

AREA INFORMATION

System 6 Area (C or M) or Update Area (Update) *HS* *Yard Nature Reserve*

Conservation Area
Nature Reserve
Reserve No
National Park
Reserve No
Local Government
Reserve No
Other
Proposed Conservation Areas
Local Government
Reserve No
Other

Conservation Area

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

AREA

Total Area	hectares
Completely Degraded	hectares
comments:	

AREA MAPPED FLORISTIC UNITS

Boundaries: System6 CALM

Units	Site (Condition)	Code	Bound	Area (ha)	Area(ha)

Boundaries determined by use of *10/12/02* *Metro Regional Area*

aerial photograph	<i>R7 5076-78</i>	<i>R8 5160-75</i>	<i>11/12/02</i>
orthophoto	<i>2034 T NW</i>	<i>2035 S SW</i>	
vegetation map			
soil map			

SHEET 1: System 6 - REPORT Information Search

Date 31/5/94

Please circle the appropriate response or respond in the space provided.

Not at EPA
3-10-96

Area M <u>5</u> Name
Title <u>Vegetation and Rare Floras Cross-tropical Wave Observatory Site</u> <u>2 Report</u>
Published/Unpublished <u>Unpublished</u> Date <u>1993, 1990</u>
Author/s <u>A. Weston</u>
Location of Publication <u>Author, D. Blair (Uni WA Physics)</u>
Purpose (why was the report prepared?)
Government <u>University of W.A</u>
Corporate
Community Group
Management Plan

Soils
Units mapped <u>described</u> referenced <u>brief</u>

Landscape
Features <u>described</u> referenced

Flora
Vegetation Map
Units <u>descriptions Droad</u> Site based (no) <u>general community</u> <u>(more detail unusual areas)</u>
Mapped
Veg Units <u>Comparable Heddle et al</u> Compared Heddle et al. Unit not mapped by Heddle et al.
Flora list <u>basic</u>
Timing %completion <u>10-20% (indicator species)</u> Significant Taxa
<u>2 visits</u> <u>Trees</u> <u>Shrubs</u> <u>Herbs</u> <u>Sedges</u> <u>Weeds</u> DRF CALM Priority Other

Winter/Spring
1990/1991

Fauna
Timing %completion Significant Taxa
Mammals Birds Sched1 Sched2 Other
Reptiles Invertebrates

Vegetation Condition
Site based Mapped Units <u>general</u>

Disturbance Factors
Phytophthora <u>observed</u> Other <u>incidental</u> tested itemised

Notes

M5 Yeal Nature Reserve

Bulletin 535 - Application mining lease

Other Names: State Forest 65 (part), Gnanangara Water Mound, Gingin Airfield

Specific Study/studies Miscellaneous studies

Flora

Vegetation Map	1	2	3	
Flora list		1	2	3, <u>4</u>
Significant Taxa		done	<u>suitable / doubtful</u>	

Fauna

Mammals
Birds
Reptiles and Amphibia
Invertebrates

Vegetation Condition Map Sites Comment

Disturbance Factors Comment Management

Swan Coastal Plain Floristic Survey (two transects)

AHC: National Estate- Listed / Interim / Notified

National Trust: Heritage Classification

<p>M5 Yearly Nature Reserve Bulletin 535 - Application mining lease</p>		
<p>M5.1 The Vacant Crown land be declared "C" Class Reserve for Conservation of Flora and Fauna, and Water and be vested in NPNCAs for a limited term of 10 years and managed under a published management plan.</p>	<p>Implemented</p>	<p>The land has been made a C Class nature reserve vested in the NPNCAs (gazetted 18/12/92). CALM's 1992 draft Forests Strategy recommends part of area as nature reserve. The 10 year period referred to is no longer relevant under current Government policy on mining in national parks. The area was proposed for interim listing in November by the Australian Heritage Commission</p>
<p>M5.2 Access to new Reserve (M5.1) for mineral exploration and evaluation be permitted under the conditions held in the vesting order protecting conservation value</p>	<p>Intent Being Met</p>	<p>Government policy on mining in national parks provides for this recommendation.</p>
<p>M5.3 Purpose of Reserve C33784 be amended to Conservation of Flora and Fauna, and Water and Reserve be vested in the NPNCAs.</p>	<p>Implemented</p>	<p>The change in purpose and vesting was gazetted on 18/12/92.</p>
<p>M5.4 Reserve C31241 be classified "A"</p>	<p>Implemented</p>	<p>July, 1992.</p>
<p>M5.5 Commonwealth retain maximum uncleared land within Gingin airfield.</p>	<p>Unresolved Issues</p>	<p>EPA is liaising with DASET to develop a mechanism for achieving the intent of the recommendation.</p>

Area M S Name	<u>Yeal Swamp transect for study</u>		
	<u>below</u>		
Source	<u>E.A. Griffin - Regional Study of the Northern Sandplain</u>		
Purpose (why was the study done?)	<u>NEGP</u>		
Government	<u>Commonwealth</u>		
Corporate			
Community Group			
Management Plan			
	<u>Report</u>		
Publication Planned	<input checked="" type="radio"/> Yes	<input type="radio"/> No	Date <u>mid 1994</u>
Planned Location	<u>Heritage Commission</u>		

Soils	
Units	<input checked="" type="radio"/> described <input checked="" type="radio"/> referenced

Landscape	
Features	<input checked="" type="radio"/> described <input checked="" type="radio"/> referenced

Flora	<u>Regional Study</u>		
Vegetation Map			
Units	<u>Muir, located AMG</u>	Site based (no)	<u>10x10m (10+)</u>
Mapped			
Veg Units	<input checked="" type="radio"/> Comparable Heddle <i>et al.</i>	Compared Heddle <i>et al.</i>	Unit not mapped by Heddle <i>et al.</i>
Flora list			
Timing	% completion <u>95% sites</u>	<input checked="" type="radio"/> Significant Taxa	
<u>Spring</u>	<input checked="" type="radio"/> Trees <input checked="" type="radio"/> Shrubs <input checked="" type="radio"/> Herbs <input checked="" type="radio"/> Sedges	<input checked="" type="radio"/> Weeds	DRF CALM Priority Other

Fauna	
Timing	% completion
	Mammals Birds
	Reptiles Invertebrates
	Significant Taxa
	Sched1 Sched2 Other

Vegetation Condition	
Site based	Mapped Units
Disturbance Factors	
Phytophthora	observed Other incidental
	tested itemised

Notes
<ul style="list-style-type: none"> • sites located to sample communities being studied. • site information both floristic and abundance/cover according to a ranked cover scale • sites visited once

Area M ₅ Name	<i>Arangara Water Mound</i>		
Source	<i>Swan Coastal Plain Floristic Survey</i> <i>(see General)</i>		
Purpose (why was the study done?)			
Government			
Corporate			
Community Group			
Management Plan			
Publication Planned	Yes	No	Date
Planned Location			

Soils			
Units	described	referenced	

Landscape			
Features	described	referenced	

Flora			
Vegetation Map			
Units	Site based (no)	<i>10</i>	
Mapped			
Veg Units	Comparable Heddle <i>et al</i>	Compared Heddle <i>et al</i>	Unit not mapped by Heddle <i>et al</i>
Flora list			
Timing	%completion	Significant Taxa	
	Trees Shrubs Herbs Sedges	Weeds	DRF CALM Priority Other

Fauna			
Timing	%completion	Significant Taxa	
	Mammals	Birds	Sched1 Sched2 Other
	Reptiles	Invertebrates	

Vegetation Condition			
Site based	Mapped	Units	
Disturbance Factors			
Phytophthora	observed	Other	incidental
	tested		itemised

Notes			
	<i>Two transects of area from E-W</i>		
	<i>N ≈ Redwood Rd</i>	<i>6</i>	<i>quadrats</i>
	<i>S ≈ Clover Rd</i>	<i>4</i>	<i>quadrats</i>

SUBMISSION No.
(File No.)

NAME ON SUBMISSION

SUBMISSION IN BRIEF

262 (6)	Dept. of Administrative Services (Australian Gov't.)	General comment: protection of flora & fauna may require modification for protection of aircraft safety (birds, fire hazards etc.)
306 (7)	B.H. Muir	Agrees, 5.2 not vested in W.A.W.A.
423 (10)	N.F. Fewster	
462 (11)	Shire of Wanneroo	Supports but is concerned that future gas pipelines and powerlines may reduce area's conservation value.
501 (12)	M.A. Vaughan	Opposes mining, wants flora & fauna survey.

M5 YEAL NATURE RESERVE

The area comprises Reserves C31241, for Conservation of Flora and Fauna, vested in the W.A. Wildlife Authority; and C33784, for Government Requirements, not vested; Location 8011 (Gingin Airfield), owned by the Commonwealth of Australia; and vacant Crown land. It is situated about 10 km west of Gingin (Figure 81).

Gingin Airfield has vegetation which ranges from low open-forest and low woodland of banksia and pricklybark to low woodland of paperbark.

The section north-west of the airfield has deep pale grey sands with low woodland of banksia, Christmas tree and pricklybark with some stands of jarrah and marri and a varied understorey which includes telegraph sedge and silky bloodflower. On moister sands and peats there is closed-forest of paperbark, with some flooded gum and an understorey of species including sedge. North of the airfield there is woodland and open-woodland of marri, and low woodland of paperbark and swamp banksia with some holly-leaf banksia. The understoreys carry pea plant and white myrtle, and include closed-scrub of wattle. South of the airfield there is a swamp area, and to the east of this is woodland of jarrah and marri, with a second storey of sheoak and bull banksia, and a varied understorey. There is a series of high dunes in the south-eastern section of the area, and the adjacent Commonwealth Bombing Range.

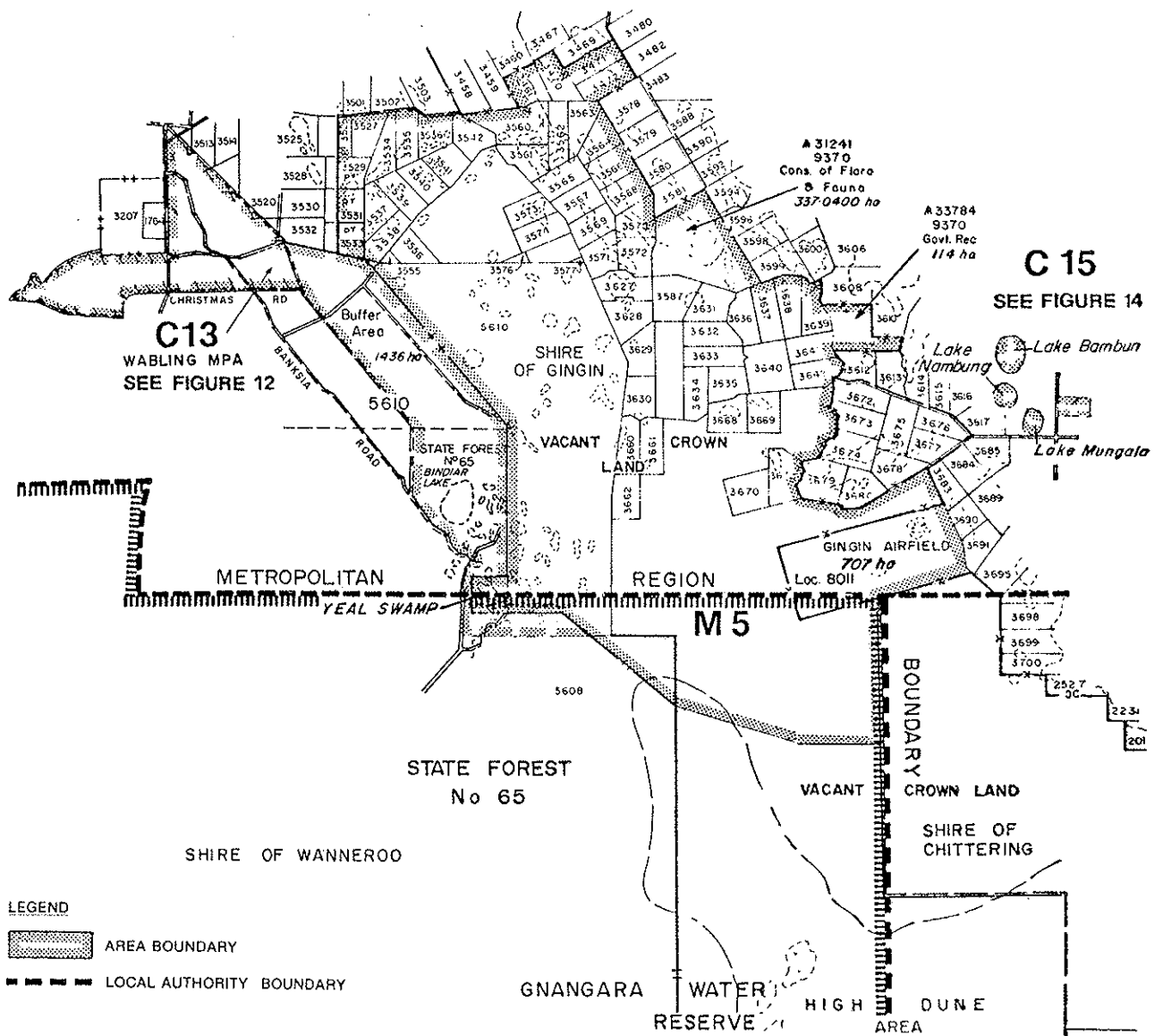
The whole of the proposed Yeal Nature Reserve has very high conservation value. It contains the northernmost extension of jarrah on the Coastal Plain. Because of its vegetation and soil formations, the area is of great scientific interest and is well worth preserving.

Yeal Swamp and Reserves C31241 and C33784 lie within the Gnangara Water Reserve, and within the proposed Underground Water Pollution Control Area and Public Water Supply Area. Reserve C31241 is within the Gingin Brook Catchment, and Reserve C33784 is within the Ellen Brook Catchment. Water levels are likely to be affected by proposed groundwater extraction.

There are SEC lines and a gas pipeline in the area and future gas and powerlines and road construction may also affect it. There are numerous mineral claims in the area. Mining for diatomite in Yeal Swamp has been approved by the W.A. Wildlife Authority under strict conditions. This would deepen the swamp and possibly minimise the effects of groundwater extraction. The adjacent Commonwealth Bombing Range has not been cleared of unexploded ordnance, so that public access is restricted.

Recommendations

- M5.1 Reserve C31241 should be classified as Class A.
- M5.2 Reserve C33784 should be cancelled and its area, together with the vacant Crown land, should be declared a Class C Reserve, for Conservation of Flora and Fauna, Water, and Mining, vested jointly in the Ministers for Conservation and Environment, Water Resources, and Mines.
- M5.3 The Geological Survey of Western Australia should give a high priority to the early evaluation of the mineral potential of Reserve C33784 and the vacant Crown land.
- M5.4 The Commonwealth of Australia should retain, where possible, uncleared areas within Gingin Airfield.



LANDS DEPARTMENT PUBLIC PLAN N°
 GINGIN 40 SHTS 1,2,3,4, MOORE RIVER NW
 SWAN 1:10000 BG 35/3-5
 DCE Ref. No A8, A 10-2, A11, A15,

SHIRES OF GINGIN, WANNEROO and CHITTERING

Figure 81



HON. MINISTER FOR CONSERVATION
AND THE ENVIRONMENT

3410
198/76 IB:tg

also 110/81 45

FOR YOUR ADVICE

Re: A.V. Crane M.L.A. - B. McMurdo, Wildflower Cultivation,
Lots 3670 to 3680 inclusive, Conditional Purchase Lease
Application.

The report and recommendations contains information and advice
on the above proposal.

