WA WETLAND MANAGEMENT CONFERENCE, WORLD WETLANDS DAY
WEDNESDAY 2 FEBRUARY 2005
COCKBURN WETLAND CENTRE, BIBRA LAKE,
WESTERN AUSTRALIA

WETLAND MANAGEMENT: WATER ISSUES

Jim Davies (Ph.D, FIEAust),
Scott Wills (B.Sc NRM (Hons))
Alex Rogers (BE (Env), MIEAust)
JDA Consultant Hydrologists, PO Box 117, Subiaco, WA 6904
Tel: (08 9388 2436) Fax: 9381 9279 Email: jimjda@iinet.net.au

ABSTRACT

The geomorphic wetland classification system widely used in WA distinguishes between basin, channel and flat land forms with various periods of water longevity. Wetlands of the Swan Coastal Plain were classified in the early 1990's based on contemporary air photos and site visits. Since the classification was published rainfall has continued to decline.

It is argued that wetland condition is related to the prevailing climate regime, particularly rainfall, which determines frequency and duration of soil moisture status and surface water inundation. The drying climate has resulted in generally declining groundwater levels affecting wetland hydro-period such that some lakes will become sumplands, some sumplands become damplands and some damplands become drylands.

The dependency of some wetlands on a perched water table, rather than the regional water table is shown to not be explicitly described using the geomorphic wetland classification system. For groundwater dependent wetlands, which are the majority of wetlands on the Swan Coastal Plain, this paper explores the wetland classification system relative to the continued drying climate of South West WA and the link between size of groundwater capture zones and typical management buffer dimensions; a link we do not consider has not been adequately dealt with in published literature. The issue of long term prediction of cycles in wetland water levels is discussed.

