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Natural Resource Zones of the South West Land Division, Western Australia

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Natural Resource Zones of the South West Land Division Western Australia

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The Natural Resource Zones of the South West Land Division provides a new way of grouping areas which have similar natural characteristics. It provides a logical alternative to Shire boundaries for the presentation of natural resource information in the South West Land Division. It will be used in the development of strategies for the protection and management of natural resources in the South West Land Division of Western Australia. The principles of this system may be extended to cover the whole state.

The system was developed initially to assist in the protection and management of native vegetation identified as an issue in the Report of the Remnant Vegetation Steering Committee (1991). However, it was realised that the concept of identifying ecological regions or zones could be used to investigate and assess other natural resources. It was therefore felt appropriate to broaden the scope of the system by coining the term Natural Resource Zones.

Development of this zoning system for the South West Land Division involved overlaying maps of the natural regions (Beard and Sprenger 1984), the drainage basins, and isohyets to produce 84 zones identifying areas with a unique combination of biological, physical characteristics. The zones may be imposed on any geographic information system database. The information from a number of zones may be grouped if they make up a natural region, for example an entire river catchment such as the Blackwood River. This information may then be used to guide planning for the protection and management of the natural resources in the South West Land Division of Western Australia.

The benefits of the Natural Resource Zones for investigating the issues, problems and management of a natural resource are that:-

resource information may be reported and analysed at two scales as follows:-

i) an evaluation of the natural resources issues on a localised scale can be undertaken within each zone; and

ii) by combining the information for each zone within broader natural regions, river catchments or rainfall zones, it will be possible to consider the same issues in broader ecological context.

1. Introduction

The Natural Resource Zones of the South West Land Division (Figure 1) provides a new way of grouping areas which have similar natural characteristics. Land information is often presented disaggregated into Shires. However, these have artificial boundaries which can aggregate very different kinds of land. Natural Resource Zones provides alternative boundaries in which the zones have similar characteristics. These zones will be used in the development of strategies for the protection and management of natural resources in the South West Land Division of Western Australia. It provides a framework in which natural resource data may be reported and analysed on an ecologically meaningful basis. The principles of this system may be extended to cover the whole state.

This system was developed to assist in the protection and management of native vegetation. Therefore in this report native vegetation, a natural resource, has been used as a worked example to demonstrate the the principles and the applicability of the system. However, the Natural Resource Zones may be used with any other natural resource database in a similar manner.

The relative merits and disadvantages of the Natural Resource Zones are discussed and its potential value to Government and community groups throughout the South West Land Division of Western Australia are highlighted.

2. Development of the natural resource zones

The stimulus to prepare the Natural Resource Zones system came from the wide acknowledgement that parts of the agricultural areas of the South West Land Division have been over cleared from an environmental viewpoint. It was recognised that a regional or zoning system was needed within which sound decisions could be made on the future planning and management of native vegetation.

The Remnant Vegetation Steering Committee draft report (1991) reviewed the issues related to remnant native vegetation on a State-wide basis and provided 42 recommendations on policy direction for the future use and management of land occupied by remnant native vegetation.

Recommendation 21, Section 6, Consideration in Planning Protection in this report states :-

> "Regional Differences
>
> A State-wide zoning of remnant vegetation should be established that includes priorities for its protection and guidelines for its management in each zone.
>
> Responsible agencies: Environmental Protection Authority (EPA), Department of Conservation and Land Management (CALM), WA Department of Agriculture (WADA)".

In response, to this recommendation, in early 1992, the EPA began consulting other agencies, including the two nominated above, which are responsible for the management and protection of native vegetation in Western Australia. As part of this process, the EPA convened a meeting of Government agencies in January 1992 to discuss the need and options for the development of a regional zoning system for the State.

It was decided first to develop a system for the South West Land Division because it is in this region that native vegetation has reached low levels.