Report;

1. Lots 3670 to 3680 inclusive are located about halfway
between the Muchea and Gingin townsites (Attachment 1)
and about 1.0 km north of the Gingin Airfield (Attachment 2).
2. The total area of the land is about 770 ha.
3. A well made gravel road gives access to only Lots 3672,
3675, 3676, 3677 and 3678. The other lots have some access
via a rough sand track.
4. The subject land is uncleared and the vegetation appears
healthy with a more dense growth in the wetland areas
(Attachment 3).
5. The topography is of low sand dunes with intermittent
swamps in the dune swales.
6. The whole of the subject land is vacant Crown land and is
zoned Rural under the Gingin Town Planning Scheme.
7. The adjoining land to the north and east is freehold and is
mostly cleared or partly cleared

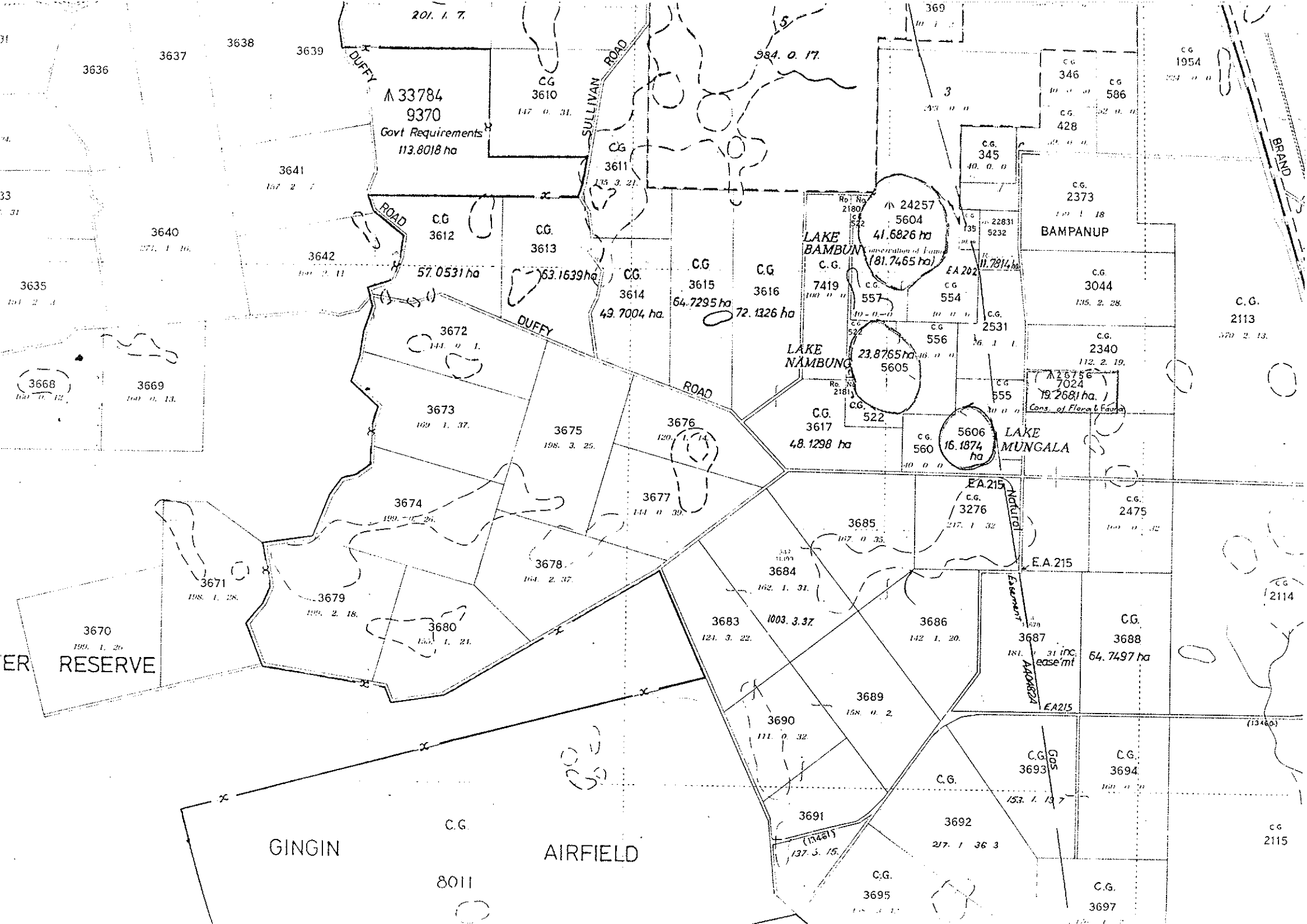
8. A portion of the subject land, Lots 3670 and 3671 (the western most lots), are located within both the System 6 Report's recommendation area M5 and the Gngangara Water Reserve (Attachment 2 & 4).
9. In brief, the System 6 recommendation M5 recommends that nearly the whole of the proposed Yeal Nature Reserve including Lots 3670 and 3671 become a Class C reserve for Conservation of Flora and Fauna, Water and Mining and be vested in the Ministers for Conservation and the Environment, Water Resources and Mines.
10. There is also a System 6 recommendation area to the east C15 and recommends that the wetlands be protected (Attachment 2).
11. There are two current mining leases on the subject land (Attachment 5).
12. The Department of Lands and Surveys report on past leases for the subject land (Attachment 6) shows that a similar application was made in March 1981 and this was refused.
13. The wildflower harvesting season lasts only several weeks in the year. Unless there is to be cultivation (and the application suggests that this will be minimal) conditional purchase and presumably eventual freehold appears to be unnecessary. This is similar to the recommendation made in the Conservation and Environment Council's "Report on Wildflower Farms" which you have recently viewed.
14. In any case freeholding of the land in question would be undesirable because:
 - (i) Two of lots (3670 and 3671) lie within the System 6 proposed new reserve.
 - (ii) Proximity to the proposed new reserve.
 - (iii) Proximity to Gingin Airfield.
 - (iv) Proximity to the Gngangara Water Reserve, into which the subject land drains.

Recommendations

1. Lots 3672 to 3680 inclusive - a Conditional lease is not warranted, however, a short term or special lease would be more appropriate.
2. In respect of Lots 3670 and 3671, no lease should be granted as they form part of the System 6 proposed new reserve.

C.F. Porter
DIRECTOR

5th March, 1982



33784
9370
Govt Requirements
113.8018 ha

3612
57.0531 ha

3613
63.1639 ha

3614
49.7004 ha

3615
64.7295 ha

3616
72.1326 ha

24257
5604
41.6826 ha
181.7465 ha
Conservation of Family

LAKE NAMBUNG
23.8765 ha
5605

5606
16.1874 ha

LAKE MUNGALA

7024
19.2681 ha
Cons. of Forest & Fauna

EA 215
3276

2475

3688
64.7497 ha

GINGIN

AIRFIELD

C.G.
8011

3691
137.5.15

C.G.
3695

3692
217.1.36.3

C.G.
3697

C.G.
2115

C.G.
2114

C.G.
2113

370.2.13.

C.G.
2373

111.1.18

C.G.
3044

135.2.28.

C.G.
2340

112.2.19.

C.G.
2113

370.2.13.

C.G.
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3688

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BACKGROUND INFORMATION ON SWAN LOCATIONS 3670 TO 3680
INCLUSIVE - SUPPLIED BY UNDER SECRETARY FOR LANDS.

Swan Locations 3670 to 3680 inclusive were surveyed in 1933 ex vacant Crown land.

Classifications of the land in 1933 by Mr Surveyor W.H. Brown indicated the land to be suitable for "intense culture" and "grasses".

No evidence exists as to why the land was not made available for Conditional Purchase release.

In 1968 a Mr J.L.G. Marshall obtained a lease over Swan Locations 3672 to 3680 for the purpose of "Carob Bean Tree Experimentation". The lease was cancelled in 1973 at the request of the lessee following fires in the Gingin-Muchea area that destroyed all trees and improvements.

The land has remained vacant but is now being considered by the System 6 Study (item M5) for consolidation as part of the Yeal Nature Reserve.

An application was received in March 1981 to select Locations 3670 to 3680 for the cultivation of wildflowers, however, the application was declined. At the time, policy on such land use was still being formulated and the applicant was advised that if land was released (anywhere in the State) for cultivation of wildflowers, he would be afforded the opportunity of applying.

B.L. O'Halloran
UNDER SECRETARY FOR LANDS.

February 24, 1982.
TH:DLF

27 JAN 1982

Mr A.V. Crane, M.L.A.
Member for Moore
167 Wanneroo Road
WANNEROO 6065

Dear Mr Crane

My Minister has asked that I acknowledge your letter of January 7 regarding Mr B.R. McMurdo and his interest in cultivating wildflowers.

The Masters has forwarded the correspondence to the Department of Conservation and Environment and no doubt you will be hearing from the Hon. I.J. Laurance, MLA in due course.

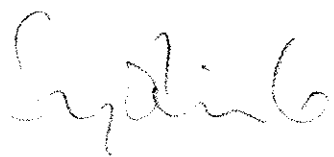
Yours sincerely

Secretary to Minister

January 22, 1982

DIRECTOR
CONSERVATION & ENVIRONMENT:

For your advice please.





167 Wanneroo Road,
WANNEROO, W.A. 606

Telephone: 405 3139

34

Parliament House,

Perth 6000

RECEIVED	3410
15 JAN 1982	
MINISTER FOR CONSERVATION & ENVIRONMENT	

7th January, 1982.

The Hon. G. Masters, M.L.C.,
Minister for Conservation and the Environment,
PERTH

Dear Mr. Masters,

Further to my previous discussions with you on this matter and a deputation you received from Mr. B. R. McMurdo of Heath Rise, Carine, I wish to make further representation on his behalf and support his submission to System 6 Committee, which he has forwarded to your Department.

For your information I am enclosing herewith a copy of this submission for your own file.

As stated during discussions with Mr. McMurdo, he is genuinely interested in preserving this area and cultivating wild flowers as a business. I believe he is not interested in capital gain but in genuine production and the preservation of our natural assets.

For these reasons I give him my fullest support and would appreciate if you could help him to obtain the area of land for which he has applied.

Yours sincerely,

A. V. CRANE, M.L.A.
MEMBER FOR MOORE

TO: The Department of Conservation and Environment

35

Attachment to System 6 Study Submission Form

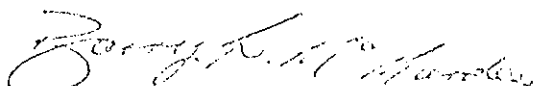
FROM: Mr B R McMurdo
8 Heath Rise
CARINE

- 1 I have recently applied to the Minister for Conservation and Environment for the area Lots 3670-3680, Crown land within the Shire of Gingin, on a Conditional Purchase Lease, for the purpose of farming wildflowers.

The area has previously been leased (approximately 1976).

- 2 As stated in my submission to the Minister, the management of this area would be of a strict nature; my goal is to preserve our natural heritage, not destroy it.
- 3 There would be minimal clearing of the land.
- 4 The wetlands within the boundaries would be kept, as far as possible, in their natural state.
- 5 The area has a great variety of wildflowers growing on it in pickable quantities. As you are aware - I am sure - picking the majority of our wildflowers encourages their growth, it does not destroy them.
- 6 In my submission, I have indicated my willingness to liase with any responsible authority with regard to the management of this parcel of land. I would not object to acceptable and workable restrictions being placed on the venture. -
- 7 The President of the Shire of Gingin has indicated that the Shire would be willing to support a venture of this nature within its boundaries and they raise no objection to a lease on this parcel of land.
- 8 If the proposed Neal Nature Reserve is, as stated, of a very high conservation value because of its vegetation and soil formation, why do the recommendations have to suggest that this area be evaluated for its mineral potential?

I do not agree with this recommendation. I submit that the area should be preserved, not destroyed or altered because of the presence of minerals - or anything else, for that matter!


B R McMurdo

30 November 1981

EPA – POLLUTION CONTROL OFFICE
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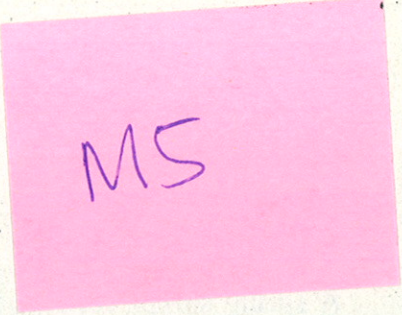
Application for mining leases 70/378 and 70/379, Yeal Swamp

Mr I Rule, Mr H Horton, Mr & Mrs Hines and Mr P Rule

Report and recommendation
of the Environmental Protection Authority

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Environmental Protection Authority
Perth, Western Australia
Bulletin 535
June 1991



REPORT ON
SPRING SURVEY FOR DRF AND PRIORITY SPECIES
AUSTRALIAN INTERNATIONAL GRAVITATIONAL OBSERVATORY
SITE
WALLINGUP PLAIN
SHIRE OF GINGIN

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SUMMARY

A spring survey for rare flora along and near the site of the 3 km long arms of a proposed gravitational observatory on Wallingup Plain was undertaken on 21 October and 2 November 1990. The six principal Declared Rare Flora species searched for during the survey were:

- o *Diuris purdiei*
- o *Drakaea jeanensis* (now referred to as *Drakaea elastica*)
- o *Drosera occidentalis*
- o *Hydrocotyle lemnoides*
- o *Aponogeton hexatepalus*
- o *Dryandra mimica*

The eleven principal Priority species searched for were:

- o *Chamelaucium* aff. *megalopetalum* (now referred to as *Chamelaucium* sp. Gingin)
- o *Conostephium minus*
- o *Haemodorum loratum*
- o *Helipterum pyrethrum* (now referred to as *Rhodanthe pyrethrum*)
- o *Gonocarpus pithyoides*
- o *Jacksonia sericea*
- o *Phlebocarya filifolia*
- o *Restio stenostachyus*
- o *Tetralthea pilifera*
- o *Eucalyptus foecunda*
- o *Stachystemon axillaris*

Two of the Priority species, *Cartonema philydroides* and *Conostephium minus*, were found in and near the Survey Area during the survey, and there may be habitats there for nine other DRF and Priority species having ranges that more or less include the Wallingup Plain or nearby areas. These species are *Caladenia huegelii*, *Drakaea elastica*, *Daviesia physodes*, *Gonocarpus pithyoides*, *Lysinema elegans*, *Macarthuria apetala*, *Restio stenostachyus*, *Tetralthea pilifera* and *Stachystemon axillaris*. Neither of the two DRF species, the *Caladenia* and the *Drakaea*, have been found as far north-west as the Wallingup Plain.

In order to minimise the project's potential to damage wetlands in the area and possible habitats for rare plants it is recommended that the proposed observatory site be shifted up to 1 to 1.5 km west and 1 to 1.5 km south.

The report also recommends that in so far as possible:

- o existing tracks be used for access,
- o widths of access tracks and clearing for the observatory be kept to a minimum, and
- o provision be made in planning the observatory for animals to cross over or under it.

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**SPRING SURVEY FOR ENDANGERED AND RESERVE FLORA SPECIES
AUSTRALIAN INTERNATIONAL GRAVITATIONAL OBSERVATORY
SITE
WALLINGUP PLAIN, SHIRE OF GINGIN**

1.0 INTRODUCTION

In a letter to John Ferreirinho, University of Western Australia's Department of Physics, dated 9 May 1990, staff from the Department of Conservation and Land Management's (CALM) Northern Forest Region office (Alan Briggs and Sue Moore) suggested that a botanist resurvey the Physics Department's proposed gravitational observatory site on Wallingup Plain for rare flora in October. The letter and an enclosure highlighted six declared rare species and eleven priority species to be looked for during the suggested spring survey, particularly within wetland areas. The letter and enclosure (1989 lists of Priority species of the Northern Forest Region, which is now part of the Swan Region) are reproduced here as Appendix 1.

The survey was suggested to supplement a previous rare flora survey of the proposed observatory site done in June 1989. The location of the proposed observatory site is shown in Figure 1, at a scale of 1:50 000. Blair *et al.* (1990?) give details of the observatory.

The report on the previous survey (Weston 1989) also gives brief descriptions of the observatory site Survey Area's physical environment and vegetation. The report is reproduced here, with corrections of typographical errors, as Appendix 2.

The six Declared Rare Flora (or 'Declared Endangered Flora') species highlighted in the CALM letter are:

- o *Diuris purdiei*
- o *Drakaea jeanensis* (now referred to as *Drakaea elastica*)
- o *Drosera occidentalis*
- o *Hydrocotyle lemnoides*
- o *Aponogeton hexatepalus*
- o *Dryandra mimica*

The eleven Priority (or 'Reserve List Flora') species highlighted in the CALM letter are:

- o *Chamelaucium* aff. *megalopetalum* (now referred to as *Chamelaucium* sp. Gingin)
- o *Conostephium minus*
- o *Haemodorum loratum*
- o *Helipterum pyrethrum* (now referred to as *Rhodanthe pyrethrum*)

- o *Gonocarpus pithyoides*
- o *Jacksonia sericea*
- o *Phlebocarya filifolia*
- o *Restio stenostachyus*
- o *Tetratheca pilifera*
- o *Eucalyptus foecunda*
- o *Stachystemon axillaris*

These 17 species and other Swan (Metropolitan plus Northern Forest) Region Declared Rare Flora (DRF) and Priority (P) species and other significant species were searched for on 21 October and 2 November 1990. Lists of DRF and Priority species most likely to have ranges which include the Survey Area are included in this report as Tables 1 and 2.

On the first date my colleague, Robert Saffrey, and I drove and walked through the Proposed Gravitational Observatory Site Survey Area and nearby looking for significant flora species and their habitats. Although we concentrated our survey on "wetlands", we also looked at numerous sites and transects in banksia woodlands. On the second date I drove through the area with CALM staff officers Roger Hearn, Sue Moore and Ken Atkins looking for significant species Robert Saffrey and I had noted during the earlier field trip.

This report addresses the spring 1990 surveys and discusses DRF, Priority, rare, geographically restricted, threatened, vulnerable and poorly collected species, with particular reference to the species sought during the searches. It also presents reproductions of photographs of vegetation of the Survey Area and the Priority species found during the survey.

The 1990 Survey Area is essentially the same as the 1989 Survey Area except that the arms of the proposed observatory site were reduced from 4 km long in 1989 to 3 km in 1990. The Survey Area is north and north-east of the Yanchep Pine Plantation in State Forest No. 65, between Military (Old Yanchep) Road and Gingin Brook Wanneroo Branch.