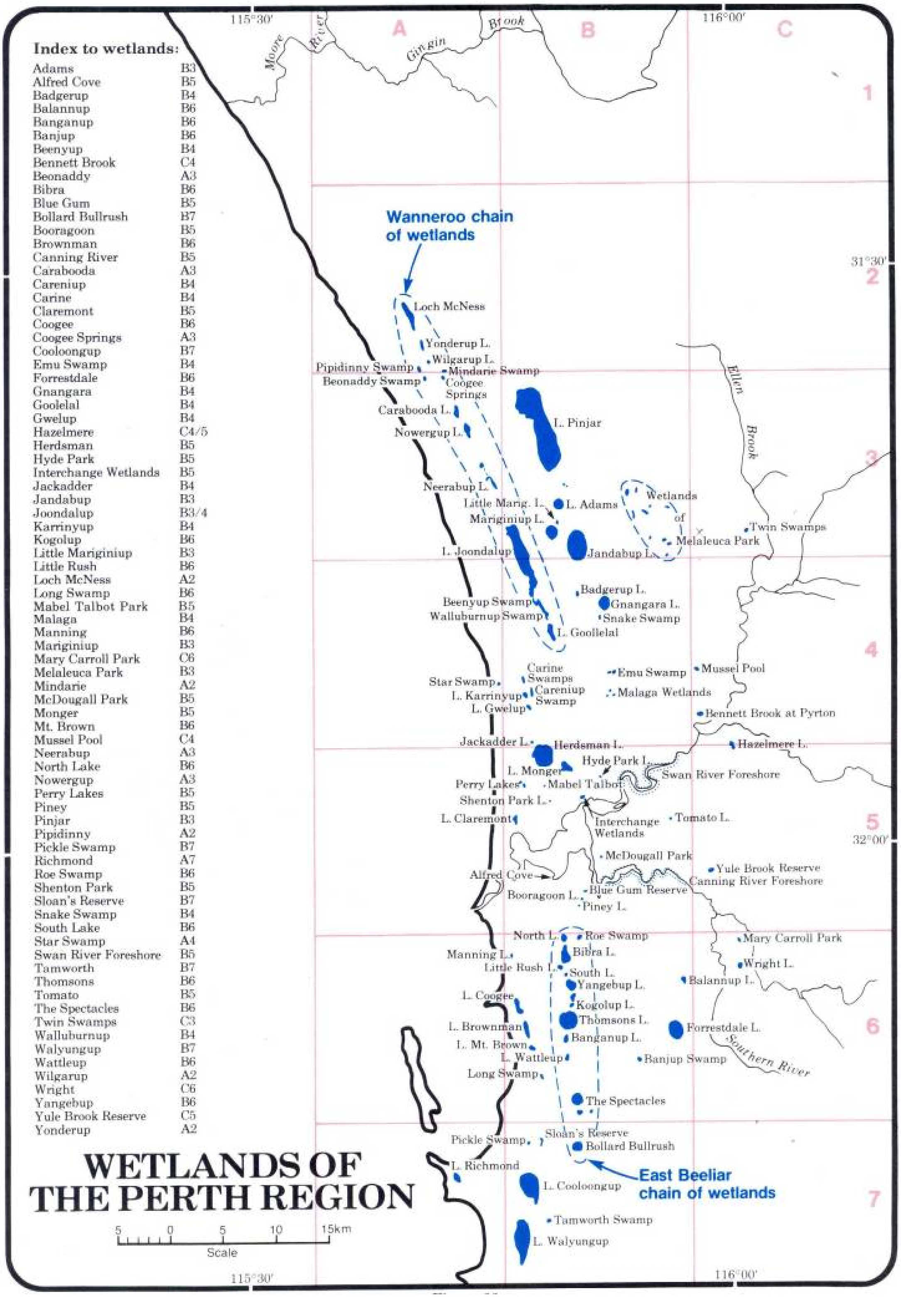
1. WETLAND DEFINITION

The wetlands in WA have been defined locally as "areas of seasonally, intermittently or permanently waterlogged soils or inundated land whether natural or otherwise, fresh or saline, eg. waterlogged soils, ponds, billabongs, lakes, swamps, tidal flats, estuaries, rivers and their tributaries", (Wetlands Advisory Committee, 1977)

2. SWAN COASTAL PLAIN – A MULTITUDE OF GROUNDWATER DEPENDENT WETLANDS

The Swan Coastal Plain extends over an area from Geraldton in the north to Dunsborough in the south with the Darling Scarp as the eastern limit. The top of the saturated groundwater zone (i.e. water table) intercepts the ground surface in many locations on the Swan Coastal Plain, forming wetlands. There are more than 9600 wetlands covering approximately 25% of the land area of the Swan Coastal Plain (Balla, 1994). Wetlands have been mapped over the extent of Wedge Island to Dunsborough. Figure 1 reproduced from WAWA (1987) shows lakes of the Swan Coastal Plain in the Perth Region. Perth is considered unique in having such an extensive variety of groundwater dependent wetlands.

Figure 1: Wetlands (lakes) of the Perth Region (WAWA, 1987)



3. WETLAND CLASSIFICATION

The geomorphic system of wetland classification as used in WA is presented in Table 1 (Semeniuk 1987, Hill et al 1996 a & b), comprising basins, channels and flat wetlands of varying water longevity.

Table 1: The geomorphic wetland classification system (Semeniuk, 1987)

Water Longevity	Landform		
	Basin	**Channel**	**Flat**
