</i> <i>Kennedia prostrata</i> * <i>Lotus</i> sp. * <i>Lupinus</i> sp.
Geraniaceae	* <i>Erodium botrys</i> * <i>Pelargonium capitatum</i>
Euphorbiaceae	* <i>Euphorbia terracina</i> <i>Phyllanthus calycinus</i> <i>Poranthera microphylla</i> <i>Ricinocarpus glaucus</i>
Rhamnaceae	<i>Stenanthemum notiale</i> subsp. <i>chamelum</i>
Dilleniaceae	<i>Hibbertia huegelii</i> <i>Hibbertia hypericoides</i>
Violaceae	<i>Hybanthus calycinus</i>
Thymelaeaceae	<i>Pimelea ?suaveolens</i> subsp. <i>suaveolens</i>
Myrtaceae	* <i>Chamelaucium uncinatum</i> <i>Eremaea beaufortioides</i> var. <i>beaufortioides</i> <i>Eucalyptus gomphocephala</i> <i>Eucalyptus marginata</i> <i>Hypocalymma robustum</i> <i>Melaleuca systema</i>

APPENDIX A: VASCULAR PLANT SPECIES RECORDED WITHIN THE SURVEY AREA, OCTOBER 2003

FAMILY	SPECIES
Apiaceae	<i>Eryngium pinnatifidum</i> <i>Trachymene pilosa</i>
Epacridaceae	<i>Conostephium pendulum</i> <i>Leucopogon capitellatus</i>
Primulaceae	* <i>Anagallis arvensis</i>
Rubiaceae	<i>Opercularia vaginata</i>
Campanulaceae	* <i>Wahlenburgia capensis</i>
Goodeniaceae	<i>Lechenaultia stenosepala</i> <i>Scaevola canescens</i> <i>Scaevola repens</i> ?var. <i>angustifolia</i>
Stylidiaceae	<i>Levenhookia stipitata</i> <i>Stylidium amoenum</i> <i>Stylidium calcaratum</i> <i>Stylidium macrocarpum</i>
Asteraceae	* <i>Taraxacum officinale</i> * <i>Hypochaeris glabra</i> <i>Podolepis gracilis</i> * <i>Ursinia anthemoides</i> <i>Waitzia suaveolens</i> var. <i>suaveolens</i>

Note: * denotes introduced species

**APPENDIX B: VASCULAR PLANT SPECIES RECORDED WITHIN EACH
PLANT COMMUNITY, OCTOBER 2003**

SPECIES	W1	W2	W3
* <i>Acacia iteaphylla</i>	*		
<i>Acacia pulchella</i>	*	*	*
<i>Acacia saligna</i>	*	*	
<i>Acanthocarpus preissii</i>	*	*	
<i>Alexgeorgea nitens</i>	*		
<i>Allocasuarina fraseriana</i>	*	*	*
<i>Allocasuarina humilis</i>	*	*	
* <i>Anagallis arvensis</i>	*	*	*
<i>Anigozanthos humilis</i> subsp. <i>humilis</i>		*	
<i>Austrostipa macalpinei</i>		*	*
<i>Banksia attenuata</i>	*	*	*
<i>Banksia grandis</i>		*	
<i>Banksia menziesii</i>	*	*	
<i>Banksia prionotes</i>	*		
* <i>Briza maxima</i>	*	*	*
* <i>Briza minor</i>		*	
<i>Burchardia umbellata</i>	*		*
<i>Calothamnus quadrifidus</i>	*	*	*
<i>Calothamnus sanguineus</i>	*		
* <i>Carpobrotus edulis</i>	*		
* <i>Chamelaucium uncinatum</i>	*		
<i>Conostephium pendulum</i>		*	*
<i>Conostylis aculeata</i>	*	*	*
<i>Corynotheca micrantha</i>	*	*	*
<i>Daviesia divaricata</i> subsp. <i>divaricata</i>			*
<i>Daviesia nudiflora</i> subsp. <i>nudiflora</i>	*	*	*
<i>Daviesia triflora</i>	*	*	
<i>Desmocladius fascicularis</i>	*		
* <i>Disa bracteata</i>	*		
<i>Dryandra lindleyana</i>	*		
<i>Dryandra sessilis</i>		*	
* <i>Ehrharta calycina</i>	*	*	
<i>Eremaea beaufortioides</i> subsp. <i>beaufortioides</i>	*		
* <i>Erodium botrys</i>	*		
<i>Eryngium pinnatifidum</i>		*	*
<i>Eucalyptus gomphocephala</i>	*		*
<i>Eucalyptus marginata</i>	*	*	
* <i>Euphorbia terracina</i>	*		
* <i>Fumaria capreolata</i>	*		
* <i>Gladiolus</i> sp.	*	*	*
<i>Gompholobium tomentosum</i>	*	*	