2.0 VEGETATION

Weston (1989) and McArthur and Matiske (1985) have brief descriptions and maps of the vegetation of the Survey Area, and Dames & Moore (1990) describes similar vegetation in an area south of the Survey Area. Plates 3 and 4 of this report, photographs of the principal types of vegetation in the Survey Area, have captions which also describe the vegetation.

The distribution of vegetation in the Survey Area - woodlands, shrublands and herbaceous plant communities - reflects the pattern of low relief, sandy rises or plain dotted with many small seasonal swamps. The rises have Open Low Woodland dominated by species of *Banksia*, mainly *Banksia attenuata* and *B. menziesii*, with understories dominated by *Eremaea pauciflora* heath on higher areas and *Dasypogon bromeliifolius* - *Phlebocarya ciliata* sedgeliike plants in low areas. The swamp vegetation is characterised by Flooded Gum

(*Eucalyptus rudis*) and Swamp Paperbark (*Melaleuca raphiophylla*) in many areas. Other species of *Melaleuca* and dense swards of reeds, sedges or other shrubs are usually found with them or characterise other swampy areas. *Banksia ilicifolia* and Moonah Paperbark (*Melaleuca preissiana*) are locally common in both woodland and seasonal swamps. *Eucalyptus tottiana* trees are scattered through the woodland.

3.0 SIGNIFICANT PLANT SPECIES AND HABITATS

3.1 Background

The species searched for during the botanical survey of the Survey Area are those on two sets of unpublished lists, particularly those listed in Section 1 of this report. The lists are:

- o Gazetted Rare Flora (Government Gazette, WA, of 1 June 1990), and
- o Reserve List (Priority) Flora of the Northern Forest Region (CALM: March 1990).

The ten gazetted rare flora (DRF) species with ranges most likely to include the Survey Area, including the six species listed in Section 1, are listed and described in Table 1, and 16 Swan Region Priority species with ranges most likely to include the Survey Area, including the 11 species listed in Section 1, are listed in Table 2. Four of the species, the *Daviesia*, *Lysinema*, *Macarthuria* and *Verticordia*, were added to the Table 2 list in 1994. The Priority (P) code of each species in Table 2 is given in the second column; where the code has been changed since 1990, the current code is given in brackets. The *Phlebocarya* was deleted from Priority status in 1991.

Additional information about the species listed in Tables 1 and 2 is given in the captions to the plates and in Rye and Hopper (1981), Patrick and Hopper (1982), Hopper *et al.* (1990), Hoffman and Brown (1992), Jones (1988), Lowrie (1989), Kelly *et al.* (1990, 1993) and (Marchant *et al.* 1987).

Appendix 3 has background information and a discussion on DRF, Priority and other significant species.

During the 1990 spring survey of the Survey Area, an emphasis was placed on finding the ten species listed and described in Table 1 and the twelve Priority species originally listed and described in Table 2. The majority of them are species of low-lying areas and seasonal wetlands, and most are herbaceous plants and small shrubs which flower in the period between August and November.

The flowering times given in the tables suggest the period when a survey for the DRF species could be undertaken most productively. In the case of some species which are not in flower during that period, leaves may be sufficient for identification. For instance, the *Dryandra*, the

Drakaea and the *Drosera* leaves are distinctive enough for at least tentative identification of the species before they flower. Consequently, surveys done in mid-October and early November 1990, a year in which flowering of many species was delayed by extended winter weather, should have been able to identify any of the DRF species in Table 1, except *Diuris purdiei*, which flowers only after fire.

It should be noted that many native species which are conspicuous when in flower are easily overlooked when not in flower. A good example of this in the Survey Area is *Conostephium minus*, which is common in the Survey Area but was not identified during the June 1989 survey, when it was not in flower. Furthermore, there are series of years when some species, such as *Diuris purdiei*, produce neither leaves nor flowers.

3.2 Significant Plant Species found in the Survey Area

No DRF species was found in the Survey Area.

However, two Priority species, *Cartonema philydroides* and *Conostephium minus*, were found during the survey. These two species are described and discussed below, in Sections 3.2.1 and 3.2.2. The descriptions are based upon my notes, field records and observations, upon information in Marchant *et al.* (1987) and in the Western Australian Herbarium collections and upon information from WAWRC and Western Australian Herbarium botanists. The current, 1992 Priority numbers and the Plate numbers of each species are given in brackets.

3.2.1 *Cartonema philydroides*

(Priority 3; Plate 2)

Cartonema philydroides is a lily-like relative of the spiderwort with a tussock of long, tapering, flaccid leaves and spikes of yellow flowers. The flowers are three-petalled, and only one flower in a spike tends to be open at a time. The flowers are open early in the morning and withered in the afternoon.

One small population of the species was found in a low-lying area near the paperbarks shown in Plate 3B, approximately 200 m north of the eastern arm of the proposed observatory site.

Cartonema philydroides is usually found in small, open colonies on sandy soil on low-lying sites or lower slopes, often in the transitional area between jarrah, marri and *Banksia attenuata* woodlands and *Banksia littoralis* and moonah paperbark woodlands. I have, however, also seen it on lower sites, near swamp paperbarks, and on a higher site, near the centre of Kings Park, in Perth. The plants often favour disturbed and other open sites.

The species has been recorded in a number of locations between Kalbarri National Park and the Ludlow area, west of Capel, on the coastal plain. I have also found it a few hundred metres from the southern ocean: near the mouth of the Meerup River and in stabilised dunes south of the river.

3.2.2 *Conostephium minus*

(Priority 3; Plate 1B)

Conostephium minus is a small shrub that was found to be common on sandy soil in *Banksia* woodland low in the landscape on Wallingup Plain. It has also been found in the Ellenbrook Estate area, in Melaleuca Park, elsewhere in State Forest No. 65 and on nearby vacant crown land (Mattiske pers comm.; Muir pers. comm.; Western Australian Herbarium collections). Habitats from which the species has been collected in these areas range from a yellow sand hill opposite pine plantation block A37 to a minor moist swale 1.2 km west of Perry Road.

Conostephium pendulum plants having small flowers and unusually short leaves with recurved margins may be mistaken for *Conostephium minus*. One apparently consistent qualitative difference between the two species is the conspicuous (with a hand lens) presence of cilia on the margins of flower bracts and sepals of *Conostephium pendulum* and the fuzzy, non-ciliate appearance of bracts and sepals of *Conostephium minus*. Furthermore, *Conostephium minus* pedicels are shorter than *Conostephium pendulum* pedicels.

Plate 1A is a photograph of *Conostephium pendulum*.

3.3 Significant Habitats in the Survey Area

A majority of the DRF and Priority species sought during the survey of the Survey Area occur in a limited range of wetland habitats which have restricted occurrences, such as the clay-based seasonally inundated swamps represented in the Cannington and Kenwick areas. Low-lying banksia woodlands and seasonal swamps and other low-lying areas characterised by paperbarks and other species of *Melaleuca* and species of *Astartea*, *Pericalymma* and cyperaceous and restionaceous sedges are potential habitats for a majority of the DRF and Priority species listed in Tables 1 and 2. Limestone and sand-covered limestone are habitats for others.

No limestone, sand-covered limestone or clay-based seasonally inundated swamp habitat was found in the Survey Area, although other types of wetland areas do occur there. One significant species, *Cartonema philydroides*, was found in or next to one of the wetland areas, and all of the larger and wetter wetland areas in the Survey Area, as well as in the rest of Wallingup Plain, must be considered as potential habitats for significant species. The wetlands, including the smaller, shallower ones as well as the larger and deeper ones, cover a smaller area but encompass a much greater diversity and range of vegetation types and may have more species than the higher, drier habitats. Consequently, all of the wetlands in the Survey Area, and Wallingup Plain in general, should be regarded as significant.

Furthermore, the *Caladenia* and *Drakaea* species on the gazetted list (Table 1) are recorded from woodland habitats possibly of types found in the Survey Area. The *Caladenia*, however, has not been recorded as far north as the Survey Area.

3.4 Discussion

A majority of the species listed in Tables 1 and 2 have ranges or have been collected in habitats which appear to exclude the Survey Area.

Aponogeton hexatepalus, *Caladenia huegelii*, *Diuris purdiei*, *Hydrocotyle lemnoides*, *Jacksonia sericea*, *Rhodanthe pyrethrum* and *Tetraloche pilifera* have not been recorded as far north, and *Eucalyptus argutifolia* and *Eucalyptus foecunda* have been recorded only west of the Survey Area. *Dryandra mimica*, *Chamelaucium* sp. Gingin, *Haemodorum loratum*, *Rhodanthe pyrethrum* and *Restio stenostachyus* have, in the area between Gingin and Perth, been collected only in sites well east of the Survey Area, generally near the Great Northern Highway or east of it.

Substrates for *Aponogeton hexatepalus*, *Eucalyptus argutifolia*, *Hydrocotyle lemnoides*, *Thelymitra stellata*, *Rhodanthe pyrethrum*, *Jacksonia sericea*, *Tetraloche pilifera* and *Eucalyptus foecunda* do not appear to occur in or near the Survey Area. The *Diuris* flowers during the season following a summer fire and would probably not be found otherwise.

Two of the Priority species, *Cartonema philydroides* and *Conostephium minus*, were found in and near the Survey Area during the survey, and there may be habitats there for nine other DRF and Priority species having ranges that more or less include the Wallingup Plain or nearby areas. These species are *Caladenia huegelii*, *Drakaea elastica*, *Daviesia physodes*, *Gonocarpus pithyoides*, *Lysinema elegans*, *Macarthuria apetala*, *Restio stenostachyus*, *Tetraloche pilifera* and *Stachystemon axillaris*. Neither of the two DRF species, the *Caladenia* and the *Drakaea*, have been found as far north-west as the Wallingup Plain.

4.0 DISCUSSION AND RECOMMENDATIONS

Two significant species, the Priority Three species *Cartonema philydroides* and *Conostephium minus*, were found in or near the Survey Area during the 1990 spring survey, but it is very unlikely that construction and operation of the observatory would have more than minimal impacts upon them. Because the *Cartonema* tends to favour disturbed and weedy sites, is inconspicuous when not in flower and is thought to be more abundant than records indicate, Kelly *et al.* (1993) recommend changing the Priority status of this species to Priority Four. The *Conostephium* is difficult or impossible to distinguish from closely related species when it is not in flower, and it too may be more abundant and widespread than records indicate. Consequently, Kelly *et al.* (1993) also recommend changing the Priority status of this species to Priority Four.

Construction and operation of the observatory would be more likely to have environmental impacts upon particular wetland or semi-wetland plant communities than upon any particular significant species. However, since the first flora survey report (Weston 1989) was written,

the arms of the observatory have been shortened to 3 km each, and, as a consequence, the potential for construction and operation of the observatory to have environmental impacts has been reduced.

Additional significant reduction of potential to damage wetlands in the area, particularly the relatively large and deep wetlands on either side of the current site for the observatory's east-west arm, shown in Figure 1, could be achieved by shifting the proposed observatory site 1 to 1.5 km west and 1 to 1.5 km south.

Shifting the site as recommended would also keep the observatory's eastern end from crossing the major north-south track shown on 1:20000 scale black and white Aerial Photographs 5126 and 5136 (WA 2502(C) Gnangara Mound Runs 8 and 7, 6.5.87, 860086).

It is also recommended that in so far as possible:

- o existing tracks be used for access,
- o widths of access tracks and clearing for the observatory be kept to a minimum, and
- o provision be made in planning the observatory for animals to cross over or under it.

5.0 ACKNOWLEDGEMENTS

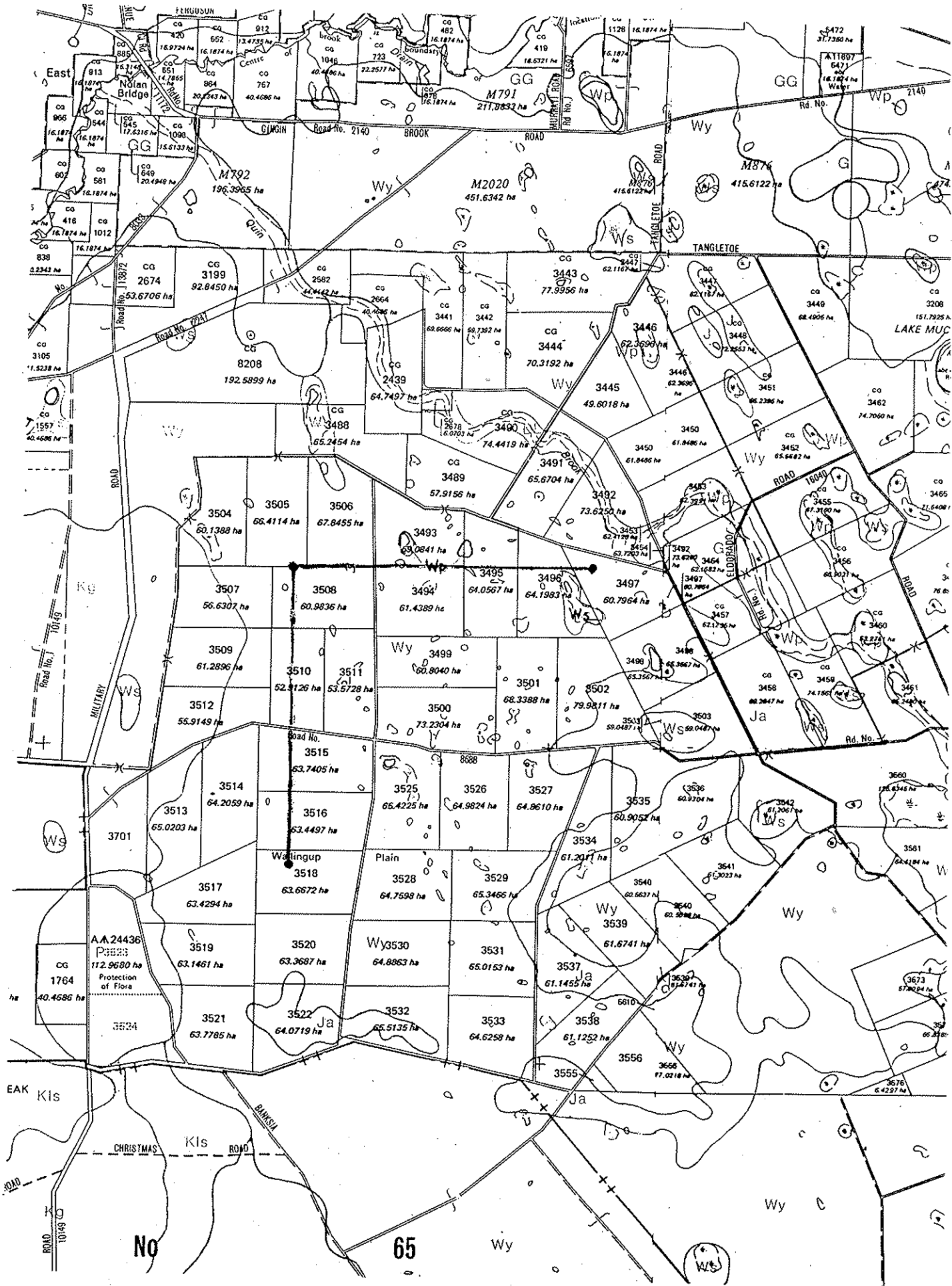
Botanists employed by the Department of Conservation and Land Management, particularly Neville Marchant, Sue Moore, Ken Atkins and Roger Hearn, have provided advice, information and other assistance with the Survey. Robert Saffrey helped with the field work.