Permanent Inundation	Lake	River	-
Seasonal Inundation	Sumpland	Creek	Floodplain
Seasonal Waterlogging	Dampland	-	Paluspplain

Summary of wetland statistics between Wedge Island and Dunsborough is reproduced in Table 2 (Balla 1994).

Table 2: Summary of wetland types in the Wedge Island to Dunsborough area (Balla, 1994)

Wetland type		Area (ha)	%	No. or length (km)	%
Basins	Lake	14100	4	200	2
	Sumpland	34339	10	4879	50
	Dampland	31370	9	3924	41
	Artificial*	606	<1	689	7
Flats	Floodplain	9543	3		
	Palusplain	241595	66		
Channels	River	1074	<1	522*	
	Creek			3347*	
	Drain			1664*	
Estuary		29249	7		
Total		362253	100	9692 basins 5533* kms	

* Channel wetlands & artificial basins for the Wedge Island to Mandurah area only.

The non-genetic nature of the geomorphic wetland classification system is well described by Hill *et al* (1996a) but has probably not received sufficient attention. For example the authors clearly state that a sumpland (seasonally inundated basin) is defined regardless of the inundation mechanism – whether by direct rainfall, regional water table rise, or surface runoff. A perched water table mechanism could readily be added. Similarly the authors show that a dampland (seasonally waterlogged basin) may result from a seasonal water table rise or from development of perched conditions. Again direct rainfall and surface runoff would be equally valid causal mechanisms. The geomorphic classification system used therefore does not, by definition, throw any light on the causal mechanism for the presence of water on which the wetland ecology depends.