**APPENDIX B: VASCULAR PLANT SPECIES RECORDED WITHIN EACH
PLANT COMMUNITY, OCTOBER 2003**

SPECIES	W1	W2	W3
<i>Grevillea bipinnatifida</i>	*	*	
<i>Grevillea vestita</i> subsp. <i>vestita</i>	*		
<i>Haemodorum spicatum</i>	*	*	*
<i>Hakea lissocarpha</i>	*	*	*
<i>Hakea prostrata</i>	*		
<i>Hardenbergia comptoniana</i>	*	*	
<i>Hibbertia huegelii</i>		*	
<i>Hibbertia hypericoides</i>	*	*	*
<i>Hybanthus calycinus</i>	*		
<i>Hypocalymma robustum</i>		*	
* <i>Hypochaeris glabra</i>	*	*	
<i>Jacksonia furcellata</i>	*		
<i>Kennedia prostrata</i>		*	
<i>Lechenaultia stenosepala</i>	*		
<i>Lepidosperma squamatum</i>	*	*	
<i>Leucopogon capitellatus</i>	*	*	
<i>Levenhookia stipitata</i>		*	
<i>Lomandra hermaphrodita</i>	*		
* <i>Lotus</i> sp.	*		
* <i>Lupinus</i> sp.	*		
<i>Macrozamia riedlei</i>	*	*	*
<i>Melaleuca systema</i>	*		
<i>Mesomelaena pseudostygia</i>	*	*	*
* <i>Moraea flaccida</i>	*		*
<i>Opercularia vaginata</i>	*	*	
<i>Orthosanthus laxus</i> var. <i>laxus</i>	*	*	*
* <i>Pelargonium capitatum</i>	*	*	
<i>Petrophile linearis</i>		*	
<i>Phyllanthus calycinus</i>	*	*	
<i>Pimelea</i> ? <i>suaveolens</i> subsp. <i>suaveolens</i>		*	
<i>Podolepis gracilis</i>		*	
<i>Poranthera microphylla</i>			*
<i>Ptilotus manglesii</i>	*	*	
<i>Ptilotus polystachyus</i>	*		
<i>Ptilotus stirlingii</i> var. <i>stirlingii</i>	*	*	
<i>Ricinocarpus glaucus</i>	*	*	*
<i>Scaevola canescens</i>	*	*	
<i>Scaevola repens</i> ?var. <i>angustifolia</i>	*		
<i>Schoenus clandestinus</i>	*	*	
* <i>Silene gallica</i>		*	
<i>Sowerbaea laxiflora</i>		*	*

**APPENDIX B: VASCULAR PLANT SPECIES RECORDED WITHIN EACH
PLANT COMMUNITY, OCTOBER 2003**

SPECIES	W1	W2	W3
<i>Stenanthemum notiale</i> subsp. <i>chamelum</i>		*	
<i>Stirlingia latifolia</i>		*	
<i>Stylidium amoenum</i>		*	
<i>Stylidium calcaratum</i>			*
<i>Stylidium macrocarpum</i>	*		
<i>Synaphea spinulosa</i>	*		
* <i>Taraxacum officinale</i>	*		
<i>Tetragia octandra</i>	*	*	
<i>Thysanotus manglesianus</i>	*		*
* <i>Trachyandra divaricata</i>	*		
<i>Trachymene pilosa</i>		*	*
<i>Tricoryne elatior</i>	*		
* <i>Ursinia anthemoides</i>	*	*	*
* <i>Wahlenburgia capensis</i>	*	*	
<i>Waitzia suaveolens</i> var. <i>suaveolens</i>		*	*
<i>Xanthorrhoea preissii</i>	*	*	*

Note: * denotes introduced species

APPENDIX C: GPS LOCATIONS OF SITES (GDA 94)

SITE	E	N	Location
1	383636	6478785	Lilburne Reserve
2	383698	6478739	Lilburne Reserve
3	383804	6478799	Lilburne Reserve
4	383624	6479098	Western Power
5	383553	6479116	Western Power
6	383485	6479105	ex-FESA