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FIGURE



GRAVITATIONAL OBSERVATORY SITE

FIGURE 1

TABLES

Table 1

Endangered (DRF) Flora looked for in the Wallingup Plain Survey Area
(see Government Gazette, WA of 1 June 1990)

<u>Species and Family</u>	<u>Localities and Distribution</u> ¹	<u>Habitat</u> ¹	<u>Flowering Times</u> ¹
<i>Aponogeton hexatepalus</i> APONOGETONACEAE	Kenwick-Darradup-Augusta	Shallow winter pools on clayey soils	(May-)Aug-Sept
<i>Caladenia huegelii</i> (=C. sp. (coastal plain)) ORCHIDACEAE	Gnangara-Margaret River	Sandy soils in banksia and eucalypt woodlands, often with <i>Allocasuarina fraseriana</i> and usually low in the landscape	Aug-Oct(-Nov)
<i>Diuris purdiei</i> ORCHIDACEAE	Southern Perth area-Yarloop	Seasonal semi-swamp on sand-over-clay soils, usually in <i>Regelia</i> and <i>Pericalymma</i> shrublands; flowers in habitats which were burnt the previous dry season	Sept-Oct(-Nov)
<i>Drakaea elastica</i> (=D. <i>jeanensis</i>) ORCHIDACEAE	Gingin-Ruabon	Sandy soils, often firm and very white, in <i>Kunzea ericifolia</i> tall shrubland and banksia woodland, low in the landscape	(Sept-)Oct-Nov
<i>Drosera occidentalis</i> ssp. <i>occidentalis</i> DROSERACEAE	Gingin-Pinjarra; Darling Range ²	With short Centrolepidaceae sedges on peaty, sandy soils which are winter-inundated, usually shallowly, in swampy areas	(Oct-)Nov-Dec
<i>Dryandra mimica</i> PROTEACEAE	Mogumber, Wattle Grove, Whicher Range	Flowers bright yellow; low sandy flat; in heath or scrub in banksia woodland or with <i>Kingia</i> and <i>Byblis</i>	Dec-Feb
<i>Eucalyptus arguitifolia</i> (= E. sp. (Yanchepp)) MYRTACEAE	Lancelin-Mindarie	Limestone outcrops and slopes	Mar-Apr
<i>Hydrocotyle lemnoidea</i> APIACEAE	Upper Swan-Kenwick-Bolgart; Darling Range	Shallow winter pools on clayey soils	Sept-Oct
<i>Ptychosema pusillum</i> FABACEAE	SSE of Cataby, NE of Gingin	<i>Banksia</i> (and jarrah) woodland	Aug-Nov
<i>Thelymitra stellata</i> ORCHIDACEAE	Mt Lesueur-Pinjarra, Pingerup Plains	Lateritic soils in forest and heath	Sep-Oct (in north)

1. The information in this table was compiled from Rye and Hopper (1981), Hoffman and Brown (1984, 1992), Sainsbury (1985), Marchant *et al.* (1987), Lowrie (1989), Hopper *et al.* (1990), Brooker and Kleinig (1990), Powell (1990), Kelly *et al.* (1990, 1993), information provided by L. Mutter and botanists of the Western Australian Herbarium and the WAWRC, and field work by A. S. Weston.

2. *Drosera occidentalis* is now believed to be more abundant and widespread than WAH collections indicate (Atkins and Moore pers. comm.; Lowrie (1989)), and its code has been changed from R (DRF) to P4.

Table 2
Priority Taxa looked for in the Wallingup Plain Survey Area

<u>Species and Family</u>	<u>Priority Code and Distribution</u> ¹	<u>Habitat</u> ¹	<u>Flowering Times</u> ¹
<i>Cartonema philyroides</i> COMMELINACEAE	P3: Kalbarri-Meerup River	Sandy soils, often firm and very white, in <i>Kunzea ericifolia</i> tall shrubland and banksia woodland, low in the landscape	Oct-Jan
<i>Chamelaucium</i> sp. Gingin (= <i>C. aff. megalopetalum</i> , N.Marchant s.n. 4.11.88) MYRTACEAE	P1: 10 km S of Gingin	Woodland on white sand, with <i>Eucalyptus todtiana</i>	Sep-Nov
<i>Conostephium minus</i> EPACRIDACEAE	P1(3): Cataby-Jandakot	Sandy soils in <i>Banksia</i> woodlands	July-Sept(-Nov)
[<i>Daviesia physodes</i>] FABACEAE	(P2): Muchea, Upper Swan (Geraldton-Augusta?)	Low-lying, but not inundated, sandy soils	Sep (Jul-Nov?)
<i>Eucalyptus foecunda</i> MYRTACEAE	P5(4): Lancelin-Lake Preston	Shallow soil over limestone (see Powell 1990)	Jan-May
<i>Gonocarpus pithyoides</i> HALORAGACEAE	P3: Gingin-Jandakot	Lake margins, swamps and sandy soils in heaths and <i>Banksia</i> woodlands	Oct-Nov
<i>Haemodorum loratum</i> (= <i>H. sp. B</i>) HAEMODORACEAE	P2(3): Eneabba-Wattle Grove	Lateritic loam, grey sand and yellow sand soils (Macfarlane 1987)	(Sept-)Nov
<i>Jacksonia sericea</i> PAPILIONACEAE	P3: Wanneroo-Mandurah	Coastal Plain sandy and calcareous soils, usually low in the landscape	Nov-Feb
[<i>Lysinema elegans</i>] EPACRIDACEAE	(P2): Regans Ford-Jandakot	Sandy soils in <i>Banksia</i> woodland	Oct-Dec
[<i>Macarthuria apetala</i>] MOLLUGINACEAE	(P2): Jurien-Harvey	Sandy soils in <i>Banksia</i> woodland	Nov-Feb
<i>Phlebocarya filifolia</i> HAEMODORACEAE	P3(-): Eneabba-Jandakot	Heathland and woodland low in the landscape	Sept-Nov
<i>Restio stenostachyus</i> RESTIONACEAE	P3: Gingin-Serpentine River	Sandy winter-wet depressions and along watercourses	Feb-May (& Nov-Feb?)
<i>Rhodanthe</i> (= <i>Helipterum</i>) <i>pyrethrum</i> ASTERACEAE	P2(3): Bullsbrook-Boyanup	Clay or wet mud	Sept-Oct
<i>Stachystemon axillaris</i> EUPHORBIACEAE	P5(4): Arrowsmith River, Eneabba-Wanneroo	Sandy soils in heath and <i>Banksia</i> woodland	July-Sept
<i>Tetrateca pilifera</i> TREMADRACEAE	P3: Two Rocks, Chidlow	Clay or gravelly Darling Range soils, except GJK 1808 from <i>Banksia</i> woodland 45 mi. N of Perth, between Yanchep and Lancelin	Aug-Sept
[<i>Verticordia lindleyi</i> ssp. <i>lindleyi</i>] MYRTACEAE	(P3): Moore R. - Murray R., 15 mi. W of Gingin	Sandy-clay soils, usually low in the landscape	Nov-Mar

1. The information in this table was compiled from the sources referred to in Table 1 and above and from Priority flora lists. Changes in Priority codes are given in brackets. The names and codes of the four species added to the list in 1994 are bracketed.

PLATES

CAPTIONS - PLATE 1

Conostephium pendulum, Conostephium minus

A *Conostephium pendulum*

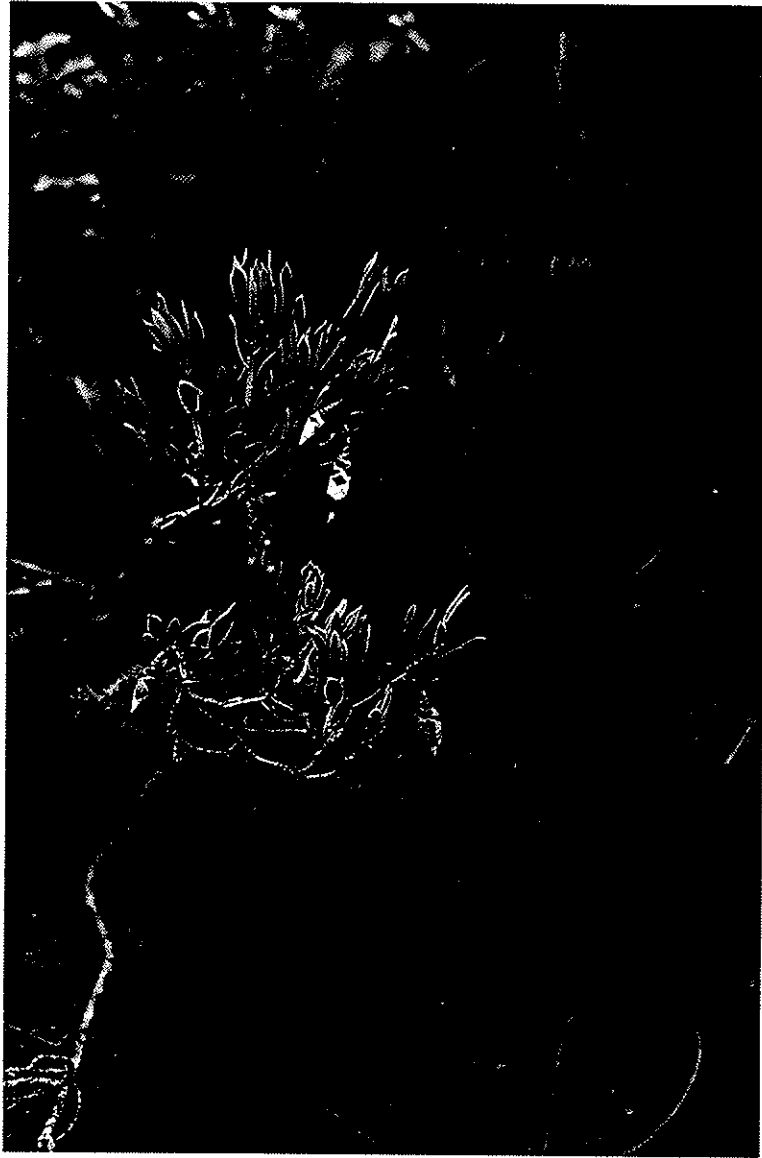
at Jandakot Airport

(ASW90.11.P3-5)

B *Conostephium minus* (Priority 3 species)

Wallingup Plain Survey Area

(ASW90.11.P0-3)



A



B

CAPTIONS - PLATE 2

Cartonema philydroides

Cartonema philydroides (Priority 3 species)

Near east-west arm of observatory, Wallingup Plain

(ASW90.10.P4-8)



PLATE 2

CAPTIONS - PLATE 3

Vegetation

- A** Flooded gum (>10 m) and swamp paperbark (8-10 m) forest,
in low-lying area which is sometimes inundated

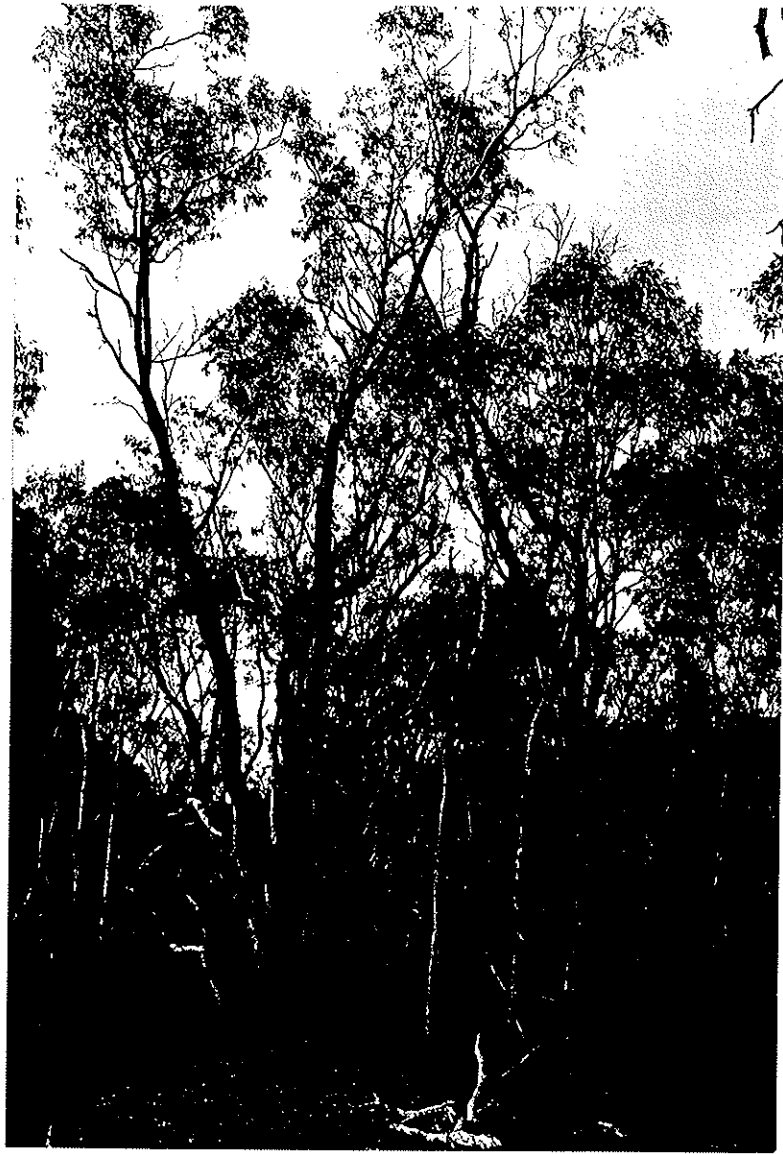
Wallingup Plain Survey Area

(ASW90.10.P4-14)

- B** Concentric bands of heath, sedges, *Kunzea ericifolia* thicket and bare sand
surrounding swamp paperbark forest 8-10 m tall in depression

Wallingup Plain Survey Area

(ASW90.10.P4-9)



A



B

CAPTIONS - PLATE 4

Vegetation

- A** Forest in background of swamp paperbark (*Melaleuca raphiophylla*), with *Melaleuca teretifolia*; standing water, *Typha ? domingensis* and *Baumea articulata* in mid-ground; yellow prostrate herb *Cotula coronopifolia* in foreground - Site 1

Wallingup Plain Survey Area

(ASW90.10.P4-5)

- B** Typical banksia woodland, with *Banksia attenuata*, *B. menziesii*, *Eucalyptus todtiana*, *Eremaea pauciflora*, *Verticordia nitens*

Wallingup Plain Survey Area

(ASW90.10.P4-11)



A

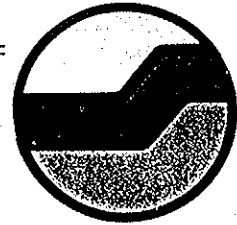


B

APPENDICES

APPENDIX 1

DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT



Please address all enquiries to: **NORTHERN FOREST REGION**
3044 ALBANY HIGHWAY
KELMSCOTT WA 6111
TELEPHONE: (09) 390 5977

Your Ref:

Our Ref: NR:46/03 SAM/ir
Enquiries: A Briggs/S Moore (390 5977)

Mr John Ferreirinho
Department of Physics
University of Western Australia
NEDLANDS WA 6009

Dear Mr Ferreirinho

PROPOSED GRAVITATIONAL WAVE OBSERVATORY-RARE FLORA SURVEY

Thank you for the copy of the rare flora survey report.

The proposal in the summary of this report that:

"If the arms of the observatory are shortened to 3km each....the east-west arm could be moved southward by 1km, south of the Wp and Ws wetlands."

This proposal has merit from a conservation perspective. Does it adversely affect the successful functioning of the observatory?

The information presented regarding rare flora appears satisfactory, however, the wetland species likely to be present are generally difficult to detect, except when they are flowering. The orchids (Diuris purdiei and Drakaea jeanensis), minute pygmy sundew (Drosera occidentalis), aquatic pennywort (Hydrocotyle lemnoides) and aquatic Aponogeton hexatepalus, are the declared rare species most likely to be found in the Wallingup Plain wetlands. These species only flower September/October-November.

The newly declared rare species Dryandra mimica may also occur on the Wallingup Plain. It flowers January - February.

To ensure that final planning for the Observatory is as effective as possible, it is important to determine, at the planning stage, if any rare plants are present. To this end, I suggest you have a botanist re-survey the area in October. Staff at this Department's Kelmscott office can provide up-to-date information on habitat preferences for these rare species. This information will be useful to the botanist surveying the area.

Since the rare flora survey was conducted, the CALM priority list of rare flora has been expanded from three categories to nine. Priority species likely to occur on the Wallingup Plain are highlighted on the attached photocopy. Any further botanical survey of the area should include these species.

Please contact Alan Briggs or Sue Moore (390 5977) if you have any queries.

Yours sincerely

Syd Shea

Syd Shea
EXECUTIVE DIRECTOR

Per *S.A. Moore*.....

