JENNY ARNOLD'S

PERTH WETLANDS RESOURCE BOOK

CHAPTERS 5 - 6

WETLANDS OF THE NORTHERN AND EASTERN GNANGARA MOUND
AND EASTERN WANNEROO WETLANDS

ENVIRONMENTAL PROTECTION AUTHORITY
AND THE WATER AUTHORITY OF WESTERN AUSTRALIA

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Jenny Arnold's Perth Wetlands
Resource Book

Chapters 5-6: Wetlands of the Northern and Eastern Gnangara Mound and Eastern Wanneroo Wetlands

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the Water Authority of Western Australia

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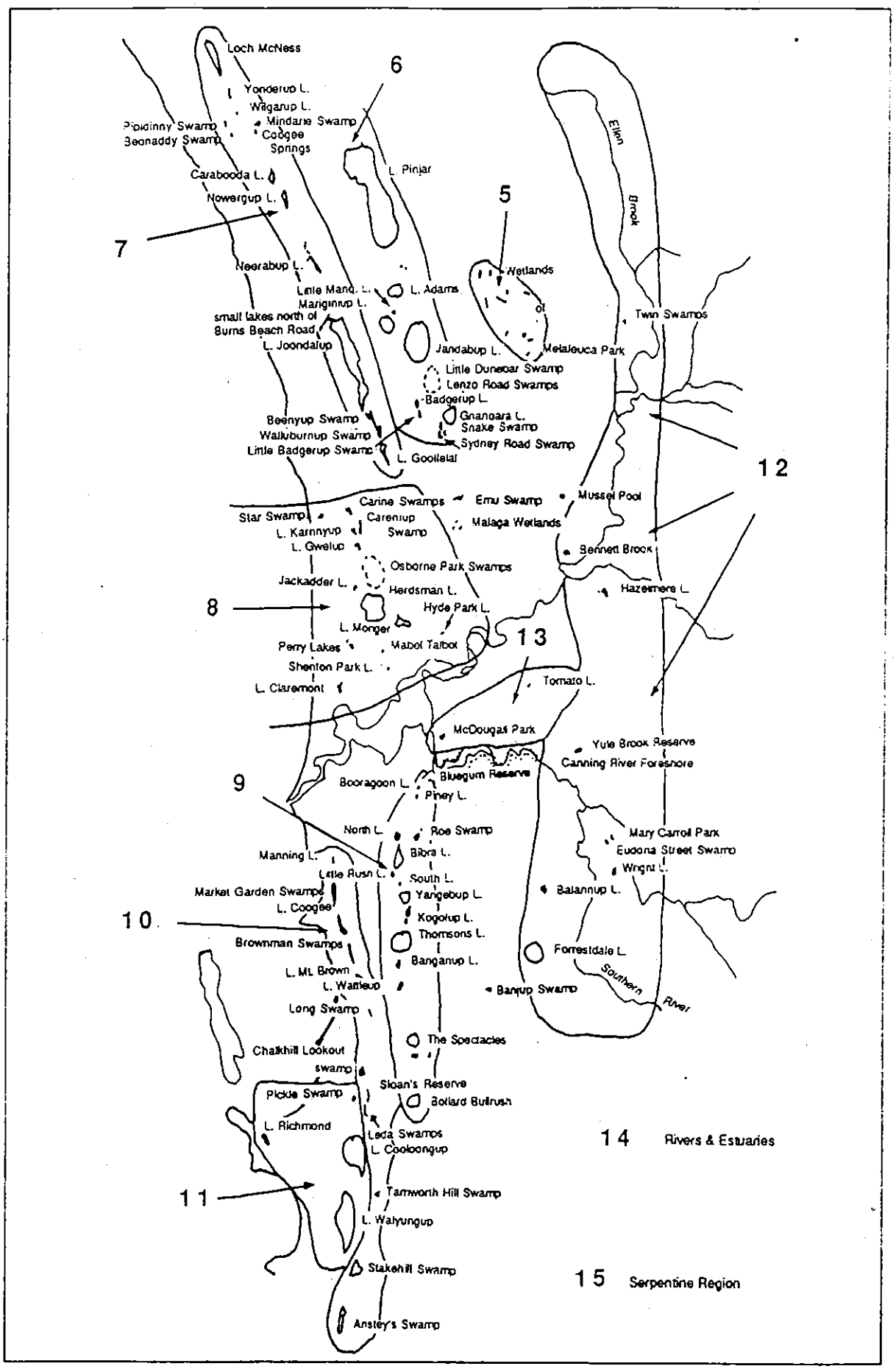
NOTES FOR USERS

Bulletin 266 consists of 15 chapters published in 6 separate volumes.

Chapters 1 - 4 (bound with the appendices) contain information general to wetlands. They form essential background to the subsequent chapters which describe most of the clearly definable seasonal and permanent lakes with open water. As such readers of Chapters 5 - 15 should be used in conjunction with Chapter 1 - 4.

The Bulletin is not an exhaustive inventory of all wetland types. Readers are referred to C. A. Semeniuk (1987), Wetlands of the Darling System - A geomorphic approach to habitat classification. Journal of the Royal Society of Western Australia. Volume 69, Part 3. pp 95-111 for a comprehensive classification of wetland types on the Swan Coastal Plain.

The index map on page (ii) shows how the wetland chains have been grouped into chapters. The position in the text where individual wetlands are discussed is shown in the index on page 418 (Chapters 1 - 4).



Map of Perth's wetlands showing the grouping of wetlands into Chapters in this Bulletin.

Chapters 5-6: Wetlands of the Northern and Eastern Gnangara Mound and Eastern Wanneroo Wetlands.

FIGURES

Other chapters in this series

5. WETLANDS OF THE NORTHERN AND EASTERN GNANGARA MOUND

5.1 SETTING

The wetlands of the northern and eastern Gnangara Mound are little known, compared with those in the urban and rural areas of the Perth metropolitan region. Most of the wetlands lie within State Forest 65 while those on the eastern and northern flanks of the Gnangara Mound lie within vacant Crown land or freehold rural land. The Forest Management Priority Areas of Wabling (Bindiar Lake), Ridges and Melaleuca and the proposed Yeal Nature Reserve contain large numbers of seasonal wetlands; Lake Muckenburra lies within a reserve used for recreation; Lake Bambun, Lake Nambung, Lake Mungala and Wallering Swamp lie within reserves for conservation of flora and fauna; an unnamed permanent lake is situated in Reserve 31241 for Conservation of Flora and Fauna and its associated wetland Quin Brook lies in vacant Crown land (within the proposed Yeal Nature Reserve). Many other wetlands lie on the northern fringe of the groundwater mound, south of Gingin Brook.

Diagrammatic sections A-A', B-B', C-C' (Refer to Figures 5.1, 5.2) show the relationships of some of the wetlands of the northern and eastern Gnangara Mound to the terrain, wetland vegetation as identified from air photographs and the water table (information from groundwater monitoring bores).

Diagrammatic sections D-D', E-E', F-F' (Refer to Figures 5.2, 5.4) show the relationships of the wetlands from Lake Pinjar on the western side of the mound, through Melaleuca Park to Ellen Brook.

Features of note include:

- the occurrence of sedgeland only where the water table 'outcrops' at the surface (as indicated by the maximum recorded water table levels) or is very close to the surface, while swamp woodland occurs upslope from the sedgeland; (sumplands and damplands of Semeniuk, 1987) and

- the occurrence of springs on wetlands forming the seasonal headwaters of tributaries of Ellen Brook (floodplains and palusplains of Semeniuk, 1987).

The vegetation of the region has been investigated by Havel (1968) and Heddle (1980). Dodd et al. (1984) described the rooting patterns of sandplain plants near Gnangara, 40 km north of Perth, showing shallow-rooted plants to be sensitive to changes in soil moisture. The Western Australian Museum carried out a survey of the fauna of the North Swan Coastal Plain (How, 1978).

The wetlands of Melaleuca Park have received some study and are considered below. Recent investigations of the area have been reported by the Water Authority of Western Australia (1986).

5.2 REFERENCES

Dodd, J, Heddle, E M, Pate, J S and Dixon K W (1984), Rooting patterns of sandplain plants and their functional significance. pp 146-177 in Kwongan: Plant life of the sandplain. Editors: J S Pate & J S Beard. University of Western Australia Press, Nedlands, Western Australia.

Havel, J J (1968), The potential of the northern Swan Coastal Plan for Pinus pinaster plantations. Forests Department Bulletin No 76.

Heddle, E M (1980), Effects of changes in soil moisture on the native vegetation of the northern Swan Coastal Plain, Western Australia. Forests Department Bulletin No 92.

Semeniuk, C A (1987), Wetlands of the Darling System - a geomorphic approach to habitat classification. Journal Roy. Soc. Western Australia. 69(3), 95-111.

Water Authority of Western Australia (1986). Gnangara Mound groundwater resources Environmental Review and Management Programme. Appendices. Dames and Moore for the Authority, Perth.

5.3 WETLANDS OF THE NORTHERN GNANGARA MOUND

5.3 (a) LANDFORMS AND VEGETATION

Mattiske and McArthur (1986) mapped Gnangara Mound landforms, soils and vegetation from the Moore River south to Ballajura and from Wanneroo Road east to the Brand Highway. Of the 17 units mapped the following ten have wetland elements to a greater or less degree.

. Alluvial Terrain

- Yanga: Flat poorly drained complex landscapes; soils include shallow sand over limestone or ferruginous pan deep leached sand, and saline soils; dense Melaleuca spp. along drainage lines.

- Gingin Brook Complex: Flat poorly drained landscape interrupted by broad low sandy rises; soils include shallow sand over ferruginous pan, red loam over limestone and black clay over limestone; Banksia spp. with scattered Actinostrobus pyramidalis on swamp; Melaleuca spp. and Eucalyptus rudis along drainage lines and fringing permanent water.

. Bassendean Dunes

- Joel: Poorly drained depressions; humus podzols; scattered M. preissiana, E. rudis and Banksia ilicifolia with a dense shrub layer.

- Seasonal Swamps: Depressions with free water in winter; humus podzols and peats; dense M. preissiana; M. rhaphiophylla and E. rudis around the edges with reeds in the centre.

- Pinjar: Extensive flat swampy areas; sandy surface with some diatomite in the surface and organic hard pan below; E. rudis, B. littoralis, and M. preissiana around edges; sedges and reeds with scattered M. teretifolia in centre; Jacksonia furcellata and Viminaria juncea on low sandy rises.

- Permanent Lakes and Swamps: Depressions; humus podzols and peats around the edges often with some diatomite; zoned vegetation with heath on upper slopes, Melaleuca spp. and E. rudis at waters edge, reeds and sedges in shallow water.

- Yeal Swamp Complex: A pattern of low sandy rises and many small seasonal swamps; rises have iron-humus or iron podzols and Banksia spp. low open woodland; swamps have surface layer of diatomite over sand; dense Melaleuca spp. and E. rudis around fringe with sedges in central parts of swamps.

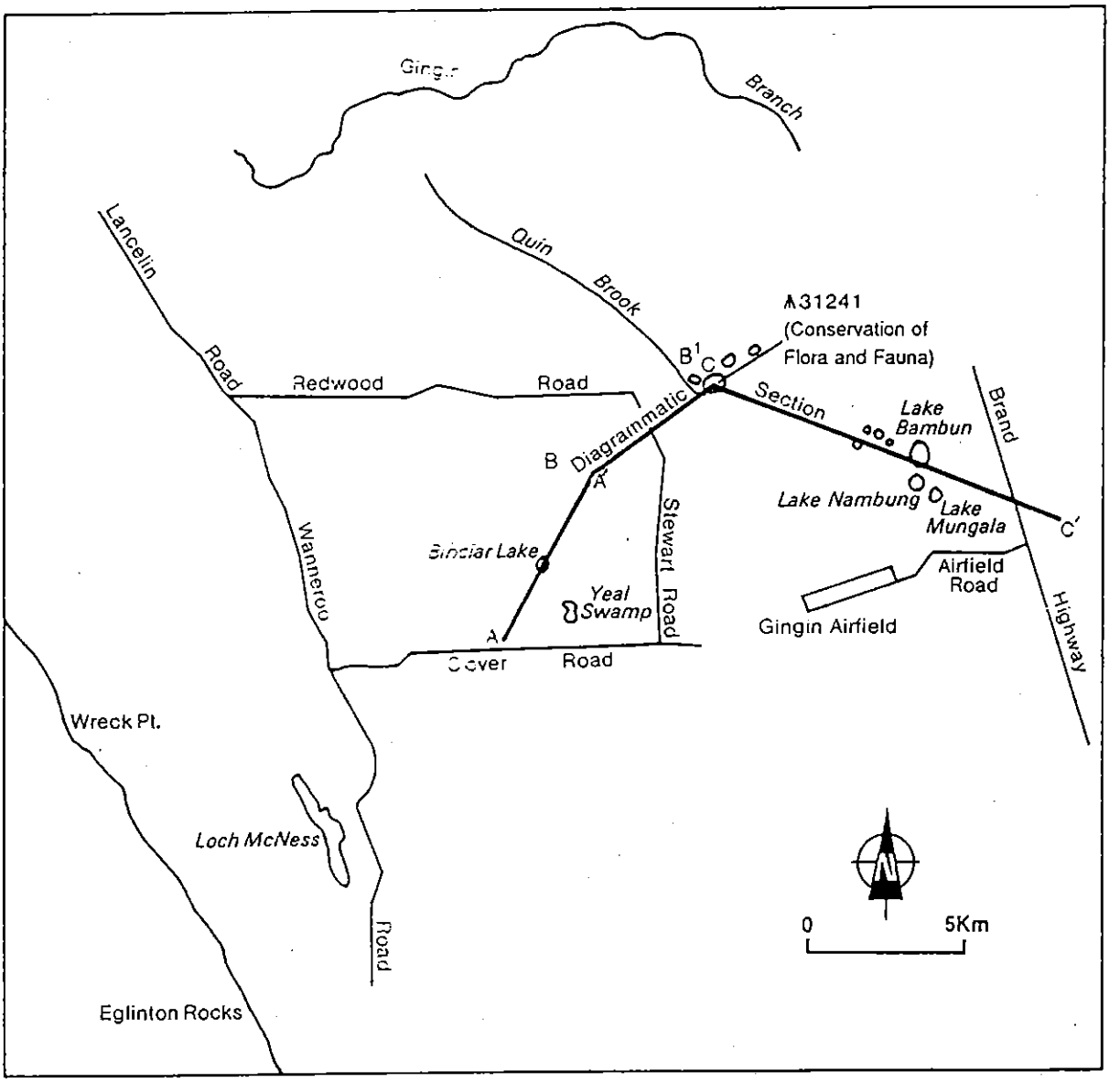


Figure 5.1 Position of cross-sections A-A', B-B', C-C' (in Figure 5.2.) in relation to features of the northern Gnangara Mound.