APPENDIX D: PHOTOGRAPHIC RECORD OF PLANT COMMUNITIES



Photograph 1: Plant community W1

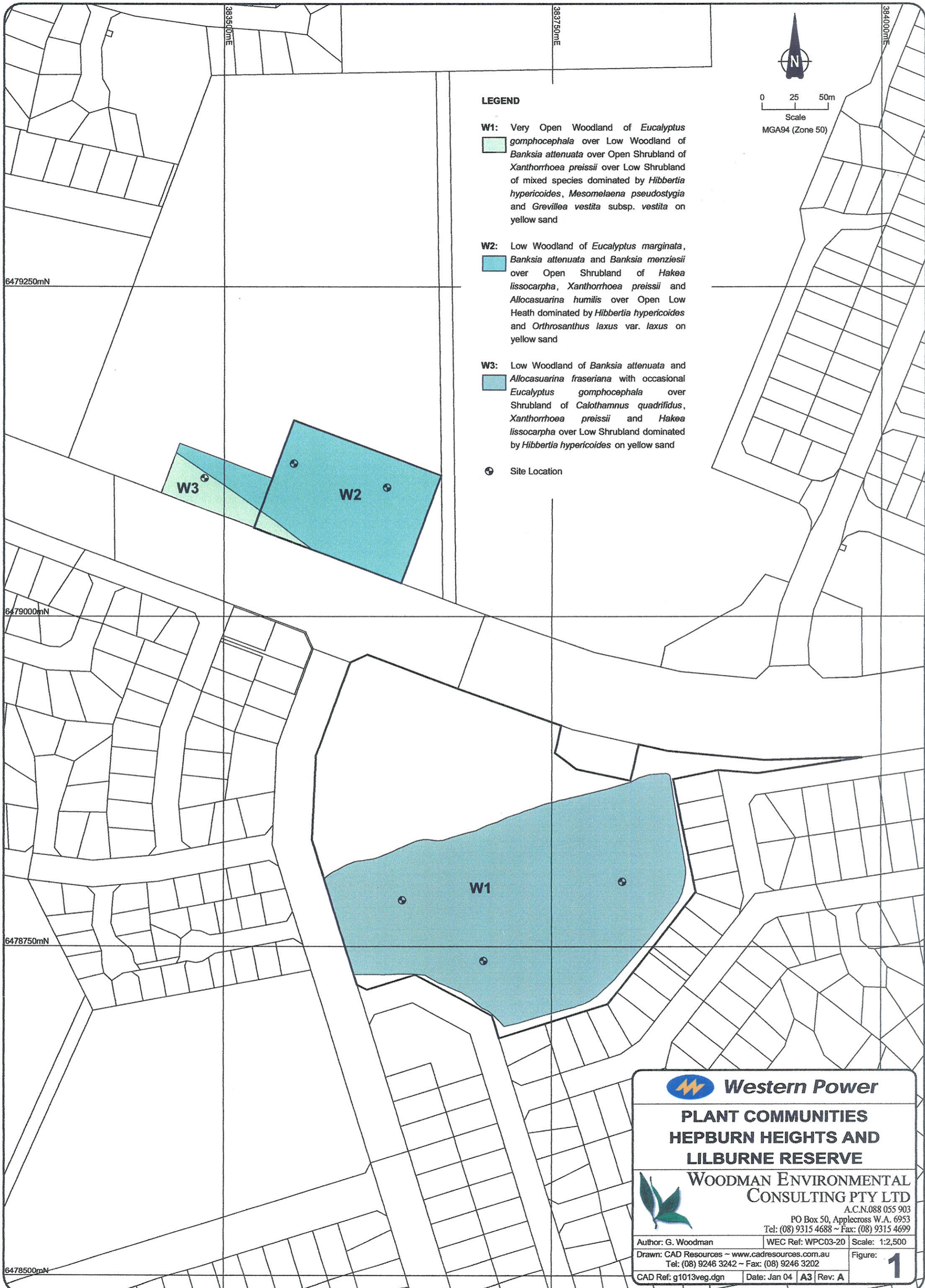


Photograph 2: Plant Community W2

APPENDIX D: PHOTOGRAPHIC RECORD OF PLANT COMMUNITIES



Photograph 3: Plant Community W3



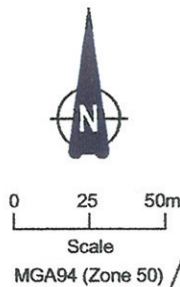
LEGEND



W1: Very Open Woodland of *Eucalyptus gomphocephala* over Low Woodland of *Banksia attenuata* over Open Shrubland of *Xanthorrhoea preissii* over Low Shrubland of mixed species dominated by *Hibbertia hypericoides*, *Mesomelaena pseudostygia* and *Grevillea vestita* subsp. *vestita* on yellow sand

W2: Low Woodland of *Eucalyptus marginata*, *Banksia attenuata* and *Banksia menziesii* over Open Shrubland of *Hakea lissocarpa*, *Xanthorrhoea preissii* and *Allocasuarina humilis* over Open Low Heath dominated by *Hibbertia hypericoides* and *Orthrosanthus laxus* var. *laxus* on yellow sand

W3: Low Woodland of *Banksia attenuata* and *Allocasuarina fraseriana* with occasional *Eucalyptus gomphocephala* over Shrubland of *Calothamnus quadrifidus*, *Xanthorrhoea preissii* and *Hakea lissocarpa* over Low Shrubland dominated by *Hibbertia hypericoides* on yellow sand

⊕ Site Location



 Western Power	
PLANT COMMUNITIES HEPBURN HEIGHTS AND LILBURNE RESERVE	
 WOODMAN ENVIRONMENTAL CONSULTING PTY LTD	
A.C.N.088 055 903 PO Box 50, Applecross W.A. 6953 Tel: (08) 9315 4688 ~ Fax: (08) 9315 4699	
Author: G. Woodman	WEC Ref: WPC03-20 Scale: 1:2,500
Drawn: CAD Resources ~ www.cadresources.com.au Tel: (08) 9246 3242 ~ Fax: (08) 9246 3202	Figure: 1
CAD Ref: g1013veg.dgn	Date: Jan 04 A3 Rev: A