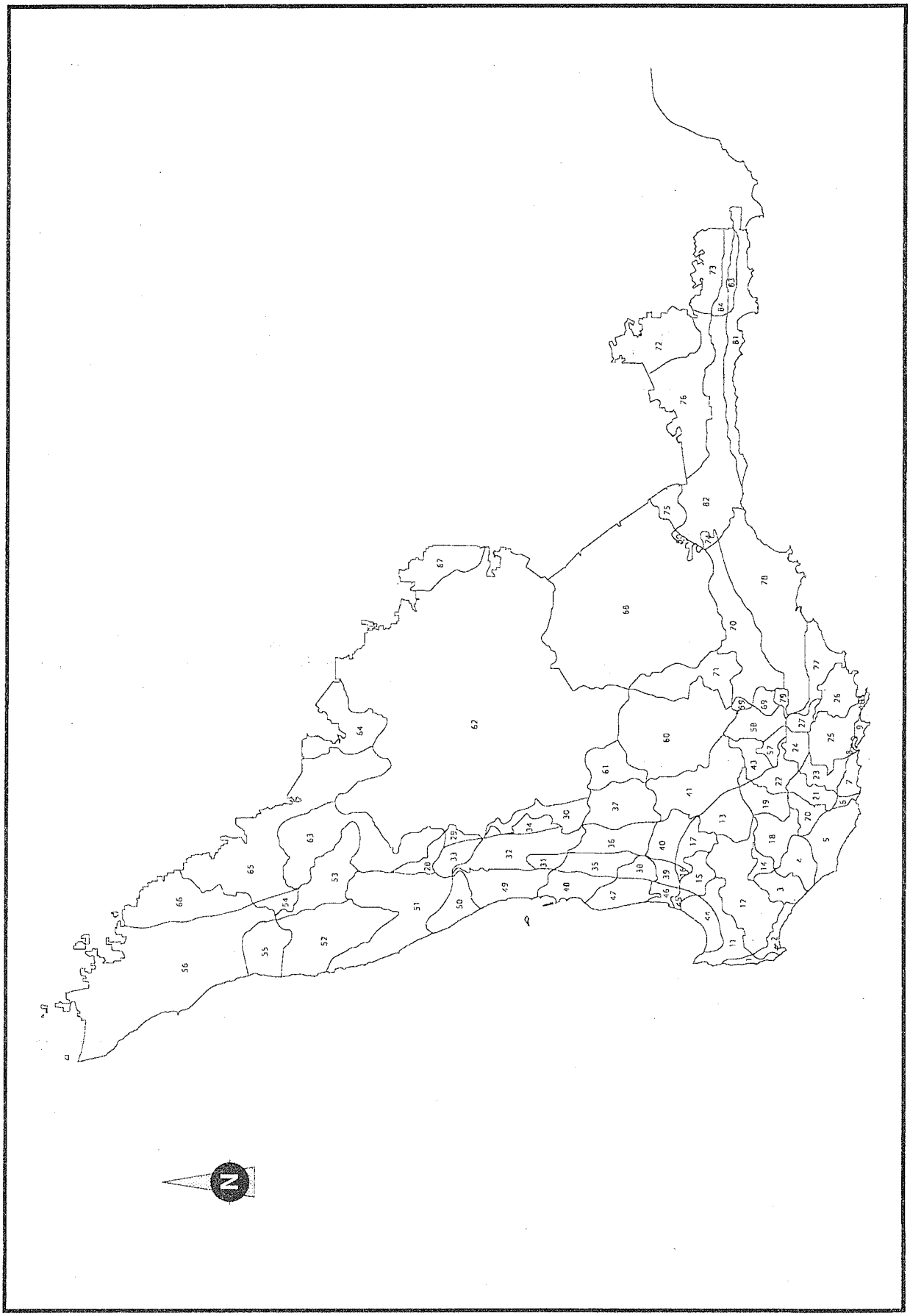

Figure 1. Natural Resource Zones of the South West Land Division

This system would be more useful if it could be used not only for the management and protection of native vegetation but also other natural resources within its ecological regions. It will facilitate a nature conservation assessment of areas subject to landuse change proposals. It is vital that natural resource issues such as native vegetation are assessed within the context of their ecological area of influence and that landuse changes which have cumulative effects are not assesses in isolation from one another.