The wetland classification reports by Hill *et al* (1996 a & b) discuss the importance of climate on wetland development, with the notion that as the climate becomes wetter and more humid, more landforms are captured as wetlands. It is noted that;

'As the climate becomes more arid, the hydro-period of wetlands changes from generally permanent and seasonal inundation to generally intermittent inundation, with effects on soils and vegetation'

The relationship of basin wetlands (lake, sumpland, dampland) to water level fluctuation is shown in Figure 3.

Wetland classification as presented in Hill *et al* (1996a) was performed using early 1990's ortho-photos and site visits and it is reasonable to assume that classification was relevant to the climate and rainfall at that time. Figure 2 shows Perth annual rainfall since 1880, indicating continued drier years since approximately 1975 which have a direct or lagged effect on groundwater levels on which wetlands depend. In the context of these drier years, we consider that a permanently inundated basin wetland (lake) as classified in the early 1990's may now only be seasonally inundated (sumpland) as illustrated in Figure 4.

Figure 2: Perth annual rainfall

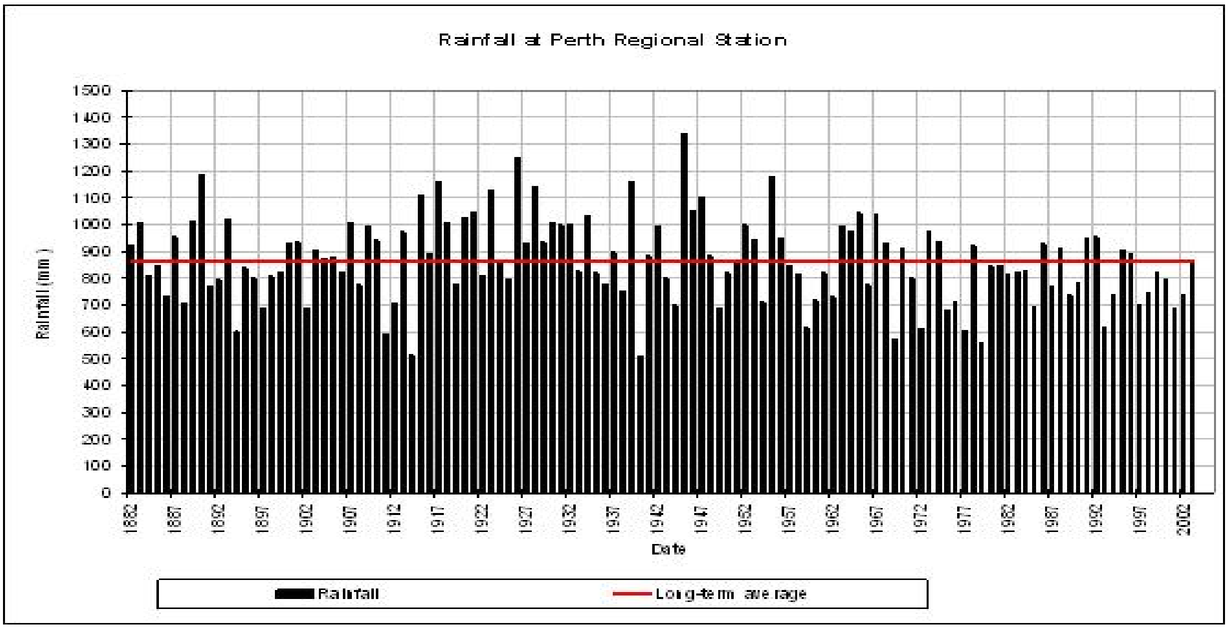


Figure 3: Basin wetlands relationship to water level fluctuation

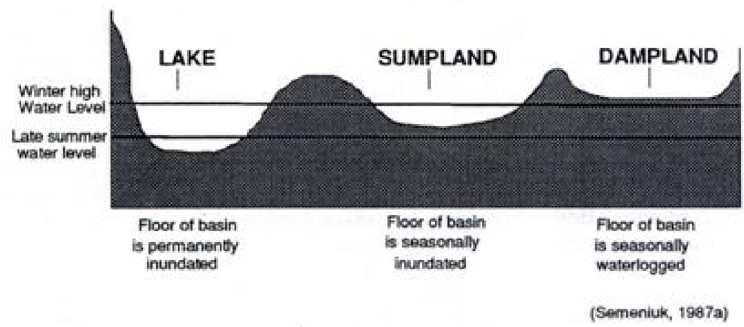


Figure 4: Effect of changing climate on wetland classification

- Drylands become damplands, creeks or palusplains
- Damplands become sumplands
- Sumplands become lakes
- Palusplains become flood plains
- Creeks become rivers

WETTER

↑

Climate change direction

↓

DRIER*

- Lakes become sumplands
- Sumplands become damplands
- Rivers become creeks
- Damplands, creeks and palusplains become drylands
- Flood plains become palusplains

* This is the case in SW of WA since wetland classifications performed in early 1990's

Hill et al (1996a) considered the difficulty of defining average variability, or year to year variability, as opposed to extremes of wet or dry year periods. Figure 5 shows for example that in an extreme dry year a lake may "dry out" (i.e. become a sumpland), and that a sumpland may only have waterlogged soil (i.e. become a dampland). However Figure 5 implies that in an extreme dry year a dampland will still be a dampland, rather than a dryland which would have been more consistent.

4. IMPLICATIONS FOR WETLAND MAPPING

Hill et al (1996a) state "*this mapping provides the most accurate and comprehensive presentation of wetland boundaries for town planning, environmental protection policy development and on-the-ground management. It has significant economic value as 'constraint mapping' for development as it provides a preliminary guide to identifying areas that are seasonally wet due to perched water tables or near-to-surface groundwater levels – between near to and to surface. The importance of this will become more obvious where there is a return to the wetter conditions experienced in Perth for most of the past century*".

Two particular points are of interest here:

- The authors do not explain why the area of wetlands was not extrapolated to estimate likely areas during those wetter previous conditions, see Figure 2.

- The implied optimism that there will be a return to wetter conditions, would probably now be tempered with the view that this is unlikely, at least in the short term.

Figure 5: Non-tidal hydro-period categories (Hill *et al.*, 1996)