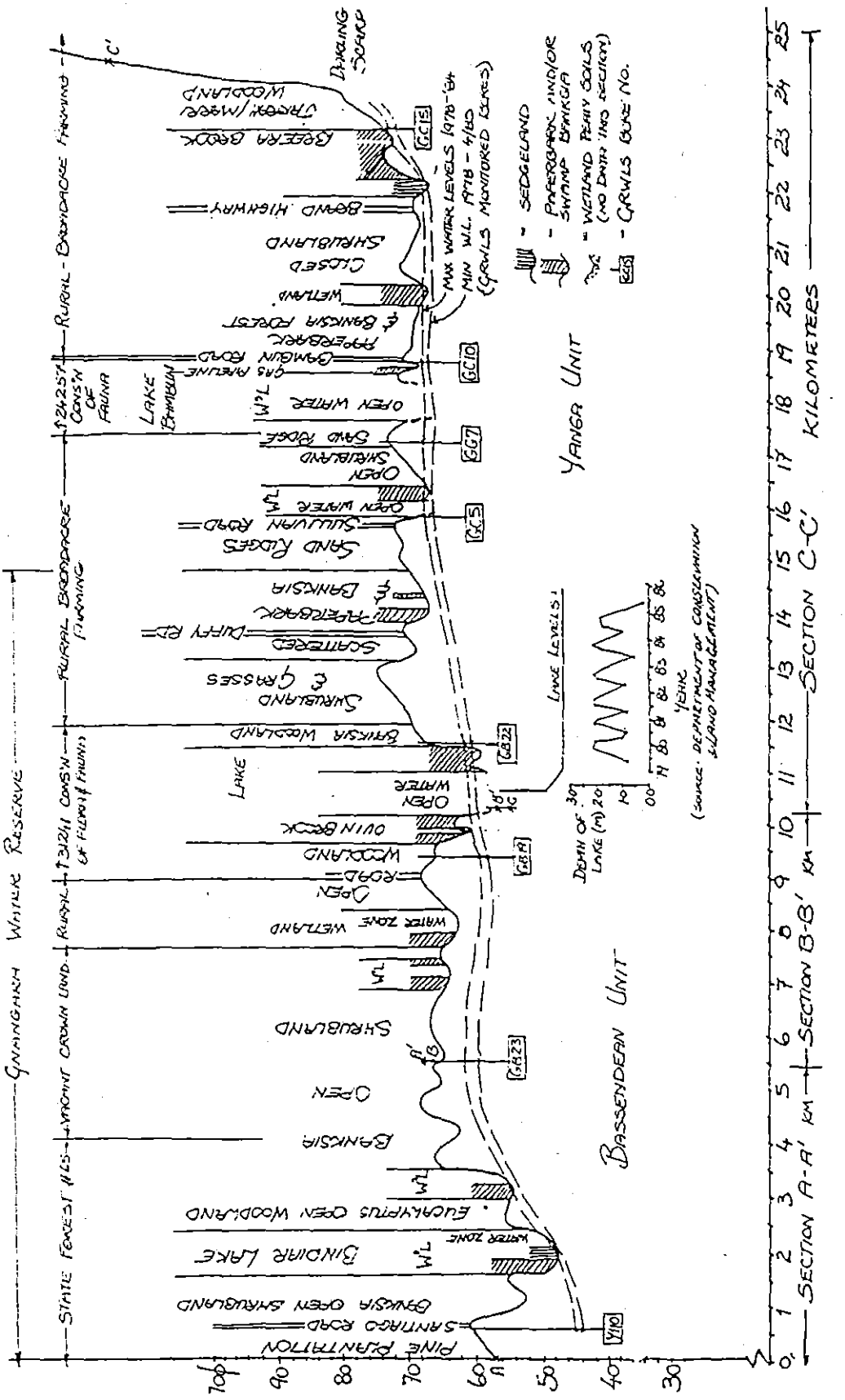


Figure 5.2 Diagrammatic cross-sections A-A', B-B', C-C', showing the relationship of some of the wetlands of the northern and eastern Gnangara Mound to the terrain, wetland vegetation and the water table

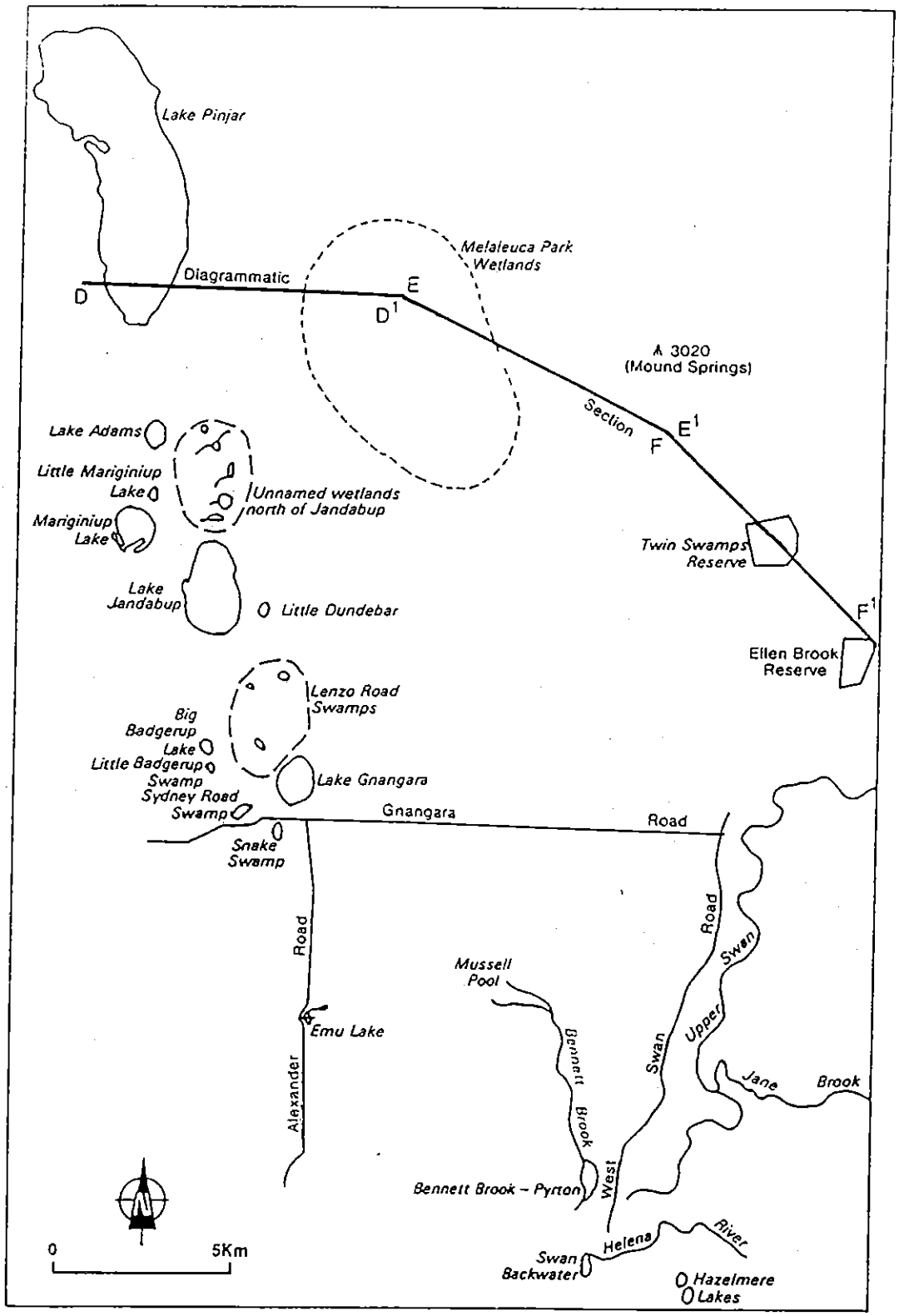


Figure 5.3 Position of cross-sections D-D', E-E' (in Figure 5.4.) in relation to features of the eastern Gnangara Mound

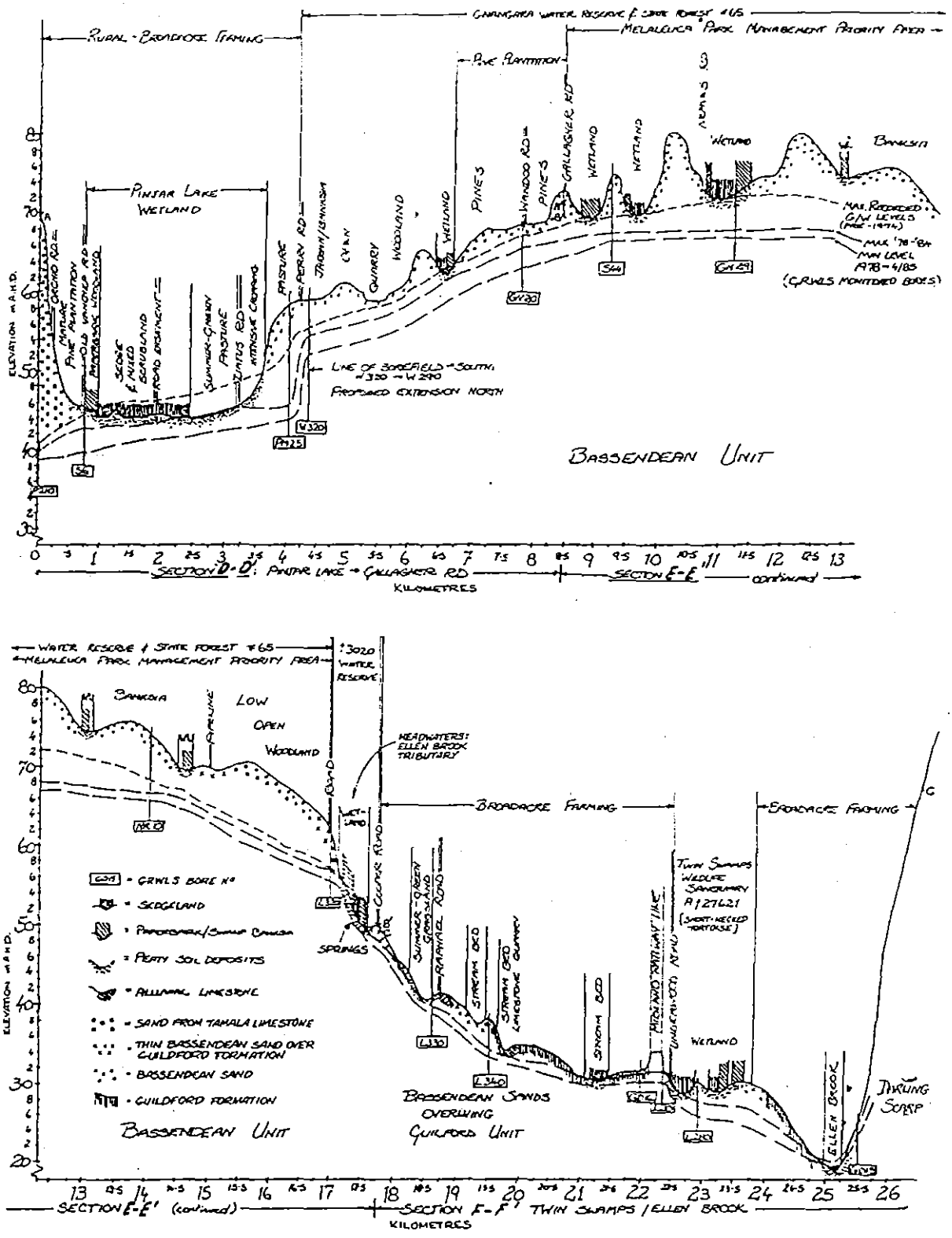


Figure 5.4 Diagrammatic cross-sections D-D', E-E' across the Gnangara Mound from Lake Pinjar to Ellen Brook showing the relationship of some of the wetlands to the terrain, wetland vegetation and the water table.

- Drainage Lines: Broad, shallow channels, peaty soils, fringe of Melaleuca spp. and E. rudis; reeds and sedges in central zone.

. Spearwood Dunes.

- Beonaddy: Flat terrain fringing water in base of karst depressions; light grey sand with water table within 2 m; E rudis, B. littoralis and Melaleuca spp; Typha sp. near waters edge.

- Lakes and Swamps: Permanent water in base of karst depressions; Melaleuca spp. and E. rudis in zone of water level fluctuation; sedges and reeds in shallow water.

Of 13 rare, geographically restricted and poorly collected species of vascular plants that might occur in or near the Gnangara Mound region listed by Weston (1986) six occur on swampy or moist ground.

5.3 (b) MANAGEMENT ISSUES

The wetlands of the Northern Gnangara Mound include some of the least disturbed wetland ecosystems of the Swan Coastal Plain. They provide opportunities to investigate these ecosystems and to understand how wetlands elsewhere on the plain may have functioned prior to the heavy impacts of land development. Therefore, efforts should be made to manage the area so that the impact of future development and climatic change does not destroy this significant resource.

5.3 (c) REFERENCES

McArthur, W M and Mattiske, E M (1986), The Gnangara Mound area, landforms, soils and vegetation. Appendix C. Gnangara Mound Groundwater Resources Environmental Review and Management Programme. Water Authority of Western Australia, Perth.

Weston, A S (1986), Gnangara Mound region ecosystems, sensitive species and conservation reserves. Appendix D Gnangara Mound Groundwater Resources Environmental Review and Management Programme. Water Authority of Western Australia, Perth.

5.4 WETLANDS OF MELALEUCA PARK

5.4.1 GENERAL INFORMATION

AMG REFERENCE: 6 493 000/398 800 (point at approx centre of area)
LOCAL AUTHORITY: Shire of Swan
RESERVE NO: State Forest 65
PURPOSE: Management Priority Area - Conservation of Flora (Forest Department General Management plan No. 87)
MANAGEMENT: Department of Conservation and Land Management
SYSTEM 6 RECOMMENDATION:M9
WATER RESERVE: Wanneroo Public Water Supply Area (UGWPCA)
DRAINAGE: not applicable
MINING: Some peat mining in wetlands (Muir, 1983); potential for silica sand.

5.4.2 PHYSIOGRAPHY AND GEOLOGICAL SETTING

The Melaleuca Park wetlands are marshes in interdunal swales in Bassendean Dunes (Gozzard, 1982). The lake deposits are peaty clays of lacustrine origin.

Muir (1983) described typical soil profiles from dunes to swamp flats.

5.4.3 AREAS

The description which follows is derived from Muir (1983).

In the 3 000 hectare Melaleuca Park, roughly 10 per cent is swamp. Twenty-five of the 45 swamps studied by Muir are less than three hectares in extent. There are also six large, shallow swamps of 16-40 hectares in area and four small deep swamps of 1-6 hectares in area and greater than three metres deep. The depth of the swamps, measured from the edge of the wetland vegetation to the lowest level in the swamp ranges from 0.6 to 3.2 m. The form of the swamps reflects the dune patterns of the area.

5.4.4 HYDROLOGY (Figure 5.4)

Figure 5.4 shows a diagrammatic cross-section from east to west across Melaleuca Park. Groundwater levels as determined by monitoring bores indicate the relationship of the wetlands to the water table.

Those wetlands which have sedge beds are those in which the water table has outcropped at the surface when groundwater levels have been very high. Discharge of groundwater occurs on the eastern slopes of the Gnangara Mound, forming tributaries to Ellen Brook, and on the western slopes of the mound, at Lake Pinjar in the case of the diagrammatic section shown in Figure 5.4.

5.4.5 WATER QUALITY

Muir reported on soil pH and total dissolved solids (TDS) for woodland and swamp soils. Water samples from swamps, taken at highest water levels (August) averaged pH 4.4 and 200 ppm TDS.

5.4.6 LAND USE

The Department of Conservation and Land Management reclassifies Melaleuca Park, designated a Management Priority Area in Forests Department Working Plan No 87, as a nature reserve to be the subject of a reserve management plan (CALM Regional Management Plan, 1987: Northern Forest Region).

5.4.7 VEGETATION

Muir (1983) described the swamp plant succession, giving a complete sequence and noting variations which are determined largely by the size and depth of the swamp. Thus, large, shallow swamps display the complete succession of vegetation assemblages and only the wettest swamps have Baumea articulata at the lowest point in the succession.

Muir described evidence from the swamp vegetation that there has been a decline in the water table as well as a filling in of the swamps with sand.