9 May 1990

SPECIES	PRIORITY CODE	CALM REGIONS	DISTRIBUTION	FLOWERING PERIOD
NORTHERN FOREST				
<i>Acacia anarthros</i>	1	NF	East of Wannamal	May-Jun
<i>Acacia aff. wilhelmiana</i> (B.R. Maslin 4088)	1	NF	Mundaring, Dale, Darkin Swamp	May
<i>Anthocercis gracilis</i>	1	NF	Mundaring Weir, Dandalup	Sep-Oct, Apr
<i>Asteridea gracilis</i>	1	NF, M	Cosnells, Mt Saddleback	Sep-Oct
<i>Astroloma</i> sp. (R.D. Royce 3978)	1	NF, CF	Bindoon, Forest Grove, Mannup	Apr-Jun
<i>Calytrix simplex</i> subsp. <i>simplex</i>	1	NF	Armadale, Mt Saddleback	Jan
<u><i>Chamaelaucium aff. megalopetalum</i></u> (N. Marchant s.n. 4.11.88)	1	NF	Gingin	Oct-Nov
<u><i>Conostephium minus</i></u>	1	GRE, NF, M	Cataby, Gingin, Bullsbrook, Gngangara, Guildford, Belmont	Jul-Sep
<i>Diplolaena andrewsii</i>	1	NF	Swan View, Woorooloo Brook	Jul-Oct
<i>Dryandya aff. polycephala</i> (A.S. George 11703)	1	GRE, NF	Regans Ford, Boonanarring	Jul-Sep
<i>Eucalyptus loxophleba</i> x <i>wandoo</i> ⁺	1	NF	Clackline, Mundaring	-
<i>Eucalyptus macrocarpa</i> x <i>pyriformis</i> ⁺	1	NF	N of Bolgart	-
<i>Gastrolobium epacridoides</i>	1	NF	Mundaring	Jul-Oct
<i>Goodenia arthotricha</i>	1	NF	Wannamal	-
<i>Grevillea curviloba</i>	1	NF, GRE	Muchea, Bindoon, Badgingarra	-
<i>Grevillea glabrata</i> subsp. <i>dissectifolia</i>	1	NF	North Bannister	Nov
<i>Grevillea thelemanniana</i> ssp. <i>thelemanniana</i>	1	M, NF	Cannington, Kenwick, Wattle Grove	Jun-Sep
<i>Grevillea uncinulata</i> subsp. <i>florida</i>	1	NF, GRE	Bindoon, New Norcia, Coomallo Creek	Jul-Sep
<i>Hakea crassinervia</i>	1	NF	Bickley, York	Jul
<i>Hemiandra linearis</i>	1	NF	Chidlow, Helena Valley	Sep
<i>Hydatella dioica</i>	1	NF, M	Upper Swan	Sep-Nov
<i>Isopogon drummondii</i>	1	GRE, NF	Cockleshell Gully, Mt Lesueur, Moqumber, Orange Grove, Forrestfield	Jun
<i>Isopogon aff. scaber</i>	1	NF	Dale, Brookton Highway	Oct
<i>Nemcia epacridoides</i>	1	NF	Darling Scarp	Sep
<i>Parsoonia rudis</i>	1	GRE, NF	Gairdner Range, Muchea	Sep-Nov
<i>Stylidium utricularioides</i>	1	NF, M	Bullsbrook, Death Adder Creek, Canning	Oct-Dec
<i>Thysanotus fastigiatus</i>	1	NF	Kalamunda, Roleystone	May-Dec
<i>Verticordia lindleyi</i>	1	M, NF	Forrestdale, Cannington, Guildford, Oakford, Muchea, Gingin	Nov-Jan
<i>Acacia campylophylla</i>	2	NF, W	York, Northam, Tamnin, Wyalkatchem	Jun-Sep
<i>Acacia aff. congesta</i> (J.S. Beard 8124)	2	NF, W	Pony Hill, Boyagin Rock	Sep-Oct
<i>Acacia aff. myrtifolia</i> [P33] (R.J. Cranfield 33)	2	GRE, NF	Gairdner Range, Yandan Hill, Boonanarring Brook	May-Oct
<i>Acacia subflexuosa</i>	2	NF, W	Bullsbrook, Wundowie, Wandering, Bruce Rock (granite)	Aug-Jan
<i>Adenanthos cygnorum</i> ssp. <i>chamaephyton</i>	2	NF	?	-
<i>Allocasuarina ramosissima</i>	2	GRE, NF	Badgingarra, Mt Lesueur, Hay Flat	Sep-Nov
<i>Anigozanthos bicolor</i> ssp. <i>extans</i>	2	WB, NF	Meckering, Pingelly, Meenaar	-
<i>Astroloma foliosum</i>	2	NF	Ellis Brook, Lesmurdie Falls	May-Jul, Sep

SPECIES	PRIORITY CODE	CALM REGIONS	DISTRIBUTION	FLOWERING PERIOD
<i>Astroloma</i> sp. (E.A. Griffin 1022)	2	GRE,NF	Eneabba, Cairdner Range, Cataby, Callingiri, Bindoon	Feb-Jul
<i>Boronia ericifolia</i>	2	GRE,NF,W	Moora, Wongan Hills, Wongamine N.R.	Aug-Oct
<i>Calothamnus graniticus</i> subsp. <i>leptophyllus</i>	2	NF,SC	Oakley Dam, Stirling Range N.P.	Jun-Aug
<i>Calytrix sylvana</i>	2	GRE,NF	New Norcia, Bindoon, Julimar, Moolisbeenee, Suzanne Brook	Aug-Oct
<i>Calytrix</i> aff. <i>variabilis</i> (SJ Patrick 458)	2	NF	Wongamine N.R.	Sep-Oct
<i>Darwinia pimelioides</i>	2	NF	John Forrest N.P., Walyunga	Oct
<i>Darwinia thymoides</i> sp. nov. (J. Alford & G.J. Keighery 64)	2	NF,W	St Ronans N.R., Dryandra	Oct-Nov
<i>Dryandra</i> aff. <i>pteridifolia</i> (E.A. Griffin 3475)	2	GRE,NF	Dandaragan, Three Springs, Alexander Morrison N.P., Regans Ford, Forrestfield	Aug
<i>Eremaea</i> aff. <i>pauciflora</i>	2	NF	Clackline, Hoddy Well	Sep-Oct
<i>Frankenia glomerata</i>	2	W,NF	Waeel, Cunderdin, Lake King, Northam	Mar,Nov
<i>Grevillea glabrata</i> subsp. <i>ornithopoda</i>	2	NF	Murray River, Pinjarra, York, Jarrahdale, Mundaring	Sep-Oct
<i>Grevillea scabra</i>	2	NF	Toodyay, York	Sep
<i>Haemodorum loratum</i>	2	GRE,NF	Eneabba, Cockleshell Gully, Bullsbrook, Wattle Grove	Sep-Nov
<i>Hakea myrtoides</i>	2	NF,M	Wannamal, Gooseberry Hill, Helena Valley	Jul-Aug
<i>Helipterum pyrethrum</i>	2	CF,NF	Bullsbrook, Boyanup	Sep-Oct
<i>Lasiopetalum cardiophyllum</i>	2	NF,W	Mt Saddleback, Bannister, Wandering	Nov
<i>Leucopogon oliganthus</i>	2	GRE,NF	Moora, Dandaragan, Moochamullah Falls	Jun-Aug
<i>Nemcia acuta</i>	2	NF,GRE	Armadale, Darlington, Bindoon, Regans Ford	Aug-Sep
<i>Nemcia axillaris</i>	2	GRE,NF	Mt Lesueur, Coomallo Creek, Moora, Wanneroo	Jul-Sep
<i>Paracaleana "dixonii"</i>	2	GRE,NF	Eneabba, Coomallo Creek, Sullivan Rock	Nov
<i>Parsonsia diaphanophleba</i>	2	NF	Murray River, Coolup	Jan-Feb,May-Jun
<i>Pithocarpa achilleoides</i>	2	NF	Woorooloo, Bindoon	Jan-Apr
<i>Platysace cirrosa</i>	2	NF,W,GRE	Wambyn, Wongan Hills, New Norcia	Mar
<i>Platysace eatoniae</i>	2	NF	?Wambyn, Mt Hardy	Aug-Sep
<i>Stylidium</i> aff. <i>repens</i>	2	NF	Canning Dam	Dec
<i>Stylidium rigidifolium</i>	2	NF	Gooseberry Hill, Pickering Brook	Oct-Nov
<i>Stylidium</i> sp. (A.H. Burbidge 2536)	2	NF	Boulder Rock, Canning Dam	Dec
<i>Tetratheca similis</i>	2	NF	Bindoon, Mt Dale area	Aug-Sep
<i>Thysanotus anceps</i>	2	NF,GRE	John Forrest, Brookton Highway, Coomallo Creek, Mt Lesueur	Dec
<i>Trymalium urceolare</i>	2	NF	Bindoon, Toodyay	Sep-Oct
<i>Acacia horridula</i>	3	NF	Helena Valley - Serpentine	May-Aug
<i>Acacia volubilis</i>	3	GRE,NF	Warradarge Hill, Gingin	May-Aug
<i>Anthotium junciforme</i>	3	NF,CF,M	Wattle Grove, Midland, Bayswater, Serpentine, Cannington, Kelmscott, Busselton	Dec-Feb
<i>Aotus cordifolia</i>	3	NF,CF	Red Hill, Byford, Witchcliffe	Aug-Dec
<i>Beaufortia eriocephala</i>	3	GRE,NF	Mt Lesueur, Cataby, Coorow, Mogumber, York, St Ronans N.R.	Sep-Oct
<i>Cartonema philydroides</i>	3	GRE,CF,NF,M	Kalbarri, Midland, Busselton, Bullsbrook	Oct-Jan
<i>Dodonaea ericoides</i>	3	NF,GRE	Geraldton, Wannamal	-
<i>Dryandra polycephala</i>	3	NF	Bindoon, Chittering Valley	Jul-Oct
<i>Eucalyptus "petrensis"</i>	3	NF,CF	Burns Beach, Seabird, Yalgorup	Jul
<i>Gonocarpus pithyoides</i>	3	M,NF	Fremantle, Yancheb, York, Bullsbrook, Gingin	Oct-Nov
<i>Hemigenia pimelifolia</i>	3	GRE,NF	Watheroo, Yuna, Morowa, Koolanooka Hills, Toodyay	Sep

SPECIES	PRIORITY	CALM	DISTRIBUTION	FLOWERING PERIOD
	CODE	REGIONS		
<i>Jacksonia sericea</i>	3	M,NF	Wanneroo, Trigg, Perth, Mandurah	
<i>Lasiopetalum glabratum</i>	3	NF	York, Carmel, Serpentine	Nov
<i>Olaex scalariformis</i>	3	GRE,NF	Eneabba, Gairdner Range, Moore River N.P.	Nov-Dec
<i>Persoonia sulcata</i>	3	NF	John Forrest N.P., Wongamine N.R.	Sep-Nov
<i>Petrophile plumosa</i>	3	NF,GRE	Bindoon, Mogumber, New Norcia	Jul-Nov
<i>Philydrella drummondii</i>	3	M,NF,SF	Baywater, Guildford, Chidlow, Helena Valley, Pinjarra, Palgarup	Oct
<i>Phlebocarya filifolia</i>	3	GRE,NF,M	Eneabba, Dandaragan, Mogumber, Gingin, Cannington, Jandakot	Sep-Nov
<i>Restio stenostachyus</i>	3	NF,M	Gingin, Canning River	Feb-Mar
<i>Scholtzia eatoniana</i>	3	NF,W	Cunderdin, York	Nov-Dec
<i>Senecio gilbertii</i>	3	NF	Bindoon, York	Sep-Nov
<i>Synaphea acutiflora</i>	3	NF	Ellis Brook, Red Hill	Jul
<i>Petratheca pilifera</i>	3	NF	Two Rocks, Chidlow	Aug-Sep
<i>Physanotus arbuscula</i>	3	NF,GRE,M,CF	Helena Valley, York, Mt Lesueur, Eneabba, Forrestfield, Baywater, Nannup, Yallingup	Nov-Jan
<i>Physanotus tenuis</i>	3	NF,W	Northam, Wagin	Sep
<i>Villarsia submersa</i>	3	NF,CF,SF,SC;M	Gunapin, Boyanup, Lake Muir, Denmark, Forrestdale Kenwick	Sep-Oct
<i>Caladenia lavandulacea</i>	4	NF,W	Harrismith, York	-
<i>Calocephalus globosus</i>	4	NF	Kauring	-
<i>Centrolepis caespitosa</i>	4	NF	Byford	Nov
<i>Frankenia conferta</i>	4	NF	East of York	-
<i>Glyceria drummondii</i>	4	NF	?Gingin	-
<i>Laloragis tenuifolia</i>	4	NF,M	Woorooloo, Midland	Nov-Dec
<i>Lemnigenia obtusa</i>	4	NF	? Observatory Hill	-
<i>Lepyrodia heleocharoides</i>	4	NF	Parkerville	Dec
<i>Petraria australiensis</i>	4	M,NF	Cannington, Serpentine River	Dec
<i>Loronia tenuis</i>	5	NF,CF	Kalamunda, Lesmurdie Falls, Oakley Dam, North Dandalup, Dunsborough	Aug-Sep
<i>Caladenia "arrecta"</i>	5	NF,CF,SC	Bindoon, Margaret River, Gibson	Aug-Oct
<i>Caladenia ixiooides</i>	5	NF	Bindoon, Beechina, Wooroloo	Sep
<i>Calothamnus pachystachyus</i>	5	NF,GRE	Bindoon, Mogumber, New Norcia	Aug-Oct
<i>Calothamnus rupestris</i>	5	NF,W	Red Hill, Coonalls, St Ronans N.R., Boyagin Rock	Aug-Oct
<i>Conostylis pauciflora</i> esp. <i>pauciflora</i>	5	CF,NF	Yarloop, Dawesville	Aug-Oct
<i>Calisia microphylla</i>	5	NF	Dobaderry Swamp, Gunapin	Jul-Aug
<i>Calyptus "aspersa"</i>	5	NF,CF,W	Mt Cooke, North Bannister, Mt Saddleback, Mayanup, Farrar, Wandering, Nalyerin	-
<i>Calyptus exilis</i>	5	GRE,W,NF	Mt Lesueur, Coorow, Boyagin Rock, Wandering, Bindoon, Gunapin	Dec-Apr
<i>Calyptus foecunda</i>	5	GRE,NF,M,CF	Lancelin, Seabird, Yanchap, Reabold Hill, Lake Preston	Jan-May
<i>Revillea drummondii</i> subsp. <i>drummondii</i>	5	NF,GRE	Bindoon, Hay Flat, New Norcia, Yandan Hill	Jun-Oct
<i>Revillea drummondii</i> ssp. <i>centristigma</i>	5	NF,CF,SF	Darling Range to Shannon River	-
<i>Revillea drummondii</i> subsp. <i>pinaleoides</i>	5	NF	Helena Valley, Glen Forrest, Mundaring, Mundaring Weir	Jun-Nov
<i>Lemnigenia platyphylla</i>	5	NF	Mt Bakewell	Oct
<i>Libbertia miniata</i>	5	NF	Hay Flat, Bindoon Hill, Julimar, Wannamal	Jul-Oct
<i>Libbertia montana</i>	5	NF,W	Mt Bakewell, Bodakine Hills, Boyagin Rock, Dryandra	Jul-Sep

SPECIES	PRIORITY CODE	CALM REGIONS	DISTRIBUTION	FLOWERING PERIOD
<i>Lasioptalum bracteatum</i>	5	NF	Helena Valley, Glen Forrest, Darlington, Dwellingup	Oct-Nov
<u><i>Stachystemon axillaris</i></u>	5	NF,GRE	Wanneroo, Mogumber, Mt Lesueur, Eneabba, Arrowsmith River	Jul-Sep
<i>Synaphea pinnata</i>	5	NF	Sussanah Brook, Greenmount, Helena Valley	Sep-Nov
<i>Templetonia drummondii</i>	6	NF,W,M	Boddington, Williams, Midland	-
<i>Caladenia triangularis</i> ⁺	8	SC,CF,NF	Darkan, Clackline	Aug-Oct
<i>Dryandra mimica</i>	8	GRE,CF,NF	Regans Ford, Busselton, Mattie Grove	Sep
<i>Eucalyptus x rivalis</i> ⁺	8	NF,CF	S of Perth	-
<i>Pimelea rara</i>	8	NF	Mundaring	Jan-Feb
<i>Thelymitra benthamiana</i>	8	NF	Gidgegannup	Oct-Nov
<i>Banksia hookerana</i>	9	NF,GRE	Dongara, Moora, Hill River	Apr-Oct

APPENDIX 2

REPORT ON
SURVEY FOR RARE AND ENDANGERED SPECIES OF FLORA
AUSTRALIAN INTERNATIONAL GRAVITATIONAL OBSERVATORY SITE
WALLINGUP PLAIN
SHIRE OF GINGIN

Prepared for

Dr. D. G. Blair and Professor J. Sandeman
Australian International Gravitational Observatory Feasibility Study
c/- Department of Physics
University of Western Australia
NEDLANDS WA 6009

23 June 1989

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APPENDICES

1. Map of Landforms, Soils and Vegetation of Survey Area (adapted from McArthur and Mattiske 1985)
2. Rare, Geographically Restricted and Poorly Collected Species of Vascular Plants that might occur in or near the Gnangara Mound Region (from Weston 1986)
3. Gazetted Rare Flora (Government Gazette - No. 69 - of 15 July 1988)

SUMMARY

The proposed site for a gravitational observatory in State Forest No. 65 north of the Yanchep Pine Plantation was surveyed on foot on 18 and 22 June 1989 for vegetation, for rare, restricted and poorly collected species of flora, and for habitats for these species.

Banksia woodlands cover most of the Survey Area, with Paperbark and *Melaleuca* seasonal swamps in depressions.

The list of species searched for during the rare and endangered flora survey of the Survey Area was compiled from two published lists:

- o Rare, Geographically Restricted and Poorly Collected Species of Vascular Plants that might occur in or near the Gngangara Mound Region (Weston 1986, Table 2), and
- o Gazetted Rare Flora (Government Gazette - No. 69 - of 15 July 1988).

The lists are presented in this report as Appendix 2 and Appendix 3, respectively.

None of the species in these two lists, or any other species that might be regarded as rare or endangered, was found during the survey.

Probable habitats for such species were not found, either. Possible habitats that might occur in the Survey Area are better represented in nearby nature reserves and proposed nature reserves.