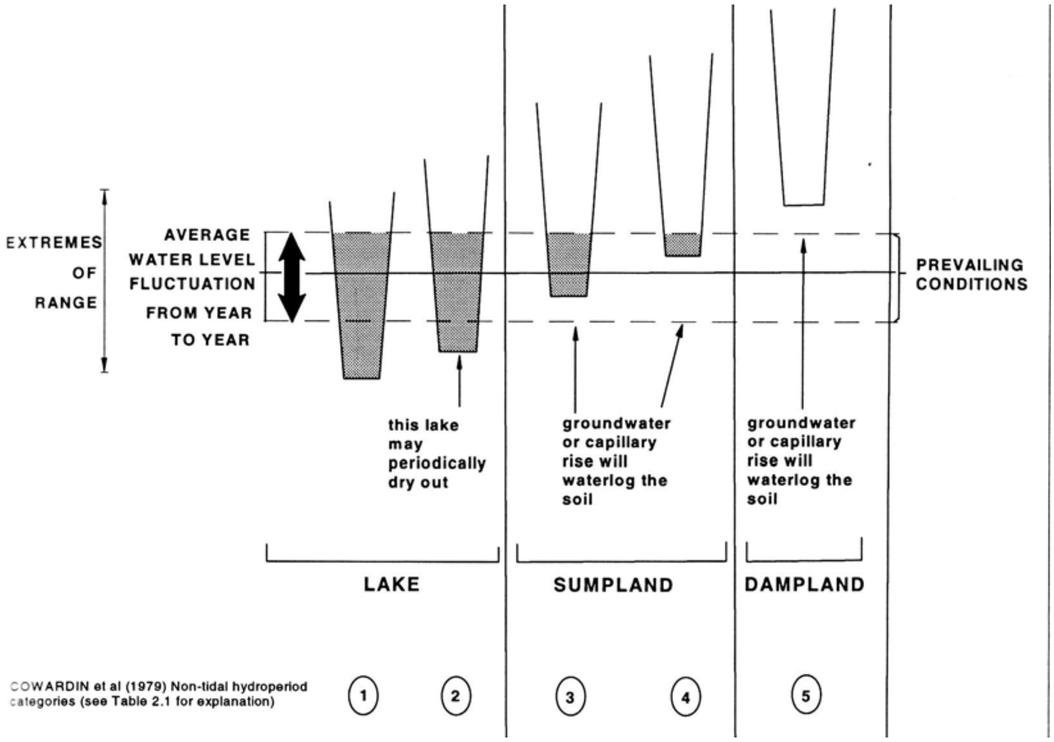
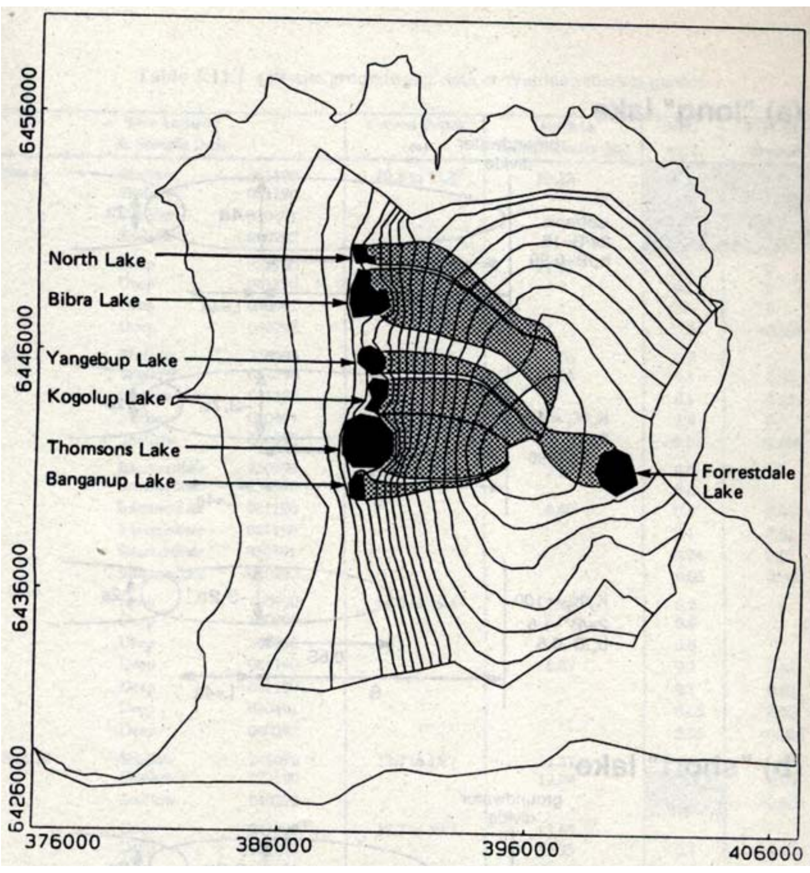


Figure 6: Predicted capture zones for seven lakes on the Jandakot Mound, without taking into account the depth of capture zones



It is open to take the view that the areas mapped as wetlands would be somewhat larger if mapped during a wetter period, and somewhat smaller if mapped during the current extended drier period, rather than using 1991 information.

It may be necessary for wetland managers utilizing existing wetland classification mapping to adequately consider the mechanism for the presence of water in the wetland and interpret the impacts of the drier climate currently being experienced by South West WA on the area and classification of the wetland.

5. WETLAND WATER DEPENDENCY: SURFACE WATER & GROUNDWATER CAPTURE ZONES

Wetland ecology depends on water availability usually described by the frequency and duration of inundation (hydro period) or waterlogging. The source of water on which individual wetlands depend is not described by the geomorphic classification system (see discussion above). Townley et al (1993) describe the interaction between lakes, wetlands and unconfined aquifers in general terms and show groundwater capture zones for seven lakes on the Jandakot Mound (Figure 6).