Bell and Stephens (1984) discussed the importance of availability of soil water in growth and reproductive development of common plant species at the Yule Brook, Botany Reserve (at Kenwick, in the Southern River landform with

Bassendean Dunes over clay deposits). They investigated the phenologies of a number of plant species to determine the roles of environmental factors such as temperature, solar radiation and moisture. They showed that availability of water was of primary importance in controlling the length of the growth period. If soil water was available, growth and reproductive development were influenced by daily solar radiation and temperature. The authors drew attention to the likely importance of rooting depth and water availability in the phenology of species. They considered that "evidence of current environmental fluctuations of moisture, temperature and radiation and the present root system morphology, seems adequate to explain shoot initiation in the currently dominant species of the kwongan communities near Perth" (p 223).

Heddle (1980) described the vegetation on a transect near the western boundary of Melaleuca Park (Neaves transect) in 1966 and 1976. Subsequent observations are described in Mattiske & Associates (1984). Only slight changes in the distribution of plant species were reported along the transects from swamp to dune ridge. This contrasts with observations on transects east of Lake Jandabup and Lake Gnangara where significant reductions in numbers of plants dependent upon "excessive wetness" were observed.

These accounts point to the importance of soil moisture in determining the vegetation of coastal plain sand plains and the relative stability of the water table in the vicinity of Melaleuca Park compared with areas with more intensive changes to land and groundwater use. Given increasing demand for groundwater, the wetlands of Melaleuca Park take on considerable importance as reserved examples of wetland plant assemblages.

5.4.8 FAUNA

There is no information on the invertebrate fauna of the Melaleuca Park wetlands. How (1978) provided lists of vertebrate species likely to be found in Melaleuca Park and discussed the results of trapping surveys carried out in the Park in 1977-78. Very few species were captured.

Muir (1983) discussed the possible effects of reduction of wetland vegetation on the fauna. He noted that woodland plants flower at different times of the year and that there is virtually a year-round pollen and nectar source for insects, nectarivorous birds and honey possums. Loss of flowering species as a result of falling groundwater levels could affect the survival of flower-dependent animal species.

Muir's observations on year-round flowering are supported by Bell and Stephens (1984). They showed that, for the heath species of the South-West of Western Australia, there is generally a greater proportion of the flora in flower each month and a less concentrated peak in flowering behaviour than in other regions with a mediterranean climate, other than South Africa. Given the importance of soil water in determining the growth and reproductive responses of heath plants, changes to groundwater availability could be reflected in changes in the durations of flowering (see 5.4.7 above).

5.4.9 MANAGEMENT ISSUES

The ongoing conservation value of Melaleuca Park wetlands could be influenced by drawdown of the unconfined groundwater.

Management of recreational activities in the park, particularly use of off-road vehicles, litter dumping and fire, is important if the wetland communities are to be maintained.

Mining of the wetlands for peat could reduce the extent and diversity of wetland plant communities.

The basis for management of Melaleuca Park and other areas of State Forest in the Gnangara region are outlined in the Regional Management Plan 1987-97 (Department of Conservation and Land Management 1987).

5.4.10 REFERENCES

Bell, D T and Stephens, L J (1984), Seasonality and phenology of Kwongan species. pp 205-222 in Kwongan: Plant life of the sandplain. Editors: J S Pate and J S Beard. University of Western Australia Press, Western Australia.

Department of Conservation and Land Management (1987). Regional management plan 1987-1997, Northern Forest Region. CALM, Western Australia.

Gozzard, J R (1982), Muchea Sheet 2034 I and Part 2134 IV, Perth Metropolitan Region, Environmental Geology Series. Geological Survey of Western Australia.

Heddle, E M (1980), Effects of changes in soil moisture on the native vegetation of the northern Swan Coastal Plain, Western Australia. Bulletin 92, Forests Department of Western Australia.

How, R A (editor) (1978), Faunal study of the north Swan Coastal Plain. Report prepared by the Western Australian Museum for the Department of Conservation and Environment, Western Australia, 1978.

Mattiske, E M & Associates (1984), Monitoring the effects of groundwater extraction on native vegetation on the northern Swan Coastal Plain. Prepared for the Metropolitan Water Authority, Western Australia (unpublished).

Muir, B G (1983), Drainage, swamp structure and vegetation succession at Melaleuca Park, Northern Swan Coastal Plain. Western Australian Herbarium Research Notes. No 9, 1983, pp 27-39.

FIGURES

FIGURES (Cont'd)

TABLES

6. THE EASTERN WANNEROO WETLANDS

6.1 GENERAL SETTING (Figure 6.1)

The eastern Wanneroo wetlands are mapped as marshes in interbarrier depressions, high level (Gozzard, 1982, 1982a). They are situated at, or close to, the interface between the Bassendean and Spearwood dune systems, between 45-50 m AHD. They are all situated within the rural zone of the City of Wanneroo and in the northern "rural wedge" of the Metropolitan Region Scheme.

Wetlands occupy roughly 12 per cent of the area. Relatively little of the wetland area is in Crown reserves (only a total of 4.15 square kilometres on Lake Jandabup and Lake Gnangara).

A further 97 ha in the centre of Lake Mariginiup is vacant Crown land. A small area on the south-west of Lake Pinjar is reserved but part of this has been used for sanitary landfill. The remainder of Lake Pinjar is privately owned or in road reserve and much has been substantially altered in efforts to bring the lake bed into productive land use.

The Environmental Protection Authority (1983) in its recommendations for conservation and recreation reserves in the 'System 6 area', identified a number of wetlands in the area and recommended that the then Metropolitan Region Planning Authority consider reserving them for "Parks and Recreation" according to a priority based on environmental quality (see Table 6.1 below).

All of the unalienated wetlands are the larger, more permanent wetlands. Reservation of a large part of Lake Adams was proposed as a condition of the establishment of the Lake Adams Special Rural Zone but this has never been implemented.

All of the wetlands are surface expressions of the unconfined aquifer of the Gnangara Mound with their water supply being derived from rainfall on the immediate surface and groundwater inflow. The wetlands are all shallow, so that lowering of the water table results in reduction of the area of wetland.

Boundaries of seasonal wetlands are often ill-defined or have been obscured by agriculture. It is likely that a greater area of seasonally inundated land exists during periods of high rainfall as, for example, during the mid 1960s.

Rural activities in the area include vegetable growing, plant nurseries and other forms of intensive agriculture, hobby farms and equestrian pursuits. Soils derived from the Bassendean Dunes occupy the eastern part of the area and they are of very low fertility, requiring heavy applications of fertilisers to achieve reasonable productivity. The relatively high porosity of the soils means that they also require large volumes of water. The low binding capacity of the Bassendean soils leads to rapid leaching of plant nutrients applied as fertilisers with the result that nutrients rapidly reach the unconfined groundwater. Soils derived from the Spearwood Dunes in the western part of the area are more fertile.

The unconfined aquifer of the Gnangara Mound is a very important water resource and has been subject to investigation and monitoring (Metropolitan Water Authority; Water Authority of Western Australia 1986).

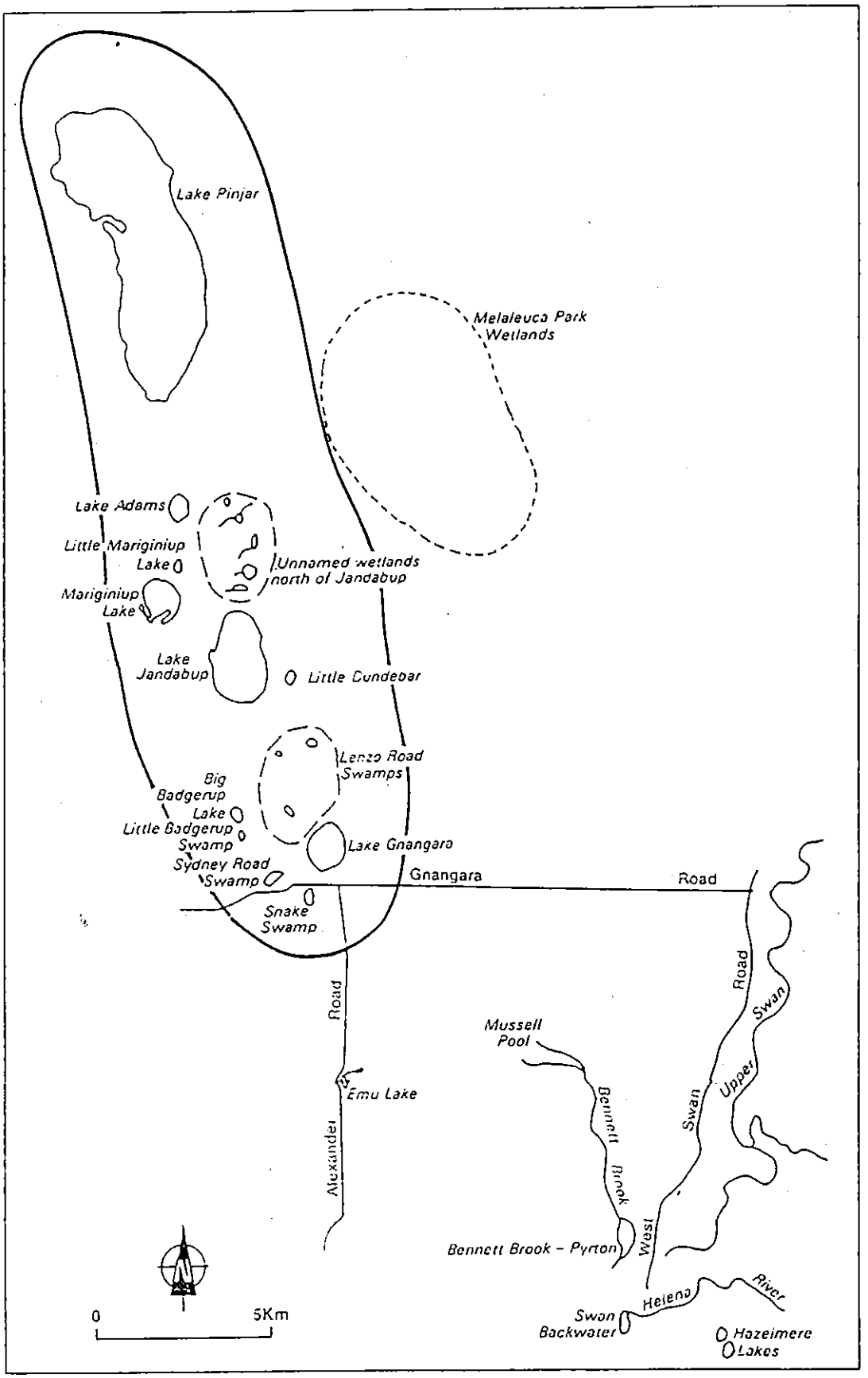


Figure 6.1 Wetlands of the Wanneroo Groundwater Area.

Concern about groundwater management resulted in the establishment of the Wanneroo Groundwater Area, (WGA) set up to manage the shallow groundwater of the region in 1982. Conservation priorities for the WGA were that efforts were to be made to ensure that adequate water supplies were to be set aside to provide for Lake Jandabup and Lake Mariginiup but that no special efforts would be made to manage groundwater to sustain the remaining wetlands.

Table 6.1. The Eastern Wanneroo Wetlands: Areas, conservation and management priorities and tenure. (Wetlands designated by Australian Map Grid Reference in cases where there is no recognised name.)

WETLAND	EPA (1983) CONSERVATION PRIORITY 1-high;11 low	WANNEROO GROUNDWATER AREA-WATER MANAGEMENT PRIORITY	LAND
Lake Pinjar (1925 ha)	11	none	private
Lake Adams (47.3 ha) SRZ[1]	9	none	private; SRZ[1] Rec Res
389500/ (4.21 ha) 6492300	10	none	private
392000/ (3.4 ha) 6492200	10	none	private
389900/ (8.62 ha) 6491900	10	none	private
392300/ (6.7 ha) 6492300	10	none	private
390300/ (25.05 ha) 6491200	2	none	private
390200/ (24.6 ha) 6490300	2	none	private
Mariginiup (127 ha)	3	water alloc to protect lake	vacant Crown land/private
Little Mariginup (20 ha) 389900/	4	none	private
6489800	2	none	private
Jandabup (330 ha)	1	water alloc to protect lake	Cons & Rec. Reserves, private
Dundarbar (19.2 ha) cluster centred on 392000/	none	none	private
6484500 (70 ha)	8	none	SRZ, golf course
Badgerup)	7	none	private,
L Badgerup)(26 ha)			future SRZ
Gnangara (128 ha)	5	none	Rec Reserve
Sydney Rd Swamp (20.1 ha)	6	none	private
Snake Swamp (8.9 ha)	6	none	private

[1] SRZ = Special Rural Zone, wetland in local open space

The wetlands of a transect across this region have been the subject of detailed assessment for their environmental quality (Western Australian Water Resources Council, 1987).

Evaporation from free water surfaces and transpiration from dense wetland vegetation result in high fluxes of groundwater to the atmosphere. All intensive farming activities in the area have high water requirements and availability of groundwater has a strong influence upon land values. Thus, the wetlands and agriculture are competitors for a finite groundwater resource. The Gnangara Mound is also an important resource for public water supply (Water Authority of Western Australia, 1986). The extensive pine plantations to the east of the main lake chain also contribute significantly to the complex of land use pressures on the wetlands.

6.1.1 REFERENCES

Environmental Protection Authority (1983), Conservation reserves for Western Australia: The Darling System. Part II. Report 13, Department of Conservation and Environment, Western Australia, pp 168-173.

Gozzard, J R (1982), Muchea Sheet 2034 I and Part of 2134 IV, Perth Metropolitan Region, Environmental Geology Series, Geological Survey of Western Australia.

Gozzard, J R (1982a), Yanchep Sheet 2034 IV, Perth Metropolitan Region, Environmental Geology Series. Geological Survey of Western Australia.

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Western Australian Water Resources Council (1987), Environmental significance of wetlands in the Perth to Bunbury Region. Water Authority of Western Australia, Leederville.

6.2 LAKE PINJAR

6.2.1 GENERAL INFORMATION

LOCAL AUTHORITY: City of Wanneroo
MRS ZONE: Rural
RESERVE NUMBERS: 11598, C20432
MANAGEMENT: private; City of Wanneroo
SYSTEM 6 RECOMMENDATION: M8
WAC CLASSIFICATION: LE.f.l.se. modified
WATER RESERVE: Wanneroo Groundwater Areas
DRAINAGE: landowners have attempted to drain properties

6.2.2 PHYSIOGRAPHY AND GEOLOGICAL SETTING

The lake is a flat basin with scattered small dunes on the surface. Several channels from the dunes on the eastern side lead into the lake on its eastern shore and groundwater discharge areas along the eastern shore can be identified by the presence of wetland vegetation and springs. Considerable areas of the lake bed are of a white to grey marl-like substance, particularly on the western part. Figure 5.3 shows a diagrammatic cross-section of Lake Pinjar in relation to other features of the Gnangara Mound.

6.2.3 AREAS

The basin of Lake Pinjar is about nine kilometres long and one to two-and-a-half kilometres wide. Its area is about 19.25 km^2, representing more than twice the total area of remaining wetlands in the region.

6.2.4 HYDROLOGY

For a wetland to maintain permanent water it is necessary that inputs from rainfall and groundwater seepage exceed evaporation, transpiration and seepage out of the lake. In recent years water inputs to Lake Pinjar have been sufficient to provide, at the most, shallow surface water over a portion of the lake bed for a few months in winter. During the summer months the surface of the lake is dry but groundwater is exposed in drains in the lake bed. Small dunes in the centre of the lake are sufficiently well drained to support dry-land woodland, including banksia and acacia. However, in the past, during periods of above average rainfall, landowners have sought drainage of the lake to allow more intensive use of their properties.