Although initially it was hoped to incorporate shire boundaries into the biophysical boundaries this did not prove to be achievable. It was decided to develop a zoning system based on phytogeography (Beard's natural regions), drainage divisions and river basins, and rainfall criteria. The features of these three criteria and justification for their selection follow.

2.1 Natural regions (Figure 2)

Beard and Sprenger (1984) has described and mapped the natural regions for the whole of Western Australia (Appendix 1). They mapped the South West Land Division into nine natural regions from the South-West Botanical Province and the South-Western Interzone which are shown in Figure 2. Each region represents groups of vegetation associations which occur in areas with similar physiographic, geological and soil characteristics. These form the first component of the Natural Resource Zones for the South West Land Division of Western Australia.

Justification

Beard's natural regions were chosen for inclusion in the Natural Resource Zones because:

- of the primary significance of native vegetation , physiographic, geological and soil characteristics;
- descriptions of vegetation associations (Beard, 1974-81) and, (Beard and Webb, 1974), provide the best available information on vegetation for the entire State; and
- the natural regions are readily recognised and used by botanists and the scientific community of Western Australia.

Data Base

- The natural regions were digitised from the 1:2 500 000 map (Beard, 1980) by the Environmental Resource Information Network (ERIN). ERIN is a Federally funded project established to draw together, upgrade and supplement information on the distribution of endangered species, vegetation types and heritage sites.

2.2 Drainage divisions and river basins (Figure 3)

Drainage divisions and river basins for the State (Public Works Department (1984)) (Appendix 2) were used as the second component of the zoning system . All 19 river basins of the South West Drainage Division, the Salt Lake Basin of the Western Plateau Drainage Division and the Greenough Basin for the Indian Ocean Drainage Division were used for the Natural Resource Zones for the South West Land Division of Western Australia (Figure 3).

Justification

Drainage divisions and river basins were chosen for inclusion in the Natural Resource Zones because:

- of the relationship between native vegetation and hydrology (and thus a number of land conservation problems);