Development of the proposed Gravitational Observatory and associated, low-impact access tracks in the Survey Area would probably have little or no impact on rare, geographically restricted or poorly collected species of flora, particularly if the project avoids clearing or earthworks in the three Wp and Ws wetland areas shown in Appendix 1. If the arms of the observatory are shortened to 3 km each, an option that would, however, reduce the effectiveness of the structure, the east-west arm could be moved southward by 1 km, south of the Wp and Ws wetlands. Additional benefits of the shortening and move would be the avoiding of the Jandakot dune at the observatory's east end and, probably, a more nearly level site for the east-west arm.

It is recommended that because most of the species sought during the June survey would be in flower in August and October, the Wp and Ws wetland areas be surveyed for rare species again in those months. It is expected that such surveys would reinforce the impression gained during the June survey that there are no 'rare or endangered' species, particularly gazetted ones, in the Gravitational Observatory Survey Area.

**SURVEY FOR RARE AND ENDANGERED SPECIES OF FLORA
AUSTRALIAN INTERNATIONAL GRAVITATIONAL OBSERVATORY SITE
WALLINGUP PLAIN, SHIRE OF GINGIN**

1.0 INTRODUCTION

In a letter of 11 April 1989 addressed to Ms A Wrightson, Study Co-ordinator, Miss F Keating, for the Environmental Protection Authority, and the Department of Conservation and Land Management, requested "that prior to any development [of a gravitational observatory on the proposed Wallingup Plain site] a flora survey is to be commissioned by the proponents to determine the presence or absence of rare and endangered species". This report presents the method and results of that survey and discusses them.

The area shown in Appendix 1, the Wallingup Plain Survey Area, is halfway between Two Rocks and Gingin and is immediately north of the Yanchep Pine Plantation in State Forest No. 65 and Vacant Crown Land east of it. The Survey Area lies between Military (Old Yanchep) Road and Gingin Brook Wanneroo Branch.

The broader area within which the Survey Area lies is of planning and management interest to the Department of Conservation and Land Management (CALM), the Environmental Protection Authority (EPA), the Water Authority of Western Australia (WAWA) and the State Energy Commission of Western Australia (SECWA).

An environmental report describing proposed transmission line corridors running between the Hill River area and Pinjar is currently being prepared for the SECWA. The report indicates that one corridor runs about 200 m south of the observatory's 4 km long south arm and that the other corridor lies about 100 m east of its 4 km long east arm.

The observatory site is in the north central end of the Gngangara Water Reserve, in the WAWA's as-yet-undeveloped Barragoon Groundwater Source area (Dames & Moore 1986). Twenty-four superficial wells are scheduled for developing the source.

Two proposed System 6 nature reserves are close to, but not in, the observatory site: C13 and M5 (Environmental Protection Authority 1983; Weston 1986; Department of Conservation and Land Management 1987). System 6 Recommendation C13, or Wabling Nature Reserve (proposed), has limestone outcrop to leached sand dune and semi-swamp vegetation. It includes the former Forests Department Management Priority Area 15.3 and Reserve 24436, with some boundary adjustments. System 6 Recommendation M5, or Yeal Nature Reserve (proposed), has vegetation and soil types, including an unusual swampy tract, not represented in other reserves. The proposed reserve area is based upon Reserve 31241 but is now substantially larger than the EPA's System 6 recommendation.

The Survey Area was surveyed on 18 and 22 June 1989 for native vegetation, for rare, restricted and poorly collected species of flora, and for habitats for these species. Sites considered most likely to support rare or endangered species were more intensively surveyed. These sites were selected on the basis of stereo examination of 1:40,000 scale black and white aerial photographs flown in November 1986.

2.0 PHYSICAL ENVIRONMENT

As the Gravitational Observatory Survey Area is within the area covered by the Gnangara Mound Groundwater Resources Environmental Review and Management Programme (ERMP) (Dames & Moore 1986), descriptions of the regional physical environment given in the ERMP also apply to the Survey Area.

The climate of the Survey Area is temperate mediterranean, with warm, dry summers and mild, wet winters. Summer evapotranspiration rates are high, and few of the wetlands in the broader area within which the Survey Area lies are permanent.

McArthur and Matiske (1985) have produced a 1:50,000 scale map of Gnangara Mound landforms, soils and vegetation from stereoscopic interpretation of 1:20,000 and 1:25,000 scale colour aerial photographs. The map shows the Survey Area as being being totally within units of the Bassendean Dune System. It largely comprises Yeal Swamp Complex (Wy) landforms, soils and vegetation, with one larger Seasonal Swamp (Ws) and two small Permanent Lakes and Swamps (Wp). There are, owever, no permanent lakes or water in the Survey Area. The eastern arm of the Survey Area extends into Jandakot (Ja) and Gavin (G,Ga) landforms, soils and vegetation. Descriptions of the Bassendean units and the relevant part of their map have been photocopied from McArthur and Matiske and are presented here as Appendix 1.

3.0 VEGETATION

Beard (1979) and Heddle *et al.* (1980) map the native vegetation potential (i.e. what vegetation would be there if it had not been cleared) of the Survey Area at a scale of 1:250,000. Beard (1980) also maps it at a scale of 1:1,000,000. McArthur and Mattiske (1985) have mapped the native vegetation of the Gravitational Observatory Survey Area at a much larger, but unspecified, scale. The relevant portion of the map, along with descriptions of the units shown, are reproduced in Appendix 1. Summaries of their descriptions, with modifications based upon traverses in the Survey Area, are given below.

All of the vegetation in the southern arm of the Survey Area and most of the vegetation in the eastern arm belong to Wy-Yeal Swamp Complex, a pattern of low relief, sandy rises and many small seasonal swamps. The rises have Open Low Woodland dominated by species of *Banksia*, mainly *Banksia attenuata* and *B. menziesii*, while the swamp vegetation is characterised by Flooded Gum (*Eucalyptus rudis*) and Swamp Paperbark (*Melaleuca raphiophylla*) and other species of *Melaleuca*, usually with dense swards of reeds, sedges or shrubs. *Banksia ilicifolia* and Moonah Paperbark (*Melaleuca preissiana*) are locally common in both woodland and seasonal swamps. *Eucalyptus tottiana* trees are scattered through the woodland.

There are two separately mapped permanent swamps (Wp) and one separately mapped larger seasonal swamp (Ws) within the Wy area, but all three separately mapped swamps are described by Mattiske and McArthur as having vegetation which is not distinguishable from Wy swamp vegetation except in that it covers larger areas.

The eastern arm of the Survey Area extends into Ga(G)-Gavin and Ja-Jandakot Open Low Woodlands dominated by species of *Banksia* with dense shrub layers. The Gavin woodlands are on flat or gently undulating landscapes and have scattered emergent Moonah Paperbark trees and, in a few cases, Marri trees, while the Jandakot woodlands are on low hills and ridges with more than 5 m relief.

4.0 RARE AND ENDANGERED SPECIES AND THEIR HABITATS

The term 'rare or endangered species' as used in this report refers to species that are:

- o rare, geographically restricted or apparently rare or restricted because they are poorly collected or recorded,
- o at the limits of their ranges or in areas outside their normal ranges or habitats,
- o particularly susceptible or vulnerable to environmental changes, especially ones caused by humans, either directly or indirectly,
- o diminishing in abundance or geographical range due to clearing and other environmental changes associated with agriculture, mining, recreation, urbanisation and provision of services, or
- o poorly represented in secure conservation reserves.

The importance of these various sorts of 'rare and endangered' species is discussed in Weston (1986). Some of the 'rare and endangered' species are gazetted as rare species; most are not.

The completeness and accuracy of most lists of rare and restricted species are limited by the fact that the intensity, uniformity and seasonal coverage of collecting and systematic surveying have been insufficient to distinguish between genuinely rare (and restricted) species and species which only appear to be rare (or restricted) because they have been poorly collected.

The first published list of rare, restricted and poorly known species in Western Australia (Marchant and Keighery 1979) is based upon the numbers of specimens of each species lodged in the Western Australian Herbarium and the geographical range of the collections for each species. Subsequent lists by Leigh *et al.* (1981) and Briggs and Leigh (1988) are country-wide and based upon publications or other information provided by botanists in the various states. They cover presumably rare or threatened plants but do not deal with the adequacy of collection of any species. Species in the first list of gazetted rare Western Australian flora are described and illustrated by Rye and Hopper (1981), and Patrick and Hopper (1982) produced a supplement to this publication. Lists of gazetted rare species are updated from time to time.

Gazettal of a species is preceded by relatively detailed searches made in the field to locate populations of the species proposed as rare. The two lists of gazetted rare flora in Rye and Hopper (1981) and Patrick and Hopper (1982) comprise fewer than 150 species, probably only a small proportion of Western Australian plants that could be considered as rare. Another list, in Rye (1982), contains 527 species of flowering plants that are geographically restricted and includes most, if not all, of the species gazetted at that time as rare. The Rye list is based upon a detailed herbarium survey supervised by Western Australian Wildlife Research Centre (WARC) botanists of species which might be rare or geographically restricted.

In some cases, rare species occur in areas where they were not previously known to occur (in some others, rare species once known to occur in an area are no longer there). For example, *Synaphea pinnata* is a plant species previously gazetted as rare (Government Gazette, 14 November 1980) which has since been found to be more common or widespread than previously believed.

Most lists of species are incomplete in that they do not contain varieties, subspecies or undescribed species, some of which are also rare.

Other sources of incompleteness and ambiguity are:

- o insufficient locality information given on the labels which accompany herbarium specimens,
- o inaccurate identification of specimens, and

- o treatment of groups of species as single species.

In an attempt to cope with these problems the Department of Conservation and Land Management now has three, unofficial types of lists of rare and restricted species, including varieties and subspecies:

- o gazetted rare species, including subspecies and several as yet undescribed species, which on the basis of field surveys are believed to be rare and vulnerable,
- o monitored species, which are believed to be moderately rare or geographically restricted but adequately conserved in reserves, and
- o species provisionally regarded as rare, geographically restricted or poorly known.

The gazetted list of flora does not include all, or probably even a majority of, rare species. The current list (15 July 1988) concentrates on the south-western part of Western Australia and particular groups of species, which have, in general, been studied in greater detail than others. For example, species of *Acacia* and members of the families Proteaceae, Myrtaceae and Orchidaceae account for approximately 150, well over half, of the gazetted species. It is likely that in the south-west alone there are many more ungazetted rare and restricted species than gazetted ones.

A modified and slightly expanded list of rare flora is due to be gazetted later this year.

So little is known about the abundance, distribution and taxonomy of nonvascular plants that few, if any, such species are gazetted as rare flora or are included in lists of rare species, although many of them may also be rare or geographically restricted.

4.1 RARE AND ENDANGERED PLANT SPECIES OF THE SURVEY AREA

The list of species searched for during the rare and endangered flora survey of the Survey Area was compiled from two published lists:

- o Rare, Geographically Restricted and Poorly Collected Species of Vascular Plants that might occur in or near the Gngangara Mound Region (Weston 1986, Table 2), and
- o Gazetted Rare Flora (Government Gazette - No. 69 - of 15 July 1988).

The lists are presented in this report as Appendix 2 and Appendix 3, respectively.

The first list, of 13 species and with information about the species' principal habitats, distributions, flowering times and numbers of collections in the Western Australian Herbarium in 1986, is based upon surveys of plant collections in the Western Australian Herbarium between 1978 and 1986. The species are listed in alphabetical order, with species and family names conforming to Green (1985). Gaps in information in the original table have been filled by reference to Marchant *et al.* (1987).

The number of collections of a species in the Western Australian Herbarium may give some indication of the rarity of a species, although species believed to be rare tend to be collected more frequently, especially if they are conspicuous.

The flowering times given in the table suggest the period when a survey for the species could be undertaken most productively. In the case of the 13 species listed, October would be the best time because most of them have been collected in flower then.

Eight of the 13 species have been recorded in wetland habitats. The other five have been collected in *Banksia* woodland and scrub vegetation. Although habitats for some of the listed species do not occur in the Survey Area, all of the species were sought during the survey.

At the time the Appendix 2 table was compiled, in 1986, the only one of the 13 species gazetted as rare was *Stachystemon axillaris*. That species is no longer gazetted, nor are any of the other species on the list gazetted.

Most of the named species in the current list of gazetted rare species, reproduced in Appendix 3, are listed in the Census of the Vascular Plants of Western Australia (Green 1985). The Flora of the Perth Region (Marchant *et al.* 1987) describes 12 of these species as occurring in the Perth Region. Five of the 12 are described as having ranges and habitats which do not definitely exclude the Gravitational Observatory Survey Area, although at least the first four have not been recorded on the coastal plain north of Perth. These five species are:

- o *Aponogeton hexatepalus*
- o *Diuris purdiei*
- o *Drakaea jeanensis*
- o *Drosera occidentalis*
- o *Thelymitra stellata* (= *Thelymitra fuscolutea* var. *stellata*)

All are species of low-lying areas and seasonal wetlands. Because they all are herbaceous plants and flower in the period between August and November (the *Thelymitra* flowers between October and January - Hoffman and Brown 1984), it is unlikely that any would be identifiable at the time the survey was carried out. However, these species were also sought during the survey.

The three *Asterolasia* species are in the Census but under different names. Flora descriptions of the ranges and habitats of the three species exclude the Survey Area.

Fifteen of the named species and subspecies in the gazetted list of species are in neither Green (1985) nor Marchant *et al.* (1987), but 10 of the 15 are in the families Liliaceae and Haemodoraceae and are first described in Volume 45 of the Flora of Australia (George 1987). According to the descriptions the Survey Area is well outside the range of any of them.

The other five of the 15 are *Caladenia dorrieni* (= *C. filamentosa* var. *dorrieni*), *Diuris drummondii* (= *D. emarginata* var. *emarginata* auct. non R.Br.), *Eremophila verticillata*, *Myoporum turbinatum* and *Prostanthera carrickiana*. The ranges of these five species are also well outside the Survey Area.

Three of the undescribed species in the gazetted list occur in the vicinity of Perth:

- o *Caladenia* sp. (coastal plain) S. D. Hopper 3400 (= *C. grandis*)
- o *Drakaea* sp. (south west) S. D. Hopper 3566 (= *D. micrantha*)
- o *Eucalyptus* sp. (Yanchep) M. I. H. Brooker 8608

The first two species are orchids which have been recorded in the Perth Region only in the Canningvale area, south of Perth. The eucalypt is a thin-stemmed mallee that grows on limestone within 10 km of the coast north of Yanchep. The site nearest to the Survey Area where it has been recorded is on Wabling Hill. Although the Survey Area appears to be outside the habitat and geographical ranges of the three species, though only slightly in the case of the eucalypt, all three species were looked for during the survey.

None of the species listed above or in Appendix 2 was found in the Survey Area, although all of them were actively sought during the survey. The types of wetlands which are the habitats of most of these species were also sought during the survey.

4.2 HABITATS

Most of the species sought during the survey of the Gravitational Observatory Survey Area occur in a limited range of wetland habitats which have a restricted occurrence, such as the clay-based seasonally inundated swamps represented in the Cannington area. With possible exceptions in the three Ws and Wp wetlands indicated in Appendix 1, it is probable that none of these wetland habitats is represented in the Survey Area.

However, possible habitats that might occur in the Survey Area are better represented in nearby nature reserves and proposed nature reserves.

5.0 CONCLUSIONS AND RECOMMENDATIONS

Development of the proposed Gravitational Observatory and associated, low-impact access tracks in the Survey Area would probably have little or no impact on rare, geographically restricted or poorly collected species of flora, particularly if the project avoids clearing or earthworks in the three Wp and Ws wetland areas shown in Appendix 1. If the arms of the observatory are shortened to 3 km each, an option that would, however, reduce the effectiveness of the structure, the east-west arm could be moved southward by 1 km, south of the Wp and Ws wetlands. Additional benefits of the shortening and move would be the avoiding of the Jandakot dune at the observatory's east end and, probably, a more nearly level site for the east-west arm.

It is recommended that because most of the species sought during the June survey would be in flower in August and October, the Wp and Ws wetland areas be surveyed for rare species again in those months. It is expected that such surveys would reinforce the impression gained during the June survey that there are no 'rare or endangered' species, particularly gazetted ones, in the Gravitational Observatory Survey Area.

6.0 ACKNOWLEDGEMENTS

David Blair, Mariee Bougher, Bruce Montgomery, Bill Smalley and botanists employed by the Department of Conservation and Land Management have provided advice, information, the use of equipment and other assistance with the project.

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APPENDIX 1.