6.2.5 WATER QUALITY

No data available.

6.2.6 LAND USE

The lake bed is subdivided for the most part into narrow east-west orientated lots with a limited area of high land above the wetland margin in each lot. Grazing and cultivation to provide pasture are the principal land uses. Some broiler-poultry sheds and a piggery are located on the eastern side of the lake. There has been some pressure to subdivide the land into smaller blocks but the subdivision pattern and the land form make further fragmentation difficult.

Extensive areas of pine plantations occupy the land on the eastern and western sides of the lake. The growth of the pine plantations has probably contributed to changes in the water balance of Lake Pinjar.

6.2.7 VEGETATION

The lake has not been subject to a detailed survey of its vegetation. The eastern margin of the lake is characterised by narrow bands of swamp paperbark and other wetland species which mark the areas of groundwater discharge, with dryland vegetation situated both higher and lower on the landscape. This distribution suggests that groundwater discharge is too low to maintain extensive permanent wetland vegetation on the eastern side. Much of the lake basin has been altered by cultivation but there are also extensive areas of sparse Baumea juncea. The south-east of the lake supports

tall sedges and summer-green grass where the sedges have been cleared. A notable expansion of flooded gum has occurred on the south-western side of the lake in recent years. It is not known whether this is in response to reduced agricultural use, or a change in the water table level.

6.2.8 FAUNA

There has been apparently no systematic study of the fauna of the lake.

6.2.9 MANAGEMENT ISSUES

Lake Pinjar presents some difficult questions.

Its large size and features of its structure confer conservation and scientific interest, but it appears that from the viewpoint of protection of vegetation and wildlife habitat reservation of the lake has a very low priority. Timber and water production on areas to the east and west of the lake have, in contrast, taken on a high priority. Some residual conservation value could possibly be retained through sympathetic management by landholders with recognition for their efforts in the form of rate rebates or other taxation benefits. Alternatively, reallocation of land parcels and consolidation of the central road reserve could provide both for more effective use of land and reservation of a compact area of the wetter parts of the lake. (See EPA Bulletin 295; p 17)

The lake basin represents a 'flood plain' which is likely to be inundated in periods of sustained high rainfall and this fact limits the types of development that can occur on it. The current fragmented pattern of ownership, with subdivision into long narrow lots, imposes problems for rational use of the area, and current and future activities around the lake, especially timber and water production, will significantly affect the lake's water balance.

6.2.10 REFERENCE

Environmental Protection Authority (1987). Gnangara Mound Groundwater Resources. Bulletin 295, Environmental Protection Authority.

6.3 LAKE ADAMS

6.3.1 GENERAL INFORMATION

LOCAL AUTHORITY: City of Wanneroo
MRS ZONE: Rural
RESERVE NUMBERS: n/a
MANAGEMENT: private; City of Wanneroo
SYSTEM 6 RECOMMENDATION: M8
WAC CLASSIFICATION: LE.f.m.s.sc
WATER RESERVE: Wanneroo Groundwater Area
DRAINAGE: not affected

6.3.2 PHYSIOGRAPHY AND GEOLOGICAL SETTING

The wetland occupies a shallow circular depression slightly east of the contact between the Bassendean and Spearwood dune systems. Shallow channels have been dredged in the wetland to provide open water as a landscape feature for the "Lake Adams Special Rural Zone".

The deepest part of the wetland is below 44 m AHD with spot heights of 43.9 m on the western side. The eastern half of the wetland is above 44 m. (Figure 6.3.)

6.3.3 AREAS

Area bounded by surrounding roads (includes SRZ lots)..... 92.4 ha
Area of sedgeland ..... 28.9 ha
Dredged channels ..... 5.6 ha
Planted and regenerating flooded gums ..... 12.8 ha
Grassland, residences and cultivation ..... 45 ha

6.3.4 HYDROLOGY (Figure 6.3)

The wetland is situated on the western flank of the Gnangara Mound, in a similar relationship to the mound as Lake Jandabup.

Table 6.2 Lake Adams: water levels 1971-85 (Water Authority of WA water level records) (See also Figure 2.3).

i Maximum level recorded: 45.59 m AHD (1965).

ii Number of years maximum level has fallen within specified ranges:

m AHD	1971-75	1976-84
>45.0	1	0
44.5-45.0	3	0
44.0-44.5	1	6
<44.0	0	3

iii Minimum level recorded: 42.63 m AHD (1984).

iv Number of years minimum level has fallen within specified ranges:

m AHD	1971-75	1976-84
>43.5	3	0
43.0-43.5	2	3
42.5-43.0	0	6

An indication of falling water levels is that maximum levels since 1976 are falling within the lower range of minimum levels prior to 1976. The lake has dried completely and the water level has fallen below 43.9 m eight of the last nine years.

6.3.5 WATER QUALITY

No data available.

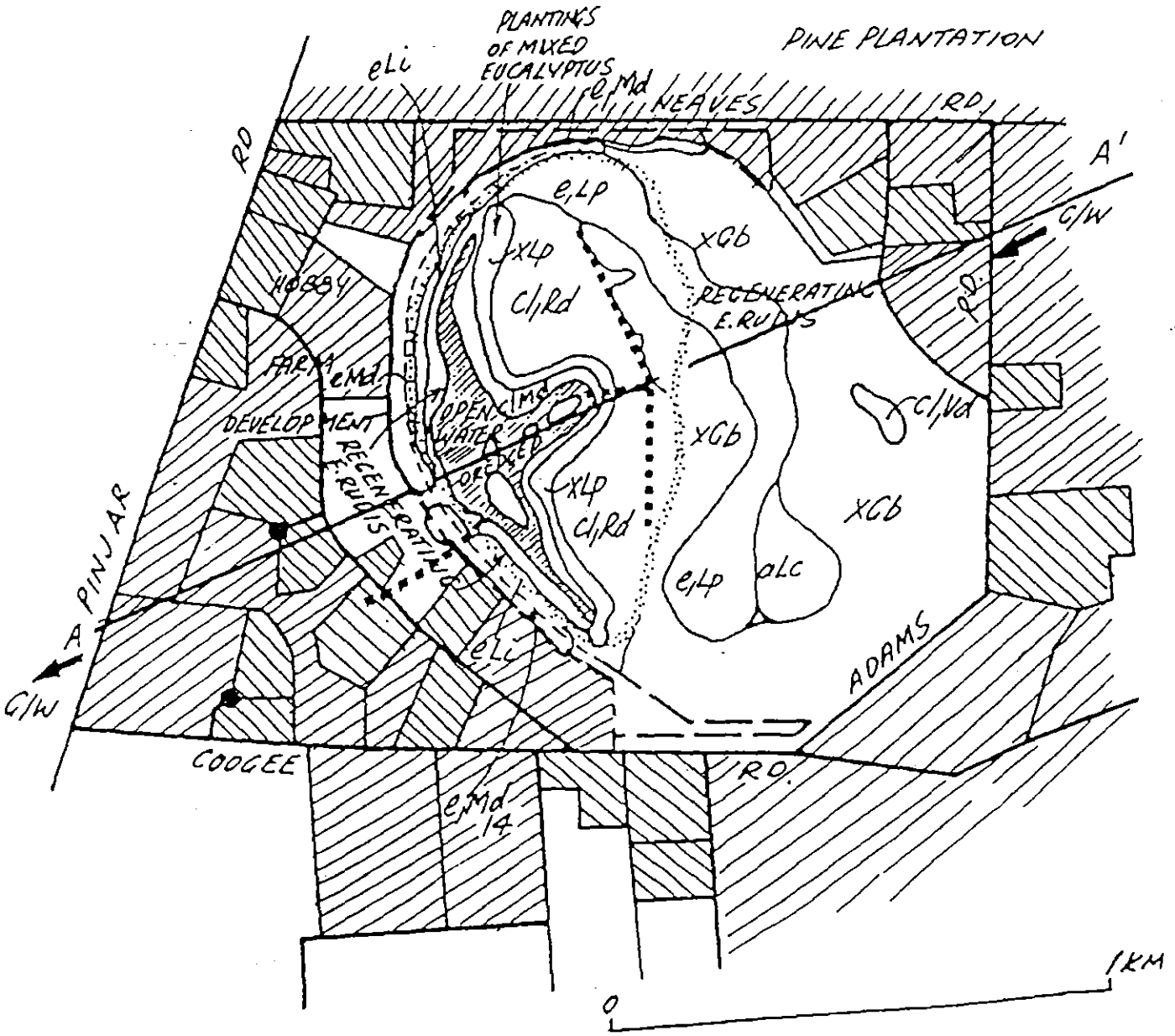


Figure 6.2 Lake Adams: wetland plant communities and surrounding land use.

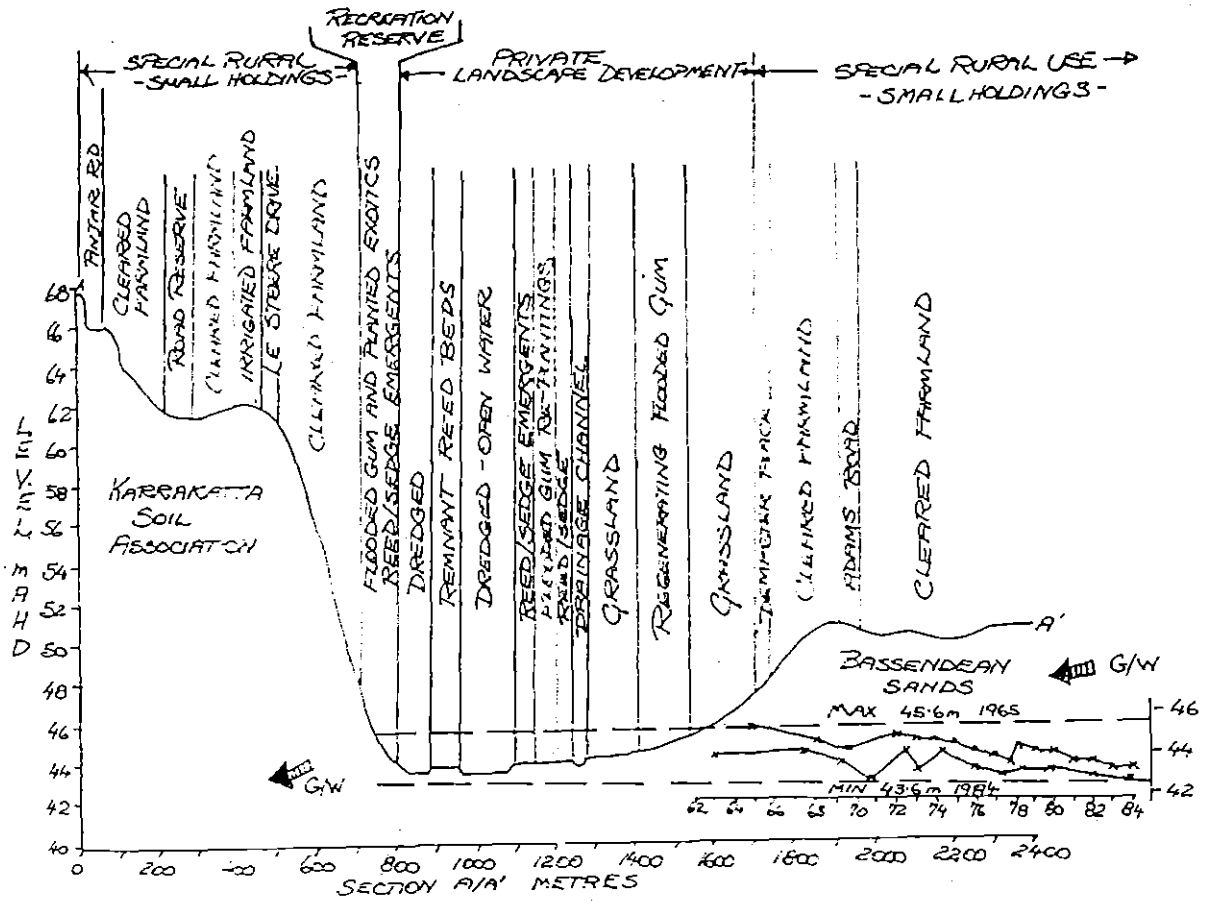


Figure 6.3 Lake Adams: diagrammatic cross-section and water level record.

6.3.6 LAND USE

Land surrounding the lake is subdivided into small holdings of about two hectares in the Lake Adams Special Rural Zone.

Land uses in the zone are governed by provisions of the Special Rural Zone planning scheme which places emphasis on horticulture and equestrian uses. Reticulated scheme water is not available to the landholders so that they are totally dependent upon groundwater and rain water. Despite a policy prevailing in the Wanneroo rural area that landholders in Special Rural Zones should be limited to a groundwater allocation of 1 500 m^3 per year, allocations well in excess of this have been made to most occupiers. These allocations were made because the implications of the policy were not made clear to purchasers at the time the Special Rural Zone was established.

6.3.7 VEGETATION (Figure 6.2)

The area was cleared and farmed as Lake Adams Farm before it was subdivided so there is little native vegetation remaining. The wetland consists of sparse sedgeland (B juncea) on the western part, with planted and regenerating E rudis (flooded gum) around the margins and on the eastern half of the wetland. Many young flooded gums were planted in the course of establishment of the Lake Adams development and these trees are now growing well. (Note: as a result of apparent recent change of ownership (1988) many of these trees have been removed.)

6.3.8 FAUNA

No available information.

6.3.9 MANAGEMENT ISSUES

Stresses

. Long-term falling groundwater levels.

. Nutrient enrichment from rural activities.

Management Issues

Lake Adams has been modified to form a landscape feature for the Lake Adams Special Rural Zone. The condition of the wetland will depend upon the availability of groundwater which will be significantly affected by the amount of pumping by landowners in the Special Rural Zone.

6.4 LAKE JANDABUP

6.4.1 GENERAL INFORMATION

LOCAL AUTHORITY: City of Wanneroo
MRS ZONE: Rural
RESERVE Nos: C7349; C33193
MANAGEMENT: Department of Conservation and Land Management; City of Wanneroo
SYSTEM 6: M8
WAC CLASS: LE.f.l.p.sc.
WATER RESERVE: Wanneroo Groundwater Area
MINING: Mineral Claim - diatomite

6.4.2 PHYSIOGRAPHY AND GEOLOGICAL SETTING

Allen (1979) studied the hydrogeology of the lake and provided a description of its physiography. It is situated in a basin surrounded by sand ridges with former shorelines within the lake basin distinguishable 3-4 m above the present shoreline, indicating that the lake has been at somewhat higher levels in the past. Fifty-five per cent of the lake bed is covered with organic sediments, mostly diatomite, while the periphery is covered with sand. According to Allen (1979), the age of the lake deposits is probably late Pleistocene to Holocene and evidence of erosion of the diatomite pavement shows that the lake had also been at lower levels in the past.

6.4.3 AREAS

Area bounded by road reserves ..... 457 ha
Conservation reserve 7349 ..... 232 ha
Area of sedgeland ..... 134 ha
Open lake basin within sedgeland ..... 110 ha
Wetland area delimited by 46.4 m AHD ..... 330 ha
(arbitrary upper limit-bathymetry)

(70 per cent of the lake is within the Conservation reserve; 21 per cent of the lake is within private land; the remainder is in reserves for recreation and other purposes.)

6.4.4 HYDROLOGY (Figure 6.5)

Allen (1979) described the hydrogeology of the lake and calculated a water balance for the period April 1977-March 1978.