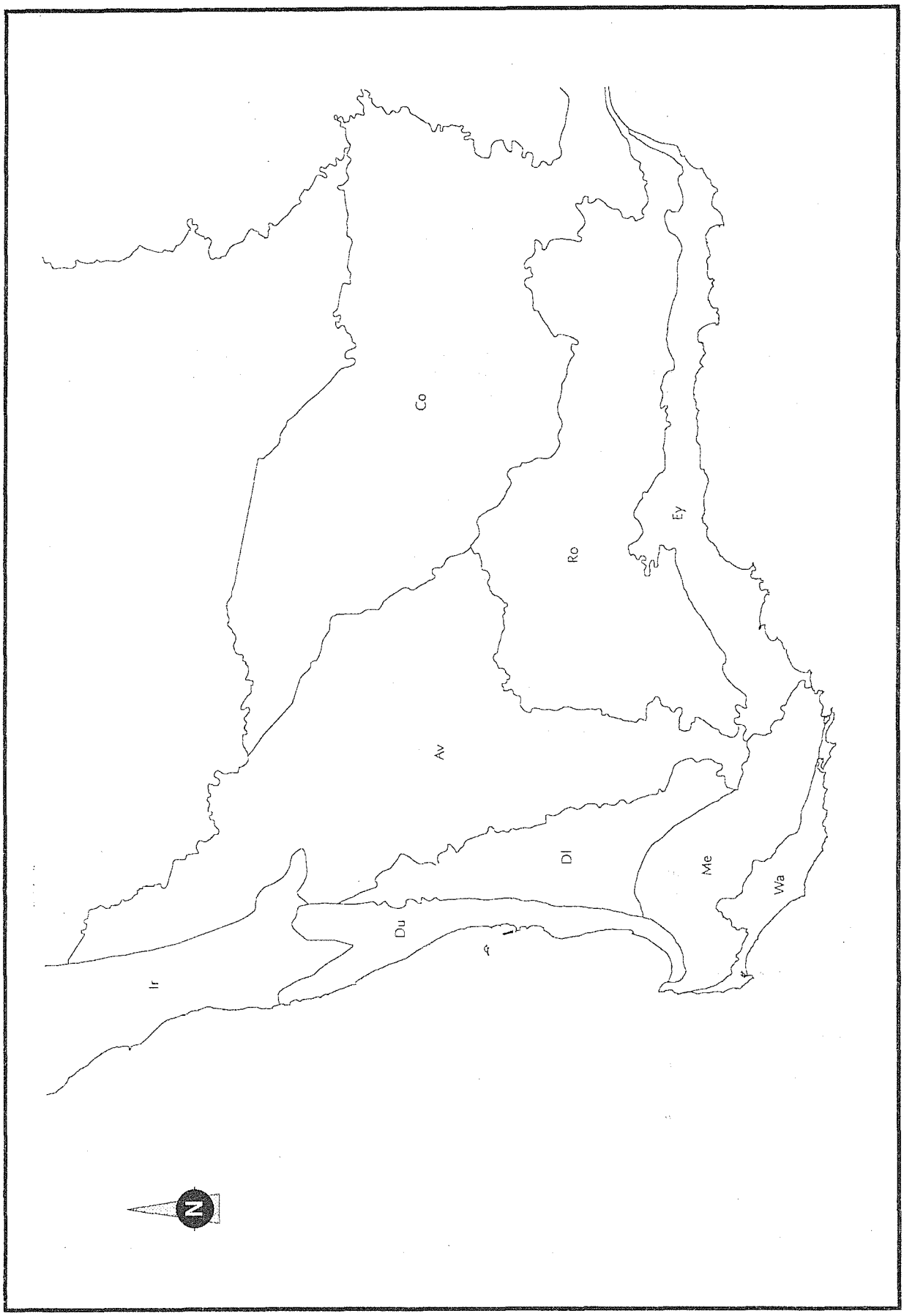

Figure 2. Beard's natural regions

Figure 3. Drainage divisions and river catchments

- drainage divisions (catchments) are a pivotal component of the voluntary approach to landcare practices and the adoption of the catchment approach may foster the nature conservation ethic together with a land conservation ethic among land managers
- the drainage divisions and river basins have been adopted by the Australian Water Resources Council.

Data Base

- The portion of the digital map which covers the South West Land Division of Western Australia was captured from 1:1 000 000 State maps.(Public Works Department, 1984).

2.3 Isohyets (Figure 4)

Isohyets form the third component of the Natural Resource Zones.

Justification

Isohyets were chosen for inclusion in the Natural Resource Zones because:

- of the principle that rainfall guides land use;
- isohyets provide a means of breaking large catchments into smaller units that relate to land use; and,
- rainfall forms an important component of guidelines for assessing applications to clear land by Government departments (eg. the WA Department of Agriculture and the Water Authority of Western Australia).

The 500mm, 700mm and 1100mm isohyets (Figure 4) have been used in developing the boundaries of the Natural Resource Zones because they relate to vegetation retention guidelines developed by the WA Department of Agriculture (WADA) which apply throughout the South West Land Division. The levels of vegetation recommended for retention in areas between these isohyets represent the minimum levels of native vegetation that should be retained within a sub-catchment for the control of soil salinisation.

Data Base

- The 1:1 000 000 isohyet map (Canterford, 1987) was digitised by the WADA.

2.4 Boundary adjustment

The digital data sets were assembled in the Intergraph Microstation Geographic Information System Environment at the WADA, to produce one project with all the boundaries present, which generated in excess of 130 composite zones. Many of these