Map of Landforms, Soils and Vegetation of Survey Area
(adapted from McArthur and Mattiske 1985)

BASSENDEAN DUNES

Ja	Jandakot	Low hills and ridges with more than 5m relief; iron podzols; <i>Banksia</i> spp. low open woodland with a dense shrub layer.
	Ja-steep	Ridges with more than 10m relief; iron podzols; <i>Banksia</i> spp. low open woodland with sparse shrub layer.
Ga	Gavin	Flat or gently undulating landscape; iron — humus podzols; <i>Banksia</i> spp. low open woodland with scattered emergent <i>Eucalyptus calophylla</i> and <i>Melaleuca preissiana</i> ; dense shrub layer.
J	Joel	Poorly drained depressions; humus podzols; scattered <i>M. preissiana</i> , <i>E. rudis</i> and <i>Banksia ilicifolia</i> with a dense shrub layer.
Ws	Seasonal Swamps	Depressions with free water in winter; humus podzols and peats; dense <i>M. preissiana</i> , <i>M. raphiophylla</i> and <i>E. rudis</i> around the edges with reeds and sedges in the centre.
P	Pinjar	Extensive flat swampy areas; sandy surface with some admixture of diatomite in the surface and organic hard pan below; <i>E. rudis</i> , <i>B. littoralis</i> and <i>M. preissiana</i> around edges; sedges and reeds with scattered <i>M. teretifolia</i> in centre; <i>Jacksonia furcellata</i> and <i>Viminaria juncea</i> on low sandy rises.
Wp	Permanent Lakes and Swamps	Depressions; humus podzols and peats around the edges often with some diatomite; zoned vegetation with heath on upper slopes. <i>Melaleuca</i> spp. and <i>E. rudis</i> at waters edge, reeds and sedges in shallow water.
Wy	Yeal Swamp Complex	A pattern of low sandy rises and many small seasonal swamps; rises have iron-humus or iron podzols and <i>Banksia</i> spp. low open woodland; swamps have surface layer of diatomite over sand; dense <i>Melaleuca</i> spp. and <i>E. rudis</i> around fringe with sedges in central parts of swamps.
DL	Drainage Lines	Broad, shallow channels, peaty soils, fringe of <i>Melaleuca</i> spp. and <i>E. rudis</i> ; reeds and sedges in central zone.

APPENDIX 2.

**Rare, Geographically Restricted and Poorly Collected Species of Vascular Plants
that might occur in or near the Gngangara Mound Region
(from Weston 1986)**

TABLE 2

RARE, GEOGRAPHICALLY RESTRICTED AND POORLY COLLECTED SPECIES OF VASCULAR PLANTS THAT MIGHT OCCUR IN OR NEAR THE GNANGARA MOUND REGION

<u>Scientific Name</u>	<u>Family</u>	<u>Habitat</u>	<u>Roots¹</u>	<u>Flower²</u>	<u>Distribution³</u>	<u>No.⁴</u>	<u>Reserves⁵</u>
<u>Cartonema philydroides</u>	COMME	Low-lying sandy soils in open jarrah/marri woodland	Shallow	7, 10-11	Kemerton - Kalbarri (E of Yanchep)	9	Yes
<u>Conospermum huegelii</u>	PROTE	Sandy/gravelly soil; often around granite rocks or on swampy or moist ground	Medium	7-10	Gieneagle-Serpentine Falls-Mogumber (Bullsbrook airfield)	29	Yes
<u>Conostephium minus</u>	EPACR	Sandy soil; <u>Banksia</u> woodland	Shallow; Root Type 5	7-10	Cataby - Perth (Gnangara)	12	?
<u>Darwinia</u> sp. A (<u>D. aff. neildiana</u>) ⁶	MYRTA	Swampy or moist sandy ground	Shallow?	?	Muchea area (Mound Spring)	3?	No
<u>Eremaea purpurea</u>	MYRTA	Subswamp; low open <u>Banksia</u> woodland	Deep; Root Type 4	10-1	Gingin - Upper Swan (Perry Road, N of Pinjar)	13	?
<u>Lhotskya brevifolia</u>	MYRTA	Sandy/gravelly soil	?	9-12	Kings Park - Moore River (Bindoon)	4	Yes
<u>Lycopodium serpentinum</u>	LYCOP	Moist ground	-	-	Mound Spring, South Coast and eastern states (Mound Spring the only non-south coast site in WA)	1? (locally)	No
<u>Lysinema elegans</u>	EPACR	Sandy soil; <u>Banksia</u> scrub	Shallow; Root Type 1	10-11	Thomson's Lake - Regans Ford (Jandakot)	3	Yes
<u>Restio stenostachya</u>	RESTI	Sandy; swampy	Shallow, fibrous	6, 9-10	Gnangara - 12 km south of Gingin (Gnangara)	4	?
<u>Stachystemon axillaris</u>	EUPHO	Sandy soil	?	-	Near Wanneroo - Arrowsmith River (Melaleuca MPA)	10	Yes
<u>Stylidium utricularioides</u>	STYLI	Flat, swampy areas	?	10-12	Pinjarra - 31mi. peg, GN Highway (Gnangara)	15	?
<u>Tetratheca pilifera</u>	TREMA	<u>Banksia</u> woodland	Shallow?	8-10	Yanchep/Lancelin - Wooroloo (Wanneroo)	7	Yes
<u>Thelymitra</u> sp. A (<u>Th. aff. carnea</u>) ⁷	ORCHI	Swamp edges	?	9-10	Wanneroo, Cannington, Jandakot (Wanneroo)	3	?

1. The root type information is contributed by E M Mattiske. Root Types 1, 4 and 5 are briefly defined in Addendum II of Appendix A in this set of documents and are described in more detail by Dodd et al., (1984).
2. Times of flowering are based on inspection of labels on Western Australian Herbarium collections. The numbers refer to the months, e.g. 9 = September, in which specimens were collected in flower.
3. Distribution information is also based upon Western Australian Herbarium collection labels. The name in brackets is the location in or closest to the survey area in which the species has been recorded.
4. The numbers indicate the number of collections of each species in the Western Australian Herbarium.
5. Species protected in National Parks or Conservation Reserves.
6. The forthcoming flora of the Perth Region being prepared by the Western Australian Herbarium assigns the temporary, informal name 'Darwinia sp. A' to this undescribed species.
7. The Perth regional flora assigns the name 'Thelymitra sp. A' to the local orchids that have been called 'Thelymitra carnea'. The plants are, apparently, not proper species but hybrids.

APPENDIX 3.

Gazetted Rare Flora
(Government Gazette - No. 69 - of 15 July 1988)

WILDLIFE CONSERVATION ACT 1950

019882F3705.

PURSUANT to the provisions of subsection (2) of section 23F of the Wildlife Conservation Act 1950, I hereby declare that protected flora of the taxa listed in the schedule to this notice growing in its original state and not in its domesticated or cultivated state are rare flora throughout the whole of the State.

The previous notice relating to rare flora published in the Government Gazette on 25 September 1987 is hereby cancelled.

BARRY HODGE,
Minister for Conservation
and Land Management.

Schedule

Acacia anomala
Acacia aphylla
Acacia argutifolia
Acacia denticulosa
Acacia depressa
Acacia guinetii
Acacia merrickae
Acacia pharangites
Acacia semicircularis
Acacia simulans
Acacia vassalii
Acacia sp. (Chiddarcooping) J. Brown 69 & A. Williams
Acacia sp. (Wongan Hills) K. F. Kenneally 7496
Adenanthos cunninghamii
Adenanthos dobagii
Adenanthos ellipticus
Adenanthos eyrei
Adenanthos ileticus
Adenanthos pungens
Adenanthos velutinus
Allocasuarina fibrosa
Anigozanthos bicolor subsp. minor
Anigozanthos humilis subsp. chrysanthus
Anigozanthos viridis subsp. terraspectans
Aponogon hexatepalus
Asplenium obtusatum
Asterolasia drummondii
Asterolasia grandiflora
Asterolasia nivea
Baechea arbuscula
Banksia brownii
Banksia cuneata
Banksia goodii
Banksia sphaerocarpa var. dolichostyla
Banksia tricuspis
Banksia verticillata
Banksia sp. (Wagin) S. D. Hopper 4171
Billardiera mollis
Boronia adamsiana
Caladenia bryceana
Caladenia cristata
Caladenia dorrienii
Caladenia integra
Caladenia plicata
Caladenia wanosa
Caladenia sp. (Murchison) S. D. Hopper 3270
Caladenia sp. (Esperance) D. R. Voigt 36
Caladenia sp. (Cape Naturaliste) S. D. Hopper 4518
Caladenia sp. (jarrah forest) S. D. Hopper 3990
Caladenia sp. (Northampton) S. D. Hopper 3347
Caladenia sp. (Leeuwin-Naturaliste) S. D. Hopper 4670
Caladenia sp. (coastal plain) S. D. Hopper 3400
Caladenia sp. (Moresby Range) G. J. Keighery 3328
Caladenia sp. (southern forest) S. D. Hopper 3553
Caladenia sp. (Muir) S. D. Hopper 3521
Caladenia sp. (salt lakes) S. D. Hopper 4162
Caladenia sp. (Dunsborough) S. D. Hopper 5520b
Chamaelucium sp. (Busselton) G. J. Keighery 3655
Chamaelucium sp. (S coastal plain) R. D. Royce 4872
Conospermum toddii
Conostylis drummondii
Conostylis lepidospermoides
Conostylis micrantha
Conostylis misera

Conostylis rogeri
Conostylis seorsiflora subsp. trichophylla
Conostylis wonganensis
Cooperhookia georgei
Corybas sp. (Albany) L. Byrne 10
Darwinia acerosa
Darwinia apiculata
Darwinia carnea
Darwinia collina
Darwinia macrostegia
Darwinia masonii
Darwinia meeboldii
Darwinia oxylepis
Darwinia squarrosa
Darwinia wittwerorum
Darwinia sp. (Scott River) G. J. Keighery 3582
Darwinia sp. (Stirling Range) G. J. Keighery 6732
Daviesia euphorbioides
Daviesia microphylla
Daviesia purpurascens
Daviesia spiralis
Daviesia sp. (Three Springs) M. D. Crisp 6480
Daviesia sp. (central wheatbelt) M. D. Crisp 6612
Daviesia sp. (Ravensthorpe) M. D. Crisp 6065
Daviesia sp. (Norseman) M. D. Crisp 6943
Daviesia sp. (Stirling Range) K. R. Newbey 6113
Daviesia sp. (Eneabba) S. D. Hopper 4829
Diuris drummondii
Diuris purdiei
Diuris sp. (Kwinana) A. P. Brown 10.9.84
Diuris sp. (Northampton) A. P. Brown 203
Drakea jeanensis
Drakea sp. (Kalbarri) A. P. Brown 8.82
Drakea sp. (south west) S. D. Hopper 3666
Drakea sp. (Great Southern) S. D. Hopper 3461
Drosera fimbriata
Drosera occidentalis
Drummondita ericoides
Drummondita hassellii var. longifolia
Dryandra serratulooides
Dryandra sp. (Stirling Range) F. Lullfitz 3379
Eremophila denticulata
Eremophila inflata
Eremophila merrallii
Eremophila microtheca
Eremophila nivea
Eremophila racemosa
Eremophila resinosa
Eremophila serpens
Eremophila ternifolia
Eremophila verticillata
Eremophila virens
Eremophila viscida
Eriostemon wonganensis
Eucalyptus beardiana
Eucalyptus bennettiae
Eucalyptus brevipes
Eucalyptus burdettiana
Eucalyptus ceracea
Eucalyptus cerasiformis
Eucalyptus coronata
Eucalyptus crucis subsp. crucis
Eucalyptus erectifolia
Eucalyptus goniantha subsp. goniantha
Eucalyptus insularis
Eucalyptus johnsoniana
Eucalyptus lateritica
Eucalyptus merrickiae
Eucalyptus mooreana
Eucalyptus rhodantha
Eucalyptus steedmanii
Eucalyptus suberea
Eucalyptus synandra subsp. (wheatbelt) A. S. George 16203
Eucalyptus sp. (Pingaring) M. I. H. Brooker 9109
Eucalyptus sp. (eastern forest) M. I. H. Brooker 9046
Eucalyptus sp. (Midlands Highway) M. I. H. Brooker 8734
Eucalyptus sp. (Moresby Range) S. D. Hopper 2759
Eucalyptus sp. (Yandanooka) M. I. H. Brooker 9206
Eucalyptus sp. (Cape Naturaliste) K. H. Reehinger 58388
Eucalyptus sp. (Norseman) S. D. Hopper 2736
Eucalyptus sp. (E Nambung) M. I. H. Brooker 9025
Eucalyptus sp. (Badgingarra) M. I. H. Brooker 9028
Eucalyptus sp. (Northampton) M. I. H. Brooker 9196

Eucalyptus sp. (Yanchep) M. I. H. Brooker 8608
Eucalyptus sp. (N Coomallo) M. I. H. Brooker 8823
Gastrolobium appressum
Gastrolobium glaucum
Gastrolobium tomentosum
Grevillea baxteri
Grevillea cirsiifolia
Grevillea dryandroides
Grevillea inconspicua
Grevillea infundibularis
Grevillea involucreta
Grevillea prostrata
Grevillea saccata
Grevillea scopigera
Hakea aculeata
Hakea megalosperma
Hakea tamminensis
Halosarcia bulbosa
Hemiandra gardneri
Hemiandra rutilans
Hemigenia viscida
Hensmania chapmanii
Hibbertia bracteosa
Hydrocotyle lemnoides
Kennedia beckxiana
Kennedia globata
Kennedia macrophylla
Lambertia echinata
Lambertia fairallii
Lambertia orbifolia
Laxmannia jamesii
Lechenaultia chlorantha
Lechenaultia laricina
Lechenaultia pulvinaris
Lechenaultia superba
Lepidium catapycnon
Leucopogon obtectus
Microcorys eremophiloides
Microtis globula
Myoporum saeoloides
Myoporum turbinatum
Neogoodenia minutiflora
Pityrodia augustensis
Prasophyllum triangulare
Prostanthera carrickiana
Prostanthera magnifica
Pterostylis pusilla
Pterostylis sp. (Northampton) S. D. Hopper 3349
Pychosema pusillum
Pultenaea pauciflora
Rhagodia scicularis
Rhizanthella gardneri
Ricinocarpos trichophorus
Roycea pycnophylloides
Spirogydens rubescens
Stawellia dimorphantha
Stylidium coroniforme
Stylidium galioides
Stylidium plantagineum
Stylidium scabridum
Tetraloche aphylla
Tetraloche harperi
Thelymitra psammophila
Thelymitra stellata
Thomasia montana
Thomasia sp. (York) A. S. George 8076
Thryptomene wittweri
Tribonanthes purpurea
Veticordia fimbriolepis
Veticordia helichrysantha
Veticordia hughanii
Veticordia staminosa
Veticordia sp. (Fitzgerald) C. A. Gardner 9148
Villarsia calthifolia
Wurmbea drummondii
Wurmbea humilis
Wurmbea tubulosa
Wurmbea sp. (Cape Naturaliste) S. D. Hopper 5871
Xyris sp. (Stirling Range) G. J. Keighery 7961

APPENDIX 3

APPENDIX 3

DECLARED RARE FLORA, PRIORITY TAXA AND SIGNIFICANT SPECIES: BACKGROUND, DEFINITIONS AND DISCUSSION

Arthur S. Weston

1. Introduction

In 1975, Western Australia's Fauna Conservation Act was retitled as the Wildlife Conservation Act, and in 1979 the Act was amended to provide protection for specified species (and other taxa) of flora as well as of fauna. The first plant species to be declared by the Minister as protected rare flora under the Act were listed in the Government Gazette, WA, of 14 November 1980. Periodically, generally once a year, the Minister publishes notices in the Government Gazette deleting and adding species to the list of protected flora. During the time a species, or other taxon, is gazetted as protected no-one is allowed to "gather, pluck, cut, pull up, destroy, dig up, remove or injure" a plant belonging to a wild population of that species without special written consent of the Minister (Hopper *et al.* 1990). Fines may be imposed for breaching provisions of the Act.

The first list of gazetted flora comprises 100 species, including a variety of one of the species. The current Schedule of "Protected flora declared as rare flora", printed in the Government Gazette, WA, of 12 November 1993, comprises over 300 taxa. Some of the species first gazetted in 1980 are absent from the current list, because they have been found to be more abundant or wide-ranging than previously indicated by collections and records or because they appear to be well-protected in nature reserves and national parks.

In general, species are gazetted or declared as rare flora (DRF) not only because they are rare or geographically restricted but also because their continued, long-term survival in the wild is believed to be threatened. Hopper *et al.* (1990) and Kelly *et al.* (1993) list criteria for adding and deleting species.

Gazetted rare species are not the only Western Australian plants that are rare, geographically restricted, threatened or vulnerable. In fact, they probably constitute only a small proportion of such species. For example, Marchant and Keighery (1979) listed more than 2,000 species that were rare or poorly collected or were geographically restricted to a range of less than 160 kilometres (100 miles). The Department of Conservation and Land Management (CALM) has more than 1700 taxa (species, subspecies and varieties) in its current, October 1992, state-wide list of Priority species, a large proportion of which were not on the Marchant and Keighery list.

This appendix discusses such species, particularly ones that are gazetted as Declared Rare Flora (DRF) or are given Priority numbers (P1-4).

2. Published Lists of Rare, Restricted and Poorly Collected Species

Australia-wide treatments of rare, geographically restricted and endangered species by Specht, Roe and Boughton (1974), Hartley and Leigh (1979), Leigh, Briggs and Hartley (1981) and Briggs and Leigh (1988) also contain Western Australian lists, which are, for the most part, based upon publications or other information provided by botanists in the various states. They cover presumably rare or threatened plants but do not deal with the adequacy of collection of any species.

Extinct and Endangered Plants of Australia, by Leigh, Boden and Briggs (1984), lists endangered and presumably extinct species and presumed threats to the continued survival of endangered species. The book also describes and illustrates

many endangered and extinct species, discusses the inconsistent use of terms to indicate various degrees of threat and rarity, and describes the binary system developed by Hartley and Leigh (1979) to classify rare, restricted and threatened species.

The first Western Australian publication on rare and restricted flora, by Marchant and Keighery (1979), is based upon the numbers of specimens of each native Western Australian species lodged in the Western Australian Herbarium and the geographical range of the collections for each species. Marchant and Keighery classify most of their 2,022 listed species as geographically restricted, presumably rare or poorly collected.

Four reports dealing with rare, restricted and threatened species were published by the Department of Fisheries and Wildlife. One, by Rye (1982), lists geographically restricted southwestern plants, and another, by Rye, Hopper and Watson (1980), is concerned with the distribution and conservation status of commercially exploited native plants. The first two lists of gazetted rare Western Australian flora are presented and the listed species are described and illustrated in Rye and Hopper (1981) and Patrick and Hopper (1982). Rye (1982) lists 527 species of southern Western Australian flowering plants that are geographically restricted, and she includes most, if not all, of the species gazetted in 1982 as rare. The Rye list is based upon investigation of collections upon which the Marchant and Keighery (1979) list was based, taxonomic publications and rare plant records of the WAWRC.

The Rye and Hopper (1981) and Patrick and Hopper (1982) publications were superseded by CALM's **Western Australia's Endangered Flora** (Hopper *et al.* 1990), which lists and discusses DRF and Priority species. The book also has illustrations and brief descriptions of all of the 1989 DRF species and some of the Priority species.

CALM has so far produced three publications in a series of Western Australian Wildlife Management Programs dealing with DRF and Priority flora in need of special protection and plans for managing them. The three published are for the Metro Area (Kelly *et al.* 1993), the Merredin District (Mollemans, Brown and Coates 1993) and the Northern Forest Region (Kelly *et al.* 1990). All three publications, but especially the more recent two, provide information about the plants, habitats, distributions, abundance and flowering times of the DRF and Priority taxa of the areas they cover.

3. Completeness and Accuracy of Lists

The completeness and accuracy of most lists of rare plants are limited because the intensity, uniformity and seasonal coverage of collecting and systematic surveying have, in many cases, been insufficient to distinguish between genuinely rare (and restricted) species and species which only appear to be rare (or restricted) because they have been poorly collected and recorded. Systematic surveying and collecting by Western Australian Wildlife Research Centre (WAWRC) and Western Australian Herbarium (WAH) botanists, and others, are correcting this deficiency.

Furthermore, a number of lists do not contain varieties, subspecies or undescribed species, some of which are also rare.

In some cases, significant species are found in areas where they were not previously known to occur. For instance, *Villarsia submersa*, a small water-lily type plant, was believed to be restricted to a few small seasonal ponds between Bunbury and Busselton until 1989, when it was found in a few ponds in the Metropolitan Region. *Synaphea pinnata* and *Stachystemon axillaris* are plant species previously gazetted as rare (Government Gazette, WA, of 14 November 1980) which have since been found to be more common or widespread or better conserved than previously believed and are no longer gazetted.

In other cases, species are no longer found in areas where they have been previously recorded, often due to habitat destruction or alteration. However, there are many species, such as *Diuris purdiei* and *Drakaea elastica*, which emerge and flower for only one or a few years after fire, then disappear until after the next burn.

Other sources of incompleteness and ambiguity in distribution and abundance information are:

- o insufficient locality information given on the labels which accompany herbarium specimens,
- o inaccurate identification of specimens, and
- o treatment of groups of species, or other taxa, as single units.

So little is known about the abundance, distribution and taxonomy of nonvascular plants that few such species are gazetted as rare flora or are included in lists of rare taxa, although many of them may also be rare or geographically restricted.

4. Gazetted Rare (DRF) and Priority Taxa

The first list of Declared Rare Flora, gazetted in 1980, was based upon assessment of species on the Marchant and Keighery (1979) list, addition of newly described species and local botanists' knowledge of species distributions and abundance. Gazettal of a taxon is now generally preceded by relatively detailed searches made in the field to locate populations of the taxa proposed as rare.

The current list of gazetted rare flora still does not include all, or even a majority of, rare plants. It concentrates on the southwestern part of Western Australia and particular groups of species, which have, in general, been studied in greater detail

than others. For example, members of the families Proteaceae, Myrtaceae, Myoporaceae, Leguminosae and Orchidaceae account for well over half of the gazetted species on the list.

In the south-west alone there are many more ungazetted rare and restricted species than gazetted ones; in the rest of the state the ratio of ungazetted to gazetted rare and restricted species may be even greater.

Since the early 1980s WAWRC and WAH botanists have been compiling lists, descriptions, illustrations and records of significant species on a regional basis throughout Western Australia. These lists and records, along with relevant taxonomic studies, provide the basis for the lists of species proposed for gazettal and being considered for gazettal.

The WAWRC and WAH have continuing programmes of research on rare flora and CALM now has lists for the entire state, and for management districts and regions, of two categories of Declared Rare Flora and four categories of Priority Species (or other taxa). These are:

- o R - Extant Declared Rare Flora Species (or other taxa),
- o X - Presumed Extinct Declared Rare Flora Species (or other taxa),
- o Priority One (P1) - taxa which are known from one or a few (generally <5) populations, which are under threat,
- o Priority Two (P2) - 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,

- o Priority Three (P3) - taxa which are known from several populations, at least some of which are not believed to be under immediate threat,
- o Priority Four (P4) - taxa considered to have been adequately surveyed and, at least in Australia, to be rare but not currently threatened by any identifiable factors.

These lists are modified and updated as relevant information and results of survey work become available. For instance, on the basis of new information about distribution and abundance some taxa are added to the lists and others are deleted from them. Other taxa may be moved from one Priority code to another.

Priority One, Two and Three species are under consideration for declaration as rare flora, pending the outcome of further survey work.

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APPENDIX 4

WILDLIFE CONSERVATION ACT 1950

WILDLIFE CONSERVATION (RARE FLORA) NOTICE 1993

Made by the Minister under section 23F (2).

Citation

1. This notice may be cited as the *Wildlife Conservation (Rare Flora) Notice 1993*.

Interpretation

2. In this notice —

“extant”, in relation to taxa, means still existing in their original state;

“protected flora” means any flora belonging to the classes of flora declared by the Minister under section 6 (6) of the Act to be protected flora by notice published in the *Gazette* on 9 October 1987 at p. 3855;

“rare flora” has the meaning given by section 23F (1) of the Act;

“taxon” includes any taxon that is described by a genus name and any other name or description.

[*Note. The plural form of “taxon” is “taxa”.*]

Rare flora

3. Subject to clause 4, all taxa of protected flora specified in Parts 1 and 2 of the Schedule are declared to be rare flora throughout the whole of the State.

Certain protected flora excluded

4. Clause 3 does not apply to those plants of a taxon of protected flora specified in the Schedule that are growing in a domesticated or cultivated state.

Repeal

5. The *Wildlife Conservation (Rare Flora) Notice 1992** is repealed.

[* *Published in the Gazette on 3 July 1992 at pp. 2951-4.*]

SCHEDULE

[Clause 3]

Protected flora declared as rare flora

PART 1 — TAXA KNOWN TO BE EXTANT

Acacia anomala
Acacia aphylla
Acacia argutifolia
Acacia denticulosa
Acacia depressa
Acacia forrestiana
Acacia lanuginophylla ms
Acacia leptalea ms
Acacia lobulata
Acacia merrickiae
Acacia pharangites
Acacia pygmaea ms
Acacia semicircularis
Acacia simulans
Acacia vassalii
Acacia sp. Dandaragan
(S. van Leeuwen 269)
Adenanthos cunninghamii
Adenanthos dobagii

Adenanthos ellipticus
Adenanthos eyrei
Adenanthos ileticus
Adenanthos pungens
Adenanthos velutinus
Allocasuarina fibrosa
Allocasuarina tortiramula
Andersonia sp. Two Peoples Bay
(G. Keighery 8229)
Anigozanthos bicolor subsp. minor
Anigozanthos humilis subsp.
chrysanthus
Anigozanthos viridis subsp.
terraspectans
Anthocercis gracilis
Apium prostratum subsp.
phillipii ms
Aponogeton hexatepalus
Asplenium obtusatum

Asterolasia drummondii
Asterolasia grandiflora
Asterolasia nivea
Baeckea arbuscula
Banksia brownii
Banksia cuneata
Banksia goodii
Banksia oligantha
Banksia sphaerocarpa var.
dolichostyla
Banksia tricuspis
Banksia verticillata
Bentleya spinescens
Billardiera mollis
Boronia adamsiana
Boronia revoluta
Caladenia bryceana
Caladenia busselliana ms
Caladenia caesarea subsp.
maritima ms
Caladenia christineae ms
Caladenia dorrienii
Caladenia elegans ms
Caladenia excelsa ms
Caladenia exstans ms
Caladenia harringtoniae ms
Caladenia hoffmanii ms
Caladenia huegelii
Caladenia viridescens ms
Caladenia voigtii ms
Caladenia wanosa
Caladenia winfieldii ms
Calectasia arnoldii ms
Calytrix breviseta subsp. *breviseta*
Chamelaucium erythrochlorum ms
Chamelaucium griffinii ms
Chamelaucium roycei ms
Chorizema varium
Conospermum toddii
Conostylis drummondii
Conostylis lepidospermoides
Conostylis micrantha
Conostylis misera
Conostylis rogeri
Conostylis seorsiflora subsp.
trichophylla
Conostylis setigera subsp. *dasys*
Conostylis wonganensis
Cooperookia georgei
Corybas limpidus
Darwinia acerosa
Darwinia apiculata
Darwinia carnea
Darwinia collina
Darwinia ferricola ms
Darwinia macrostegia
Darwinia masonii
Darwinia meeboldii
Darwinia oxylepis
Darwinia squarrosa
Darwinia wittwerorum
Darwinia sp. Stirling Range (G.J.
 Keighery 5732)
Daviesia bursarioides ms
Daviesia euphorbioides
Daviesia megacalyx ms
Daviesia microcarpa ms
Daviesia oxylobium ms
Daviesia pseudaphylla ms
Daviesia purpurascens
Daviesia speciosa ms
Daviesia spiralis
Diuris drummondii
Diuris micrantha
Diuris purdiei
Diuris recurva
Drakaea concolor ms
Drakaea confluens ms
Drakaea elastica
Drakaea isolata ms

Drakaea micrantha ms
Drakonorchis barbarella ms
Drakonorchis drakeoides ms
Drosera fimbriata
Drummondita ericoides
Drummondita hassellii var.
longifolia
Dryandra mimica
Dryandra serratuloides
Dryandra sp. Kamballup
 (M. Pieroni 20.9.88)
Dryandra sp. Stirling Range
 (F. Lullfitz 3379)
Dryandra sp. 31 (A.S. George
 16754)
Epiblema grandiflorum var.
cyanea ms
Eremophila caerulea subsp.
merrallii ms
Eremophila denticulata
Eremophila inflata
Eremophila microtheca
Eremophila nivea
Eremophila racemosa
Eremophila resinosa
Eremophila subteretifolia ms
Eremophila ternifolia
Eremophila veneta ms
Eremophila verticillata
Eremophila virens
Eremophila viscida
Eriostemon wonganensis
Eucalyptus absita
Eucalyptus argutifolia
Eucalyptus articulata
Eucalyptus balanites
Eucalyptus beardiana
Eucalyptus bennettiae
Eucalyptus blaxellii
Eucalyptus brevipes
Eucalyptus burdettiana
Eucalyptus ceracea
Eucalyptus cerasiformis
Eucalyptus coronata
Eucalyptus crispata
Eucalyptus crucis subsp. *crucis*
Eucalyptus crucis subsp. *praecipua*
Eucalyptus cuprea
Eucalyptus dolorosa
Eucalyptus erectifolia
Eucalyptus goniantha subsp.
goniantha
Eucalyptus graniticola ms
Eucalyptus impensa
Eucalyptus insularis
Eucalyptus johnsoniana
Eucalyptus lateritica
Eucalyptus leprophloia
Eucalyptus merrickiae
Eucalyptus mooreana
Eucalyptus olivacea ms
Eucalyptus phylacis
Eucalyptus pruiniramis
Eucalyptus rhodantha
Eucalyptus steedmanii
Eucalyptus suberea
Eucalyptus synandra
Eucalyptus sp. Norseman
 (S.D. Hopper 2736)
Gastrolobium appressum
Gastrolobium callistachys
Gastrolobium glaucum
Gastrolobium graniticum
Gastrolobium hamulosum
Gastrolobium tomentosum
Gonocarpus intricatus
Grevillea batrachioides
Grevillea calliantha
Grevillea christinae
Grevillea cirsiifolia

Grevillea dryandroides
Grevillea flexuosa
Grevillea inconspicua
Grevillea infundibularis
Grevillea involucreta
Grevillea saccata
Grevillea scapigera
Grevillea sp. Pithara (S. Patrick 1055)
Hakea aculeata
Hakea megalosperma
Halosarcia bulbosa
Hemiandra gardneri
Hemiandra rutilans
Hemigenia viscida
Hensmania chapmanii
Hibbertia sp. Porongurups (R.D. Hoogland 12186)
Hydrocotyle lemnoidea
Hypocalymma longifolium
Isopogon uncinatus
Kennedia becxiana
Kennedia glabrata
Kennedia macrophylla
Lambertia echinata subsp. *echinata*
Lambertia fairallii
Lambertia orbifolia
Laxmannia jamesii
Lechenaultia chlorantha
Lechenaultia laricina
Lechenaultia pulvinaris
Lechenaultia superba
Lepidium catapycnon
Leucopogon obtectus
Melaleuca sciostostyla
Meziella trifida
Microcorys eremophiloides
Microtis globula
Myoporum cordifolium
Myoporum turbinatum
Myriophyllum lapidicola
Myriophyllum petraeum
Pandanus spiralis var. *flammeus*
Paracaleana dixonii ms
Pimelea rara
Pittosporum moluccanum
Pityrodia augustensis
Pityrodia scabra
Pleurophascum occidentale
Prostanthera carrickiana
Prostanthera magnifica
Pterostylis sp. Northampton (S. D. Hopper 3349)
Ptychosema pusillum
Pultenaea pauciflora

Restio abortivus
Restio chaunocoleus
Rhagodia acicularis
Rhizanthella gardneri
Ricinocarpos trichophorus
Roycea pycnophylloides
Rulingia sp. Trigwell Bridge (R. Smith s.n. 20.6.89)
Schoenus natans
Spirogardnera rubescens
Stawellia dimorphantha
Stylidium coroniforme
Stylidium galioides
Stylidium merrallii
Stylidium plantagineum
Stylidium scabridum
Tetraria australiensis
Tetralthea aphylla
Tetralthea deltoidea
Tetralthea harperi
Tetralthea paynteri ms
Thelymitra dedmaniae
Thelymitra psammophila
Thelymitra stellata
Thomasia glabripetala
Thomasia montana
Thryptomene wittweri
Tribonanthes purpurea
Verreauxia verreauxii
Verticordia crebra
Verticordia fimbriolepis
Verticordia harveyi
Verticordia helichrysantha
Verticordia hughanii
Verticordia plumosa var. *ananeotes*
Verticordia staminosa
Villarsia calthifolia
Wurmbea tubulosa
Wurmbea sp. Cape Naturaliste (S.D. Hopper: 587.1)
Xyris sp. Stirling Range (G.J. Keighery 7951)

PART 2 — TAXA PRESUMED TO BE EXTINCT

Acacia kingiana
Acacia prismifolia
Acacia volubilis
Beyeria lepidopetala
Calothamnus accedens
Centrolepis caespitosa
Coleanthera virgata
Deyeuxia drummondii
Dicrastylis morrisonii
Eriostemon falcatus
Frankenia conferta
Frankenia decurrens
Frankenia parvula
Glyceria drummondii
Gyrostemon reticulatus
Haloragis platycarpa
Hemigenia exilis
Hemigenia obtusa
Hydatella leptogyne
Lasiopetalum rotundifolium
Lepidium drummondii
Leptomeria dielsiana
Leptomeria laxa
Leucopogon cryptanthus
Leucopogon marginatus
Menkea draboides
Nemcia lehmannii
Opercularia acolytantha
Phlegmatospermum drummondii
Platysace dissecta
Plectrachne bromoides
Pseudanthus nematophorus
Ptilotus fasciculatus
Ptilotus pyramidatus
Scaevola macrophylla
Stylidium neglectum
Taraxacum cygnorum
Tetralthea elliptica
Tetralthea fasciculata
Thomasia gardneri

K. J. MINSON, Minister for the Environment.