The water table on the eastern side of the lake is at a higher elevation than the lake bed with the result that inflowing groundwater, together with rainfall, maintains water in the lake. Allen's water balance is (volumes in millions of cubic metres for the year 1977-78):

Groundwater inflow (4.49) + Rainfall (2.04) + Lake Volume 1977 (0.31) = Groundwater outflow (1.10) + Evapotranspiration (5.87) + Lake Volume 1978 (0.19).

This water balance shows that the largest factors are groundwater inflow and evapotranspiration. There is no surface inflow or outflow.

Table 6.3. Lake Jandabup: water levels 1968-85 (See Figure 6.5).

i Maximum winter water level 46.8 m AHD (1968).

ii Number of years maximum level has fallen within specified ranges.

m AHD	1968-75	1976-84
>46	4	0
45.5-46.0	4	0
45.0-45.5	0	6
44.5-45.0	0	3

Table 6.3. Lake Jandabup: water levels 1968-85 (See Figure 6.5) (Cont'd).

iii Minimum summer water level 45.5 m AHD (1985).

iv Number of years minimum level has fallen within specified ranges.

m AHD	1969-75	1976-85
>45.5	2	0
45.0-45.5	2	0
44.5-45.0	3	3
44.0-44.5	0	7

Lake levels have shown a falling trend for the 17 years 1968-1984. Maximum levels have in recent years fallen within the ranges of minimum levels prior to 1976.

6.4.5 WATER QUALITY

Ayre et al. (1977) found that nutrient levels in Jandabup were lower than in either Loch McNess or Joondalup. Davis and Rolls (1987) have confirmed the low nutrient status of the lake.

Table 6.4. Lake Jandabup: chemical analysis of spring and autumn water samples 1970-84. (Data from Water Authority of Western Australia.)

PARAMETER	1970-75		1976-84	
	MEAN	RANGE	MEAN	RANGE
pH	7.63(n=11)	7.2-8.5	7.31(n=18)	6.4-8.3
NaCl(autumn) mg/L	511(n=5)	410-530	780(n=9)	440-1500
NaCl (spring) mg/L	282(n=6)	230-290	182(n=9)	50-315
Total N mg/L	<1.30(n=9)	<0.1-3.00	<1.61(n=16)	<0.05-2.80
Phos as P mg/L	<0.01(n=8)	<0.01-0.54	<0.15(n=18)	<0.05-0.45
Fe (mg/L)	(n=8)	nil-0.20	0.50(n=17)	0.10-1.7

Tests for heavy metals were all below the level of detection of the analytical methods used.

There is some indication of increasing autumn salinity levels since 1976, possibly as a result of greater frequency of drying out. No other trends can be detected from the values.

Davis and Rolls (1987) present data from water and sediment samples taken monthly from March 1985-April 1986, providing the most satisfactory existing information about the water quality of the lake.

6.4.6 LAND USE

While some relatively intense agricultural activity on the lake margin is long standing (eg south-east sector), there has been an intensification of agriculture around the lake in the last ten years.

Only a limited area of the lake basin is reserved and private land holdings extend into the sedgelands on all but the southern sector. Subdivision of land holdings on the eastern side and expanded horticulture on the west are examples of the kinds of intensification in progress.

The City of Wanneroo has made efforts to repair some incursions into the lake, for instance a channel constructed through reserved sedgelands at the southern end of the lake and a waste disposal site in private land on the western side. Stock from adjoining holdings graze on the sedgelands and off-road-vehicle tracks are to be seen on much of the dry lake bed towards the end of summer. These activities disrupt the plant communities and promote invasions by weed species. However, removal of stock may result in a short-term fire hazard until regenerating native plants recover sufficiently to shade out the weeds.

6.4.7 VEGETATION (Figure 6.4)

Marchant mapped the vegetation of the lake basin in 1978 (How, 1978). Since that time Mattiske (pers comm) has noted expansion of the sedgelands on the south-eastern sector of the lake in the course of observations on fixed transects.

There is little evidence of Typha in the lake; however, Typha colonies occur in a sump in private property adjoining the north-west corner of Reserve 7359.

The fringing woodlands are very limited in extent; flooded gum is regenerating on Reserve †33193 and remnants of heath and M. teretifolia occur on the eastern shore.

Lantzke (1983) has described three species of bladderworts in the sedgelands on the south-eastern sector of the lake. One of these is an unusual occurrence.

6.4.8 FAUNA

6.4.8.2 Invertebrate Fauna

Ayre et al. (1977) and the WA Museum (How, 1978) sampled lakes of the northern Swan Coastal Plain. They found that insects and crustacea were the dominant forms present with an emphasis on resilient species able to tolerate adverse and fluctuating environmental conditions (Hembree and George, 1978). They observed that abundance and diversity of invertebrate organisms increased following autumn rains.

The lake was subject to systematic sampling in 1985-87 (Davis and Rolls, 1987 and Davis, Rolls and Balla, in preparation). The results provide the best existing baseline for any lake in the area.

6.4.8.3 Vertebrate Fauna Other than Birds

Only fragmentary information is available. WA Museum records list two frog species (Limnodynastes dorsalis and Ranidella insignifera). R.glauerti has been heard calling in the sedgelands on several occasions (J Arnold).
The only fish species found in the lake by the WA Museum were mosquito fish and gold fish.

6.4.8.4 Birds

There is a considerable array of bird observations from the lake.

The WA Museum made regular observations during 1977-78 (How 1978).

The Wildlife Research Centre (Department of Fisheries and Wildlife, now Department of Conservation and Land Management) made systematic observations of bird numbers in 1979-80 (J Lane and G Pearson pers comm).

Lane and Pearson noted three major habitats: open water, sand and mud flats, and sedgelands with some subdivision of the sedgelands.

The detailed observation of a nest of the Little Bittern Ixobrychus minutus and the successful rearing of young has been described by Jaensch and photographed by Bert and Babs Wells (Jaensch, 1984) in the sedgelands of the lake.

Comparison of bird counts carried out in 1977-78 with more recent counts indicate increasing proportions of wading birds. This may be an artefact of the observations or it may indicate a change in patterns of bird usage resulting from lower lake levels and increased exposure of lake margins.

Data collected by volunteer observers for the Royal Australasian Ornithologists' Union (Jaensch, in press) have identified features of Lake Jandabup, including:

1. forty-two bird species of waterbirds have been recorded. including seven breeding species;

2. the reserve is important for the Red-capped Plover - the highest counts recorded in the WATERBIRD USAGE STUDIES, which extended through the south-west of WA were made at the Reserve (Jaensch, in press);

3. high maximum counts of Little Bittern, Royal Spoonbill and Wood Sandpiper;

4. it is an important breeding site for Little Bitterns, and the most accessible site close to Perth to study the breeding ecology of this species;

5. eight species listed in the Japan Australia Migratory Bird Agreement occur at the lake - all of the species observed were waders, except for the Great Egret;

6. using maximum counts as a criterion, no other reserve in the Jurien - Gingin Region was more important for the Pacific Heron, Spotless Crake, Purple Swamphen, Black-winged Stilt, Banded Stilt, Greenshank and Clamorous Reed-Warbler;

7. Jandabup was the only reserve north of the Swan River at which the Australian Bittern was recorded; and

8. fewer than 100 individual waterbirds were counted at the Reserve in July to November, but counts of more than 1 000 were sometimes made when mud was exposed in February, March and April.

6.4.9 MANAGEMENT ISSUES

Stresses

A significant stress in this area is the changing regional water balance due to combined effects of groundwater abstraction, pine plantations and low rainfall. Management of groundwater extraction in the Wanneroo Groundwater Area recognises the water requirements of Lake Jandabup but landowners continue to demand water to allow them to develop their properties. The Water Authority of Western Australia has made efforts to reduce pumping from production bores near the lake to minimise drawdown. The pine plantations on the eastern side of the lake probably impose high demands on groundwater. Thinning of the pines with consequent increased infiltration of rainfall to the groundwater could increase lake levels.

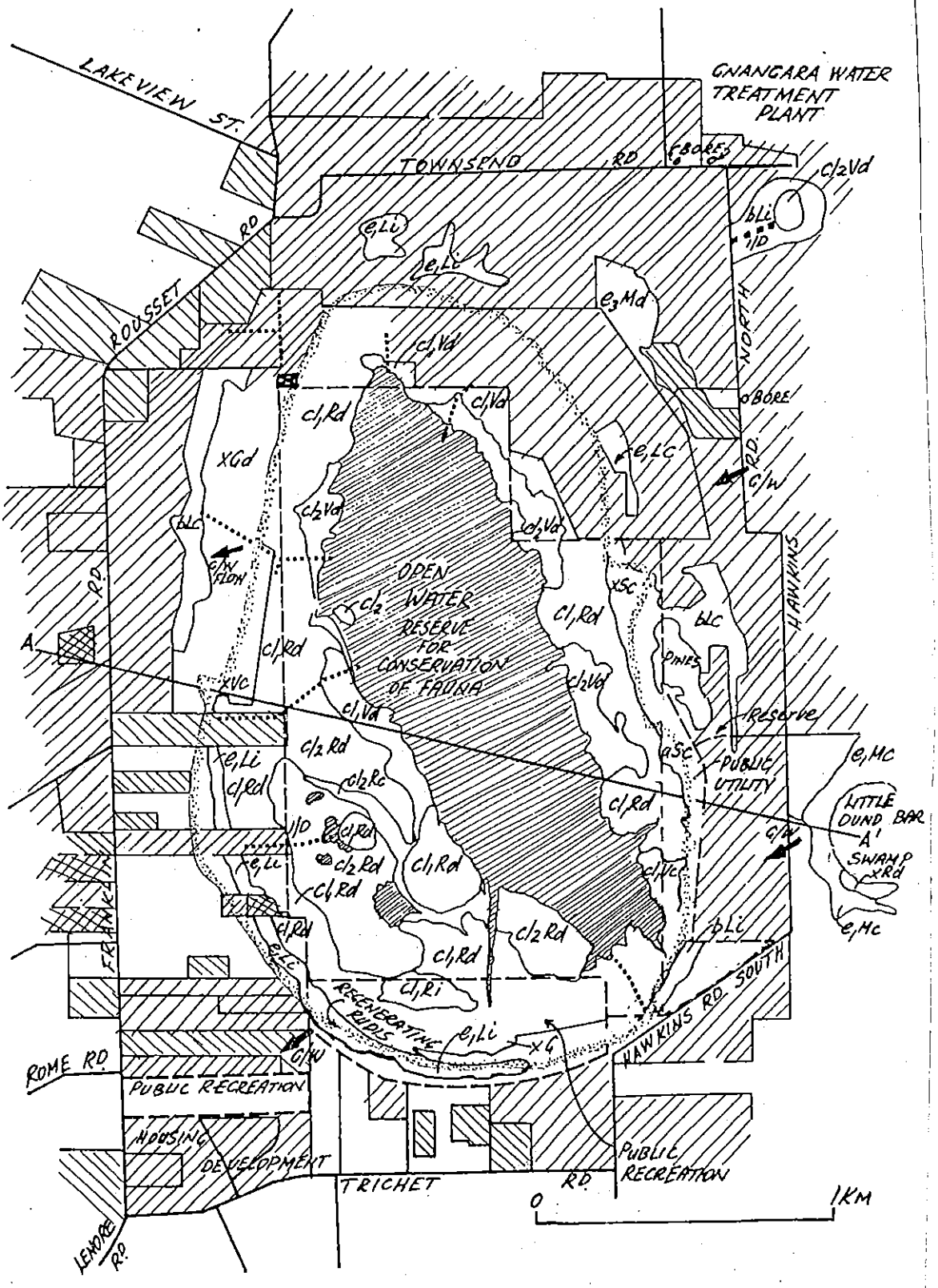
Vegetation buffers have been lost from the lake margins as a result of expansion of agriculture into the sedgelands, and grazing of the sedgelands.

Excavations and dumping on the lake bed have disrupted the sedgelands; a consequence may be invasion of weed species. Use of off-road vehicles on the exposed mud flats may have similar effects. Colonisation of disturbed areas by weeds contributes to high fuel levels on the lake margins and increases fire risk.

Management Issues

Lake Jandabup is the only wetland in the area reserved for conservation. It is utilised by a large number of species of waterbirds and wading birds. Management should attempt to protect the existing bird habitats. The current efforts by the Water Authority of Western Australia to manage groundwater abstraction to protect conservation value of the lake should be continued. Management objectives should be to maintain some surface water throughout the summer and for winter water levels to rise high enough to inundate the greater part of the sedgelands. This could be achieved by attempting to maintain water levels between 44.3 m AHD in late summer and a minimum of 44.9 m AHD in late winter. During years with low winter rainfall, and thus low recharge of the unconfined aquifer, drying out of the lake in late summer is unlikely to be catastrophic for the ecosystem (Davis and Rolls 1987). However, if the lake dries out each summer and substantial inundation of the sedgelands does not occur in winter then it is expected that the sedgelands will expand towards the centre of the lake and retreat from the margins. This would have the effect of reducing the diversity of the habitats at present available on the lake.

The Water Authority of Western Australia (1986) considered that the preferred strategy for Stage 1 of the Pinjar Groundwater Scheme would result in a drawdown of the aquifer of less than 0.5 m.



6.4

Figure 6.4 Lake Jandabup: wetland plant communities and surrounding land use.

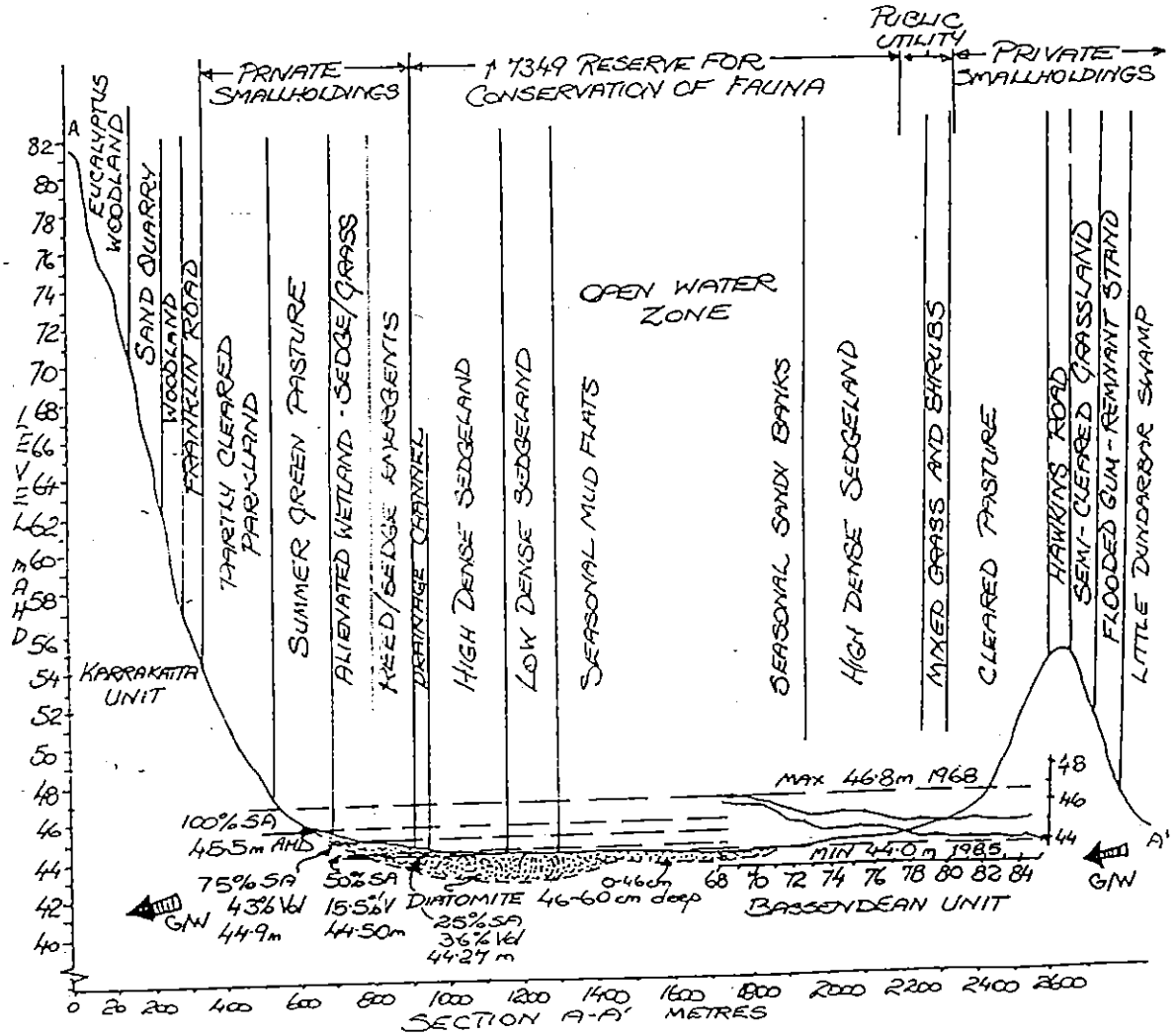


Figure 6.5 Lake Jandabup: diagrammatic cross-section and water level record.

Increased management effort, directed to controlling off-road vehicles and management of other forms of disturbance, together with weed control, would assist in protecting the conservation value of Lake Jandabup.

Management should also recognise that Lake Jandabup is a significant landscape feature in the eastern Wanneroo rural area. It should be valued for this reason. Advantage could be taken of the features of the lake to provide for education and bird-watching. The presence of relatively uncommon bird species on the lake adds to its interest.

6.4.10 REFERENCES

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6.5 LAKE MARIGINIUP

6.5.1 GENERAL INFORMATION

LOCAL AUTHORITY: Wanneroo
MRS ZONE: Rural
RESERVE NO: n/a vacant Crown land
MANAGEMENT: private/nil
SYSTEM 6 RECOMMENDATION: M8
WAC CLASSIFICATION: LE.f.1.p.so
WATER RESERVE: Wanneroo Groundwater Area
MINING: Mineral Claim-diatomite & peat

6.5.2 PHYSIOGRAPHY AND GEOLOGICAL SETTING

The lake occupies a shallow circular depression in the Quaternary "superficial formations" slightly east of the contact between the Bassendean and Spearwood dune systems.

The lake bed consists of lake deposits of peat and diatomite 1-2 m thick (Hall, 1980). (Figure 6.7)

6.5.3 AREAS

Area to outer limit of sedgeland	127	ha
Area of sedgeland	45	ha
Open area within sedgeland	82	ha
Area of vacant Crown land	97.6	ha
Water area to 45.2 m AHD	137	ha

6.5.4 HYDROLOGY (Figure 6.7)

The lake is situated on the western flank of the Gnangara Mound and is in hydraulic connection with the unconfined groundwater. The lake lies between the 44 m contour to the east, and the 43 m contour on the west.

Elevation of the water table is higher than the lake basin on the east and lower on the western side so that groundwater flow, with rainfall, maintains water in the lake (Hall, 1980).

The water level record shows that, apart from seasonal variations, the water level displayed a falling trend from 1968 to 1972, a rising trend in 1973-1975 and has been relatively stable since then. The minimum autumn levels fell below the bottom of the lake basin in the summers of 1978, 1981 and 1985. Spot heights indicate the bottom of the lake is at 41.1 m AHD.

6.5.5 WATER QUALITY

Table 6.5. Lake Mariginiup: chemical analysis of spring and autumn water samples (Data from Water Authority of Western Australia).

PARAMETER	PRE 1976		1976 to 1984	
	MEAN	RANGE	MEAN	RANGE
pH	7.64	7.10-8.60	7.80	6.70-8.50
Total N mg/L	2.03	0.15-5.50	2.48	0.55-4.70
Phos as P mg/L	<0.12	<0.01-0.24	<0.15	<0.05-0.35
Fe mg/L	<0.10		0.25	<0.10-0.86

Highest values for heavy metals mg/L (post 1975).

Cr <0.05; Zn 0.15 (summer, 1979), Cd <0.01; Pb <0.1; Cu 0.03; Hg <0.0002.

No clear trends in water quality are detectable from inspection of these values.

6.5.6 LAND USE

The area surrounding the lake includes a mosaic of land uses including dryland pasture, market gardens, a plant nursery, irrigated pasture, a private pine plantation and woodland. Clearing extends to the edge of the sedge beds and some summer-damp areas are cultivated. Land and groundwater use in the vicinity of the lake is intensifying.

6.5.7 VEGETATION (Figure 6.6)

Little fringing woodland (<5%) surrounds the lake and that remaining is Acacia, probably representing regrowth after clearing.

The area of the lake, as indicated by the margin of the sedge bed, is 127 ha with about 35% of the total lake area being occupied by sedge beds of largely Baumea articulata and Typha orientalis.

A detailed botanical survey has not been carried out.

6.5.8 FAUNA

No systematic observations have been made on the fauna but see references by Jenkins (1968) and Bekle (1982) who recorded Sacred Ibis at Lake Mariginiup. As Ibis are now established in the Perth region these sightings are primarily of historical interest.

6.5.9 MANAGEMENT ISSUES

Stresses

Abstraction of groundwater for public supply from the Wanneroo well field is considered not to affect the lake (MWA Annual Reports to the Environmental Protection Authority; Hall, 1980). The Water Authority of Western Australia considers that, with preferred management, the aquifer in the vicinity of Lake Mariginiup will be drawn down 0.5 - 1 m as a result of the operation of the Pinjar Public Water Supply Scheme (Water Authority, 1986).

Management of groundwater allocations for private use in the Wanneroo Groundwater Area takes into account water requirements of Lake Mariginiup but estimates of the amount of groundwater available suggest that resources approach full allocation. The alienated land around Lake Mariginiup is not fully developed and as land values reflect development potential it is likely that there will be increasing pressure for additional allocations of groundwater to permit further development. Such increasing use of groundwater may lower the water table and affect recharge of the lake.

There is a limited vegetation buffer and therefore limited range of habitats and great risk of nutrient enrichment from surrounding rural uses.

Typha may replace other species of emergent plants.

Mining of the lake could affect its water relations.

Management Issues

The lake is identified in the System 6 Study as having a high priority for conservation. However, at present it offers relatively limited diversity in habitat types and, as there is no access to the lake margin, there are no opportunities for recreational or educational use. The vegetation and fauna of the lake have not been investigated. However, the following points should be noted:

- even though it is one of several lakes of its type in the region, it is one of only three with some unalienated land on it (the others are Jandabup and Gnangara);
- its water quality is apparently stable; and
- it has the capacity to be managed for improved habitat diversity and landscape value.

Recommendations for management include:

- maintaining seasonal variations in water levels;
- avoiding disturbance to the lake bed which might promote further establishment of Typha;

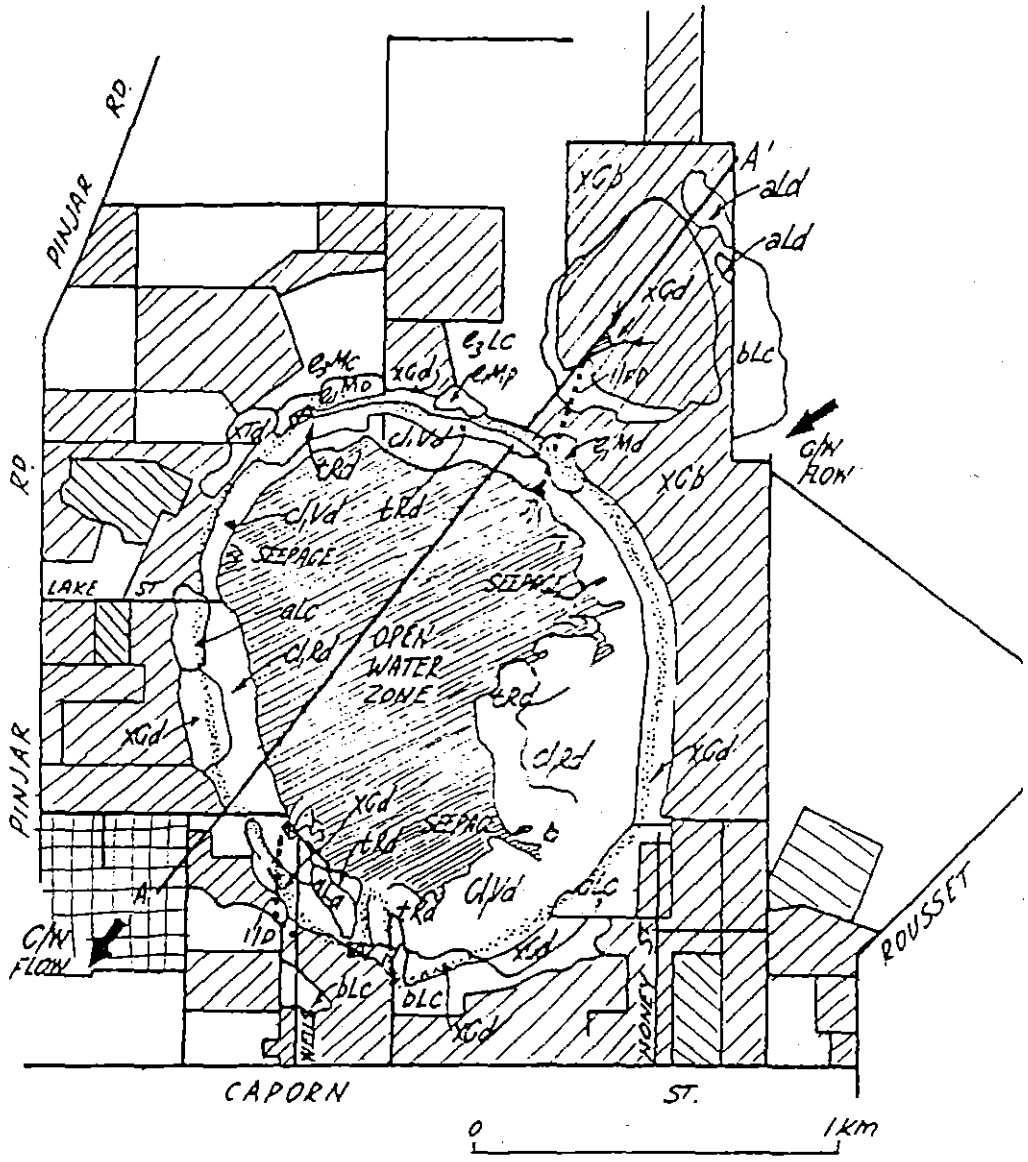

Figure 6.6 Lake Mariginiup: wetland plant communities and surrounding land use.

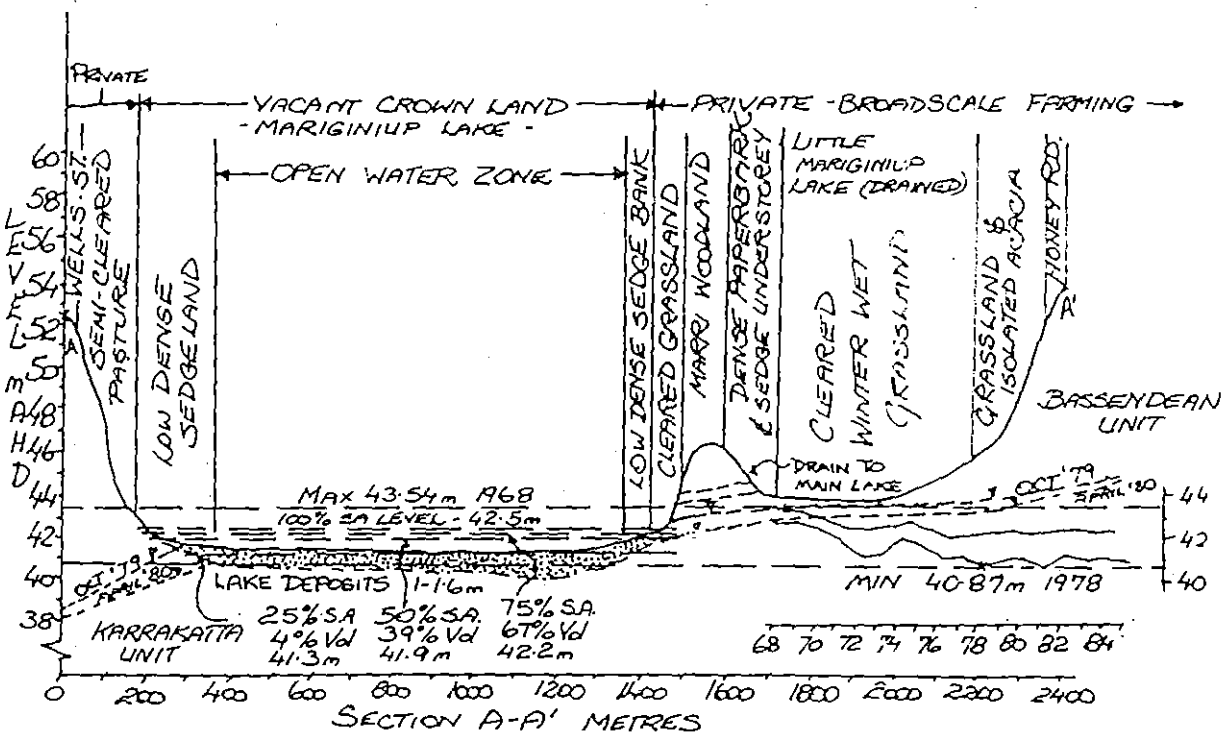

Figure 6.7 Lake Mariginiup: diagrammatic cross-section and water level record.

. maintaining some limited water in the lake throughout the year preferably to a MINIMUM of 41.2 m AHD which gives 8 ha water surface area. This may conflict with Water Authority objectives for the lake (Environmental Protection Authority, 1987). Any decision to manage water levels to sustain the lake should be supported by reservation of the lake or by enacting some regulation of activities on the lake bed.

The conservation value of the lake could be maintained and enhanced by increased management effort. This could be promoted by:

. formalising the status of the unalienated central portion of the lake by changing it from vacant Crown land to a Crown reserve for conservation of flora and fauna; and

. reaching agreements with owners of surrounding land about management - principally limiting cultivation, grazing, control of fire and weed invasions and application of plant fertiliser - in return for rate concessions or other tax concessions.

6.5.10 REFERENCES

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6.6 LAKE GNANGARA

6.6.1 GENERAL INFORMATION

LOCAL AUTHORITY: City of Wanneroo
MRS ZONE: Rural
RESERVE NUMBERS: C27279, C8399
PURPOSE: Recreation
MANAGEMENT: City of Wanneroo
SYSTEM 6 RECOMMENDATION: M8
WAC CLASSIFICATION: LE.f.l.se.o
WATER RESERVE: Wanneroo Groundwater Area
MINING: Mineral Claims for Diatomite

6.6.2 PHYSIOGRAPHY AND GEOLOGICAL SETTING

The wetland occupies a shallow circular depression in the Quaternary superficial formation, slightly east of the contact between the Bassendean and Spearwood dune systems. The lake is situated on the south-western flank of the Gnangara Mound. The lake basin has deposits of diatomite which form pavements on the northern and western sides. Seepage occurs along the north-eastern shore of the lake. On the northern end of the lake, when water levels are low, there are quaking bog areas slightly below the general level of the lake which appear to be in similar positions to those described by Simpson (1903).

6.6.3 AREAS

Area of land bounded by road reserves and boundary of State Forest:	226	ha
Areas within recreation reserves	144.6	ha
Area within water boundary defined by bathymetry map	128	ha
Rush/sedgelands within water boundary	21	ha

6.6.4 HYDROLOGY (Figure 6.9)

The hydrology of the lake has not been studied. It is no doubt similar to Jandabup but with groundwater discharge on the northern and north-western sides of the lake. The water level record shows a dramatic change since the 1960s. High water levels in the 60s probably reflect the combined effects of above-average annual rainfall and clearing of land to the east for pine plantations. Since that time the growing pine plantations plus low annual rainfall together have altered the water balance of the area so that lake levels have fallen.

Table 6.6. Lake Gnangara: water levels 1971-85 (Water Authority of WA Water Level Records).

i Maximum level: 44.62 m AHD (1965).

ii Number of years in which maximum level has fallen within the specified ranges 1985.

m AHD	1971-75	1976-84
>43.0	5	0
42.5-43.0	0	5
42.0-42.5	0	4

iii Minimum level: 41.02 m AHD (1981).

iv Number of years in which minimum level has fallen within the specified ranges.

m AHD	1972-75	1976-85
42.5-43.0	2	1
42.0-42.5	2	0
41.5-42.0	0	3
41.0-41.5	0	6

Maximum levels over the last ten years are within the same ranges as minimum levels prior to 1976.

6.6.5 WATER QUALITY

Table 6.7. Lake Gnangara: chemical analysis of spring and autumn water samples 1970-1984 (Data from Water Authority of WA).

PARAMETER	1970-75		1976-84	
	MEAN	RANGE	MEAN	RANGE
pH	7.71(n=11)	7.2-8.9	4.48(n=16)	2.9-8.0
Total Dissolved Solids mg/L				
autumn	1116(n=4)	884-1400	2931(n=7)	1017-4876
spring	564(n=6)	442-660	916(n=9)	350-1300
Total nitrogen mg/L				
autumn	5.37(n=4)	3.40-9.00	22.44(n=6)	4.15-39.4
spring	<1.66(n=5)	<0.10-3.15	8.54(n=7)	2.80-13.0
Phos as P mg/L				
autumn	0.20(n=4)	0.04-0.44	<0.14(n=7)	<0.05 -0.55
spring	<0.19(n=5)	<0.01-0.7	<0.38(n=9)	<0.05 -2.95
			omitting 1 high value 7/10/79	
			<0.06(n=8)	<0.05 -1.00

Table 6.8. Lake Gnangara: heavy metals in lake water samples 1976-84 (Data from Water Authority of WA).

HEAVY METALS 1976-84		
SUBSTANCE	RANGE OF LEVELS MEASURED mg/L	DATE OF HIGHEST VALUE
Chromium	<0.02 - 0.04	2/10/78
Zinc	<0.01 - 0.07	17/03/82
Cadmium	all values < 0.01 mg/L	
Lead	0.04 - 0.08	12/02/79
Copper	<0.01 - 0.04	17/03/82
Mercury	all values <0.0002 mg/L	

Attention is drawn to a number of points:

1. extremely low pH values have been recorded since 1976. A definitive explanation is required. It is possible that it can be a result of sulphide deposits in the lake sediments oxidising on exposure to air since the lake levels have fallen, with consequent release of sulphate. Field tests made in winter 1983 showed that the low pH values were confined to the lake and did not occur in water seeping into excavations in the bank on the north-east side (Victor Talbot, J Arnold: Department of Conservation and Environment). Occurrences of low pH conditions have been recorded in swamps elsewhere (Woodward, 1917 - Elleker, near Albany; Teakle and Southern, 1937-Herdsman Lake);

2. the pronounced increase in Total Dissolved Solids after 1975, coincident with falling water levels;

3. a marked increase in total nitrogen levels since 1975;

4. no comparable increase in phosphorus levels occurred: note that there is no agriculture upstream from Lake Gnangara, unlike other lakes in the area;

5. heavy metal levels are generally very low; and

6. very low Biological Oxygen Demand levels and very low coliform bacteria counts were recorded on occasions when low pH values were measured.

6.6.6 LAND USE

Reference has already been made to pine plantations on the eastern side of the lake. Land uses around the lake include sand mining on the south-east and south of the lake; a proposed Special Rural Zone on the western side and increasing horticultural activity to the north of the lake.

6.6.7 VEGETATION (See Figure 6.8)

There are sparse rushes on the north-west of the lake. The lake basin is surrounded by a wide sandy beach.

6.6.8 FAUNA

No systematic observations of fauna have been made. Bird numbers on the lake are usually low, probably reflecting the poor water quality. Recent personal observations of Ibis, Red-capped Plovers and Pied Stilts indicate that the lake provides feeding areas for some species.

6.6.9 MANAGEMENT ISSUES

Falling water levels and water quality problems will affect the wetland habitat. Major changes to the lake would be brought about by any mining of the lake deposits.

The Wetlands Advisory Committee (1977) produced a draft Management Plan for Lake Gnangara which contains useful material.

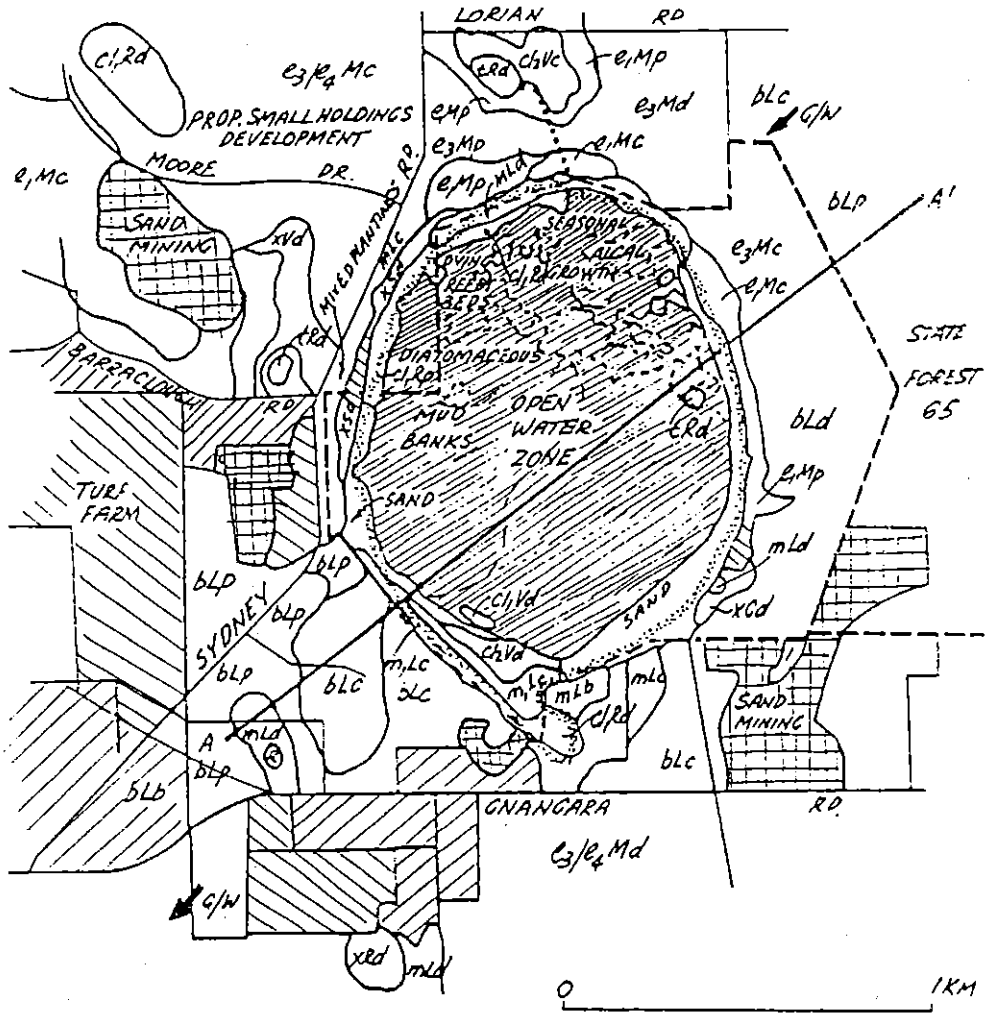

Figure 6.3 Lake Gnangara: wetland plant communities and surrounding land use.

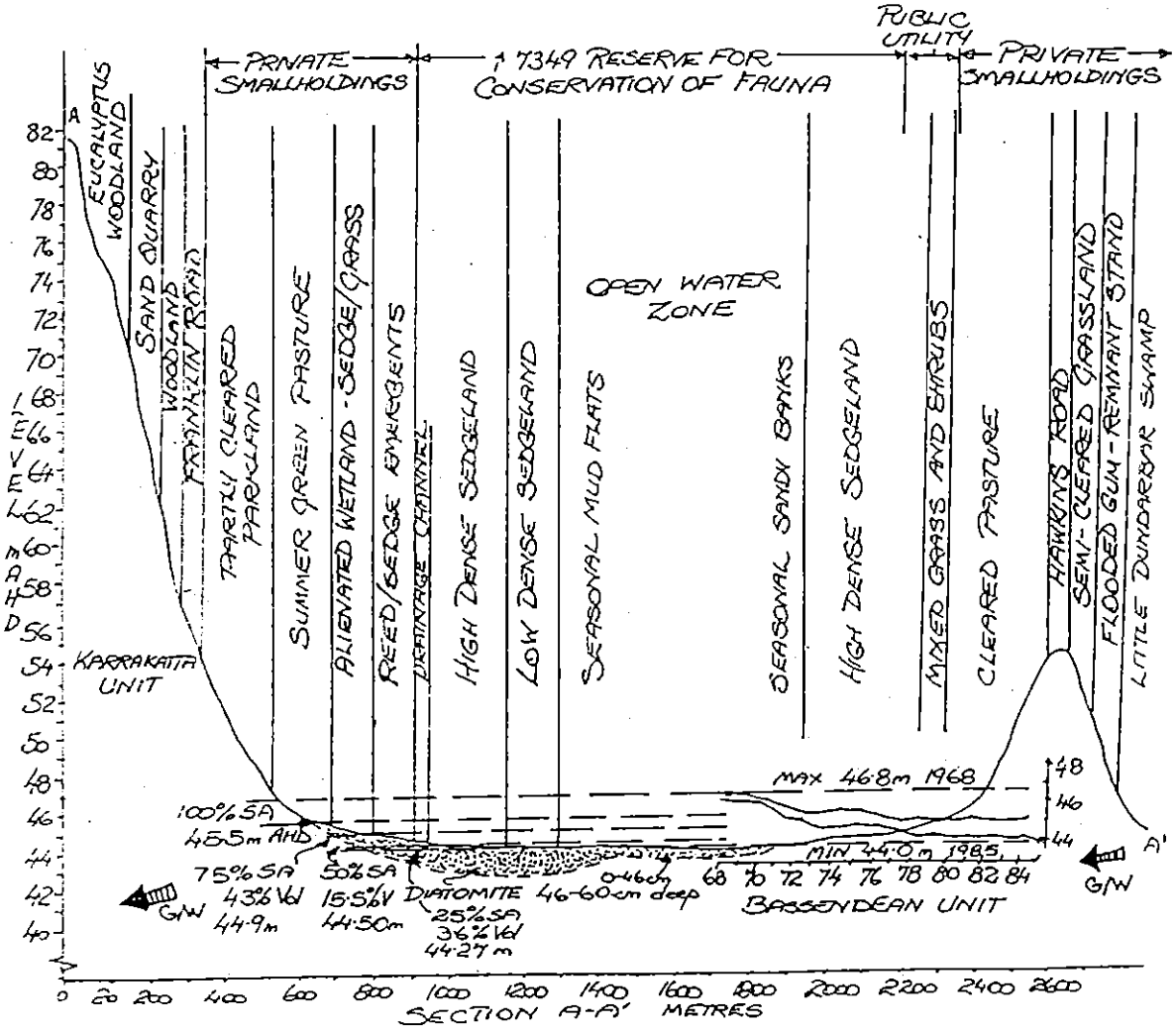

Figure 6.9 Lake Gnangara: diagrammatic cross section and water level record.

6.6.9 MANAGEMENT ISSUES (Cont'd)

Decisions on land use and mining in the area are required in the context of whether sufficient water resources are to be available to sustain the lake. Proposals to develop an active water recreation area of the lake appear to depend upon excavation of the lake deposits. Any such development should be carried out with a thorough understanding of the hydrogeology of the lake and its surroundings and with reference to the effect on the water balance of the area. Attention should be given to the demand for groundwater in the southern part of the Wanneroo Groundwater Area and in the northern part of the Mirrabooka Public Water Supply Area.

6.6.10 REFERENCES

Simpson, E S (1903), Diatomaceous earth, Wanneroo: West Australia Geology Survey Annual Report 1902, pp 79-81.

Teakle, L J H & Southern, B L, (1937), A soil survey of Herdsman Lake. Journal of the Department of Agriculture, Western Australia 14 (Dec 1937) 404-424.

Wetlands Advisory Committee Report (1977), The status of wetland reserves in System 6: Report of the Wetlands Advisory Committee to the Environmental Protection Authority. Department of Conservation and Environment.

Woodward, H P (1917), Investigation into the cause of the mineralisation of the "Seven-mile" Swamp at Grasmere, near Albany, South-west Division. Miscellaneous Report 64, Bulletin 74. West Australian Geological Survey.

6.7 LAKE BADGERUP AND LITTLE BADGERUP SWAMP

6.7.1 GENERAL INFORMATION

LOCAL AUTHORITY: City of Wanneroo
MRS ZONE: Rural
RESERVE NUMBERS: n/a privately owned
MANAGEMENT: private landowners
SYSTEM 6 RECOMMENDATION: M8 - low priority for inclusion in regional park
WAC CLASSIFICATION: LE.f.se.so (modified)
WATER RESERVE: Wanneroo Groundwater Area

6.7.2 PHYSIOGRAPHY AND GEOLOGICAL SETTING

The two wetlands lie slightly to the west of the interface of the Bassendean and Spearwood dune systems.

6.7.3 AREAS

Area of sedgeland ..... 25.8 ha
Area of open water zone ..... 2.9 ha

6.7.4 HYDROLOGY (Figure 6.11)

The water level records show that water levels have fallen since 1974 with the minimum summer level being recorded in 1981.

Table 6.9. Lake Badgerup: water levels 1973-84 (Water Authority of WA Water level records).

i Maximum level: 42.54 m AHD (1974).

ii Number of years in which maximum level has fallen within the specified ranges 1974-84.

m AHD	1973-84
>42.5	2
42.0-42.5	1
41.5-42.0	8

iii Minimum level recorded: 40.85 m AHD (1981).

iv Number of years in which minimum level has fallen within the specified ranges 1974-1985.

m AHD	1974-85
>42.0	1
41.5-42.0	1
41.0-41.5	4
<41.5	3

6.7.5 WATER QUALITY

No data available.

6.7.6 LAND USE

The area surrounding Badgerup has been used for horticulture. Land use may have been affected by the striking fall in water level that occurred during the 1970's. The wetlands are subject to consideration as a Special Rural Zone with public open space which would fulfil the System 6 recommendation. A waste disposal site is situated east of the lake.

6.7.7 VEGETATION (Figure 6.11)

Badgerup Lake was reported to have had an infestation of water hyacinth some years ago but this appears to have been eradicated. Examination of air photographs taken since 1976 shows that there has been a substantial expansion of Typha in the basins of both Lake Badgerup and Little Badgerup Swamp in recent years.