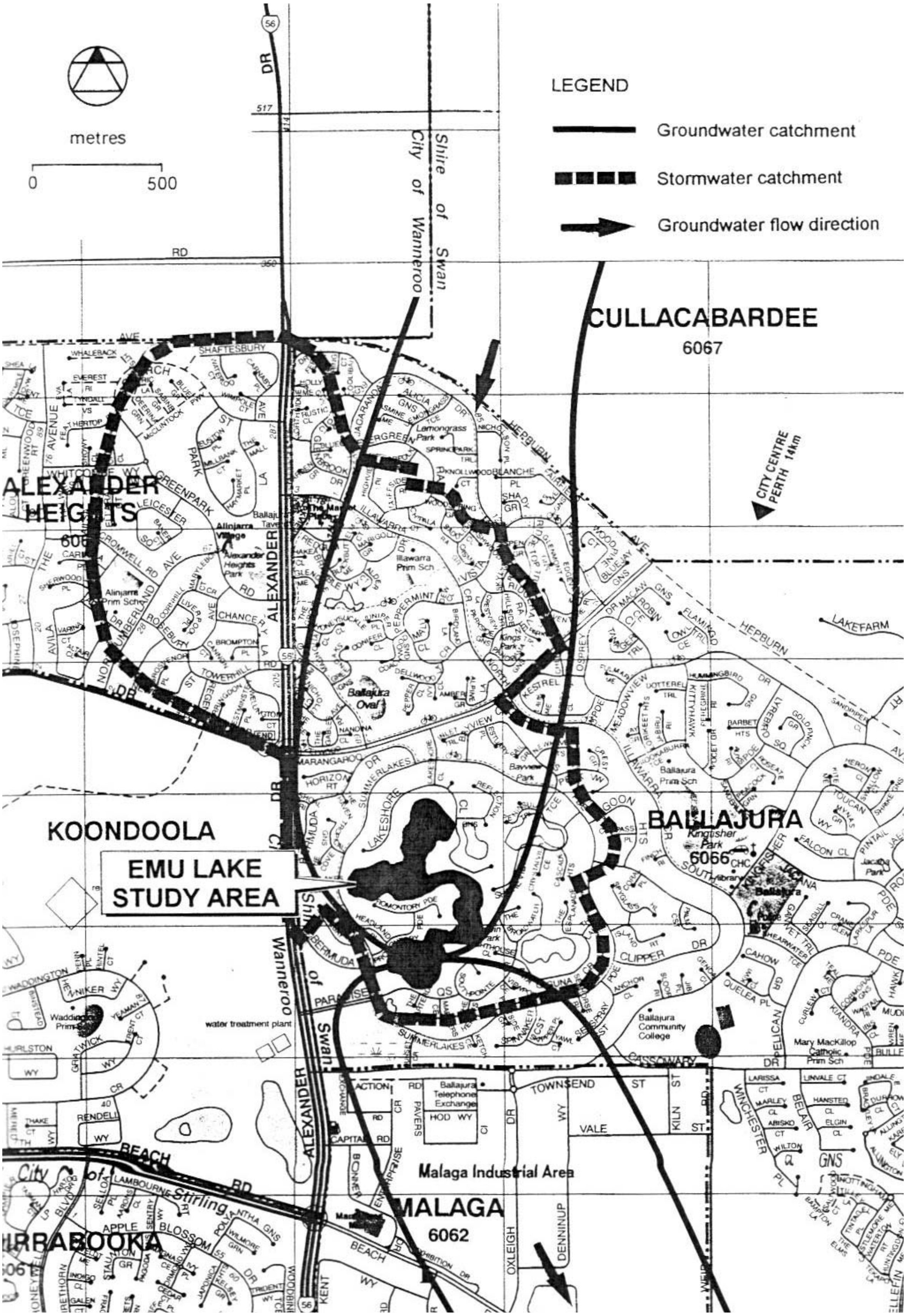
'*The groundwater capture zone of the lake defines the shape of a region at the ….. surface within which any recharge will ultimately pass through the lake. The capture zone defines the largest "buffer zone" required to be protected, to protect the quality of the surface water body.*'

The majority of lakes on the Swan Coastal Plain act as flow-through lakes which capture groundwater on the upgradient side and discharge lake water on their downgradient side.