6.7.8 FAUNA

No information available.

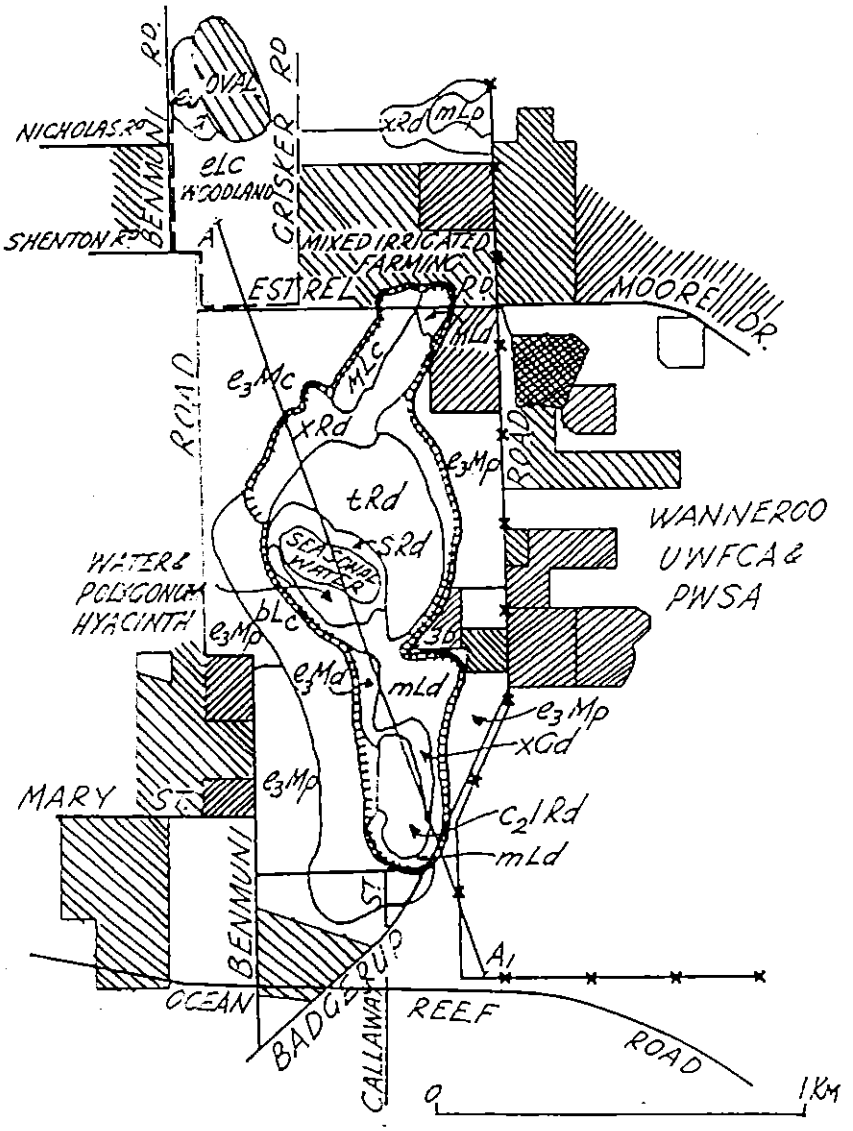

Figure 6.10 Lake Badgerup and Little Badgerup Swamp: wetland plant communities and surrounding land use.

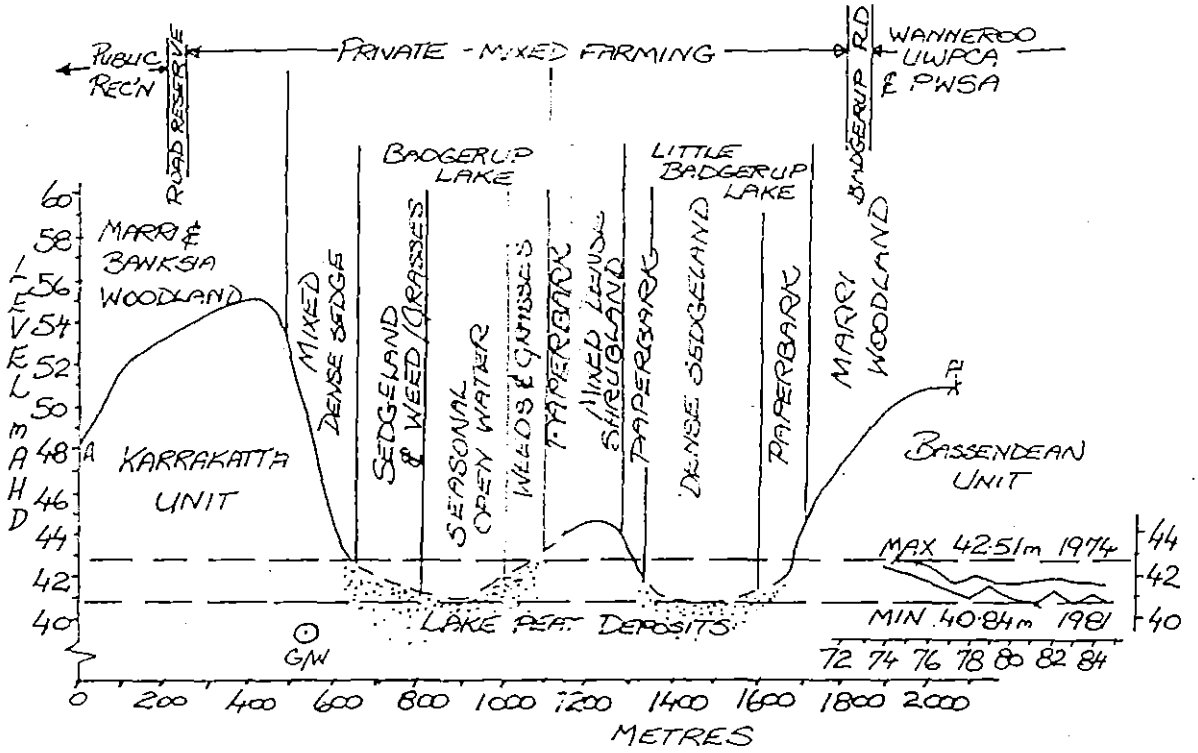

Figure 6.11 Lake Badgerup and Little Badgerup Swamp: diagrammatic cross-section and water level record.

6.7.9 MANAGEMENT ISSUES

Stresses

. Rural land uses.

. Falling water levels.

. Recreational use of the lake margins (if Special Rural Zoning approved).

Management Issues

The conservation value of Badgerup is relatively low. The System 6 Study placed it below Lake Gnangara in importance. Its value as a wetland will be determined by water levels which are affected by extraction for rural uses in the surrounding areas.

Any proposal to rehabilitate the wetland function within an area of open space should be examined in the context of water demands for the surrounding area.

6.8 LITTLE DUNDARBAR (Figures 6.12a and b, 6.13)

The water level record (Figure 6.13) for this wetland shows a sharp and continuing fall in water levels from 1976 to the present. This trend reflects the proximity of the wetland to public water supply bores and to the pine plantation. It lies within private property and has been used for vegetable growing. Figure 6.12 shows vegetation of Little Dundarbar in spring 1976 and in autumn 1985. It is included as an example of the kinds of land use changes occurring in the area. Note that the bed of the swamp has been cultivated as a market garden, and has been changed from being predominantly a sparse sedge bed in 1976. Other areas on the bed of the swamp are showing some rehabilitation from the 1976 condition. This indicates that wetland habitats have a considerable capacity to regenerate following clearing.

6.9 LITTLE MARIGINIUP

Little Mariginiup is at present a winter-wet depression in private property. It is drained towards Mariginiup Lake. The bed of the wetland is under cultivation.

6.10 SYDNEY ROAD SWAMP (Cnr Sydney Road and Gnangara Road: Western Australian Water Resources Council, 1987, uses this name for wetlands near the north end of Sydney Road.)

This area is in private property and is used for grazing - with some green pasture being sustained into the summer months. The western parts of the swamp are increasingly overgrown with Typha. A large sand mine is situated immediately to the west.

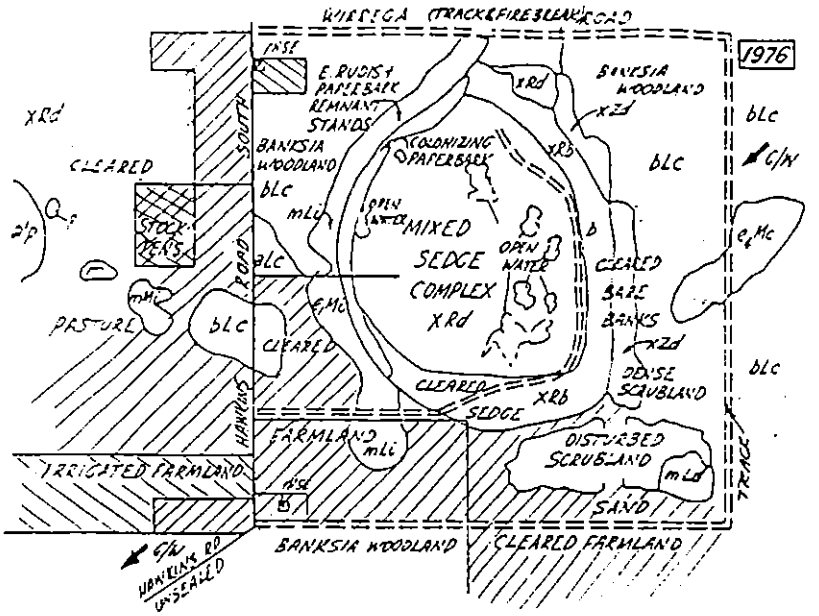

Figure 6.12 (a) Little Dundarbar Swamp: wetland plant communities and surrounding land use 1976.

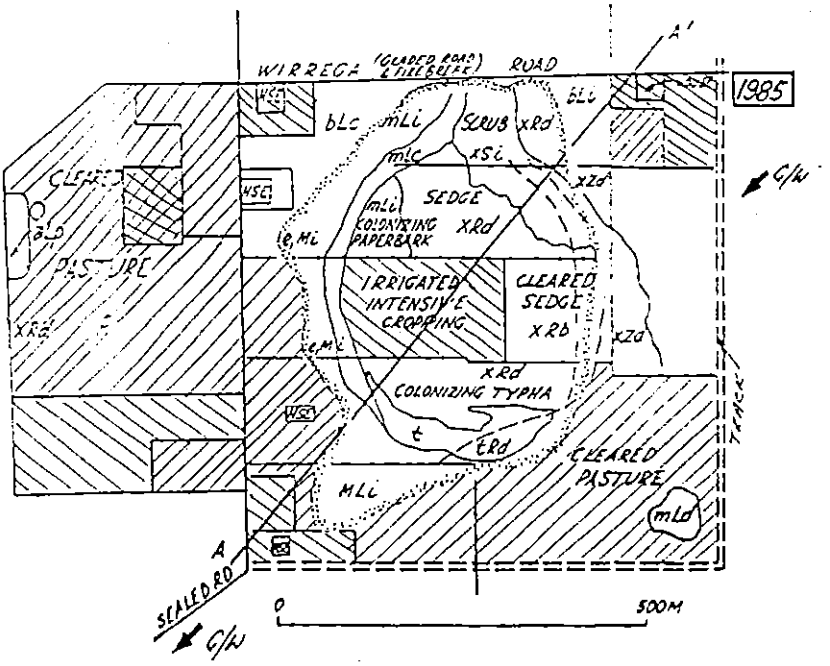

Figure 6.12 (b) Little Dundarbar Swamp: wetland plant communities and surrounding land use 1985.

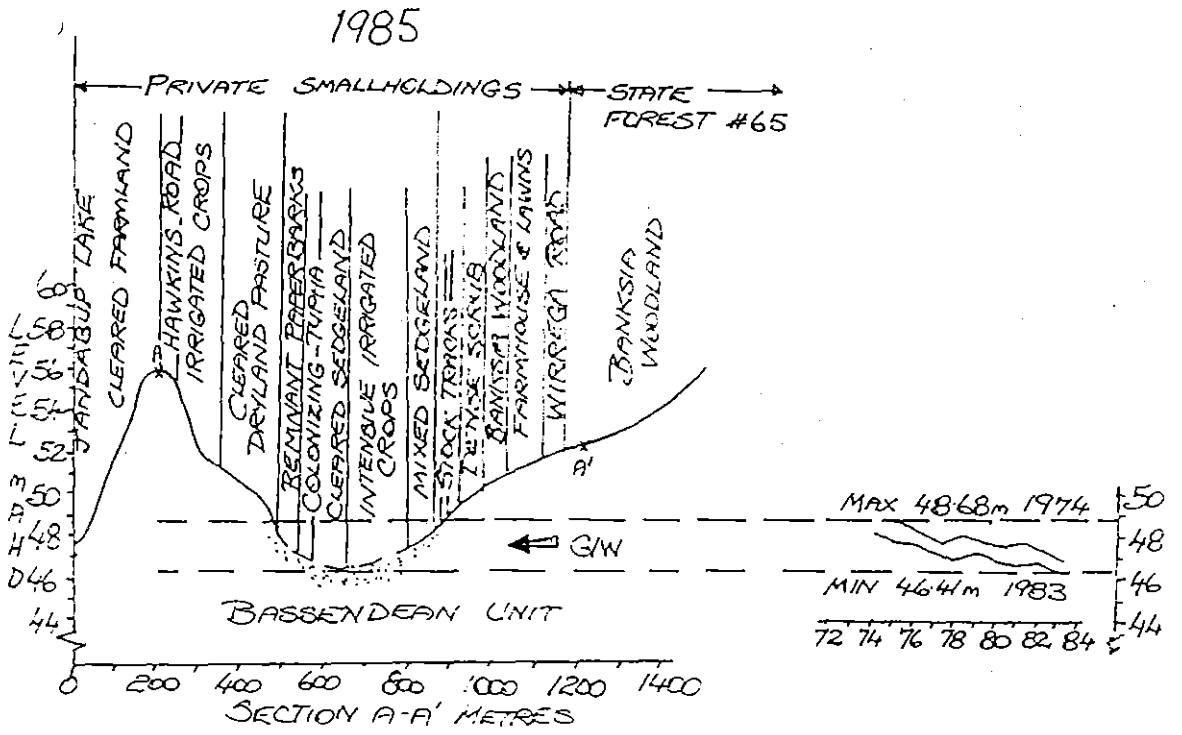

Figure 6.13 Little Dundarbar Swamp: diagrammatic cross-section (1985) and water level record.

6.11 WETLAND GROUP BETWEEN GNANGARA AND JANDABUP (Lenzo Road Swamps)

These small wetland areas are privately owned and are increasingly being brought into various kinds of cultivation. They include a number within the Lakelands Country Club (private recreation within an area on the north-west of Lake Gnangara destined to become a Special Rural Zone, subdivided for small holdings; and others existing as sedgelands or utilised for vegetable growing.

The significance of these small wetlands is:

1. they will retain some residual conservation value during seasonal inundation as feeding and breeding areas for birds;

2. with good management they have the potential to provide small landscape features;

3. plant species adapted to shallow groundwater will tend to have high rates of evapotranspiration and hence promote fluxes of water from the groundwater to the atmosphere;

4. because the water table is close to the surface, the wetlands could be used for summer grazing. The presence of organic material in the soils makes them less friable and less open to disruption under dry summer conditions; and

5. the wetlands represent 'flood plains' subject to inundation during periods of sustained high rainfall. As such there may be times when any developments located on them will be subject to flooding. This should be recognised as a normal risk of utilising the areas.

END OF SECTION