The concept of groundwater capture zones was not addressed by the subsequently published volumes of the wetlands of the Swan Coastal Plain, but rather the emphasis for lake management focused on a perimeter buffer zone of constant width. Perhaps because the notion of a groundwater capture zone is difficult to visualize being subterranean, little emphasis has been given to the management of land use within the capture zone of lakes. The Jandakot Mound lakes capture zones were refined by groundwater modelling and incorporated in a schedule to an EPA Draft Guidance Statement on Environmental Management Areas (EPA 1998). For other parts of the Coastal Plain, similar mapping has not been performed so that wetland management focuses on the perimeter buffer zone rather than the upgradient groundwater catchment. This appears to be an anomaly in the approach to wetland management which requires resolution.

An example at the local scale, Figure 7 shows a comparison between a surface water capture zone and an estimated groundwater capture zone for Emu Lake in the City of Swan. The surface water catchment is readily defined by surface topography and surrounds the lake on all sides, whereas the groundwater capture zone is aligned upgradient towards the apex of the Gnangara Mound. Downgradient of the lake is the groundwater release zone into which the lake water discharges.

Figure 7: EMU Lake Catchment Boundaries (Alan Tingay & Associates, 1998)



6. CYCLES IN RAINFALL & WETLAND WATER LEVELS

Attempts have been made by some authors to relate rainfall and wetland water levels to deterministic and repeatable cycles. When faced with a long chronological series of data the natural reaction of a researcher is to try to smooth it to reduce the ‘noise’ and accentuate the longer period ‘real’ trends or oscillations; the simplest and usual method of doing this is to take 5 or 10 years running means (unweighted) although other lengths are used when considered appropriate. Unfortunately this automatically inserts into the data a spurious periodicity of between two and three times the period over which the running means have been taken. Reynolds (1978).

For example a 10 year moving average introduces spurious cycles of between 20 and 30 years. Some authors have attempted to relate the apparent cycles to lunar and solar cycles and hence claim causal mechanism. Our view is that the astronomical cycles do not influence the rainfall or groundwater levels in the SW of Western Australia and urge caution on the part of those wishing to predict future patterns of rainfall or wetland water levels based on such moving average plots.

7. CONCLUSIONS

- Wetland classification may need to be considered as dynamic, interpreted taking into consideration climate variation.

- Many wetlands depend on regional groundwater but the geomorphic wetland classification system used in WA is non genetic and does not describe the genesis of water on which wetland ecology depends, be it rainfall, surface water, regional groundwater or perched water.

- For wetlands dependent on regional groundwater, the groundwater capture zone should be considered the largest “buffer zone” required to be protected, to protect the quality of the wetland itself.

- Spurious cycles are introduced into moving average datasets and these should not be related to known astronomical cycles to predict future rainfall or wetland water levels.

8. REFERENCES

Alan Tingay & Associates (1998) *Environmental Management Plan Emu Lake, Ballajura* Report to the Shire of Swan September 1998. Report No. 98/10.

Balla S A (1994) *Wetlands - Their nature and management.* Volume 1 Wetlands of the Swan Coastal Plain. WRC.

Environmental Protection Authority (1998) *Groundwater Environmental Management Areas.* Guidance for the Assessment of Environmental Factors (in accordance with the Environmental Protection Act 1986) No 48. Draft.

Hill A L, Semeniuk C A, Semeniuk V, Del Marco A (1996a) *Wetland Mapping Classification and Evaluation, Main Report:* Volume 2a Wetlands of the Swan Coastal Plain.WRC.

Hill A L, Semeniuk C A, Semeniuk V, Del Marco A (1996b) *Wetland Mapping Classification and Evaluation. Wetland Atlas.* Volume 2b Wetlands of the Swan Coastal Plain. WRC.

Reynolds G (1978) *Two Statistical Heresies,* Weather Journal, 33, pages 74-76.

Semeniuk C A (1987) *Wetlands of the Darling System – A Geomorphic Approach to Habitat Classification:* Journal of the Royal Society of WA 69: 95-112.

Townley L, Turner J, Barr A, Trefry M, Wright K, Gailitis V, Harris C, Johnston C (1993) – *Interaction between lakes, wetlands and unconfined aquifers.* Volume 3 Wetlands of the Swan Coastal Plain. WRC.

Water Authority of Western Australia (1987) *Perth Urban Water Balance Study*

Wetlands Advisory Committee (1977) *The Status of Reserves in System 6:* A report of the Wetlands Advisory Committee to the EPA, Perth, W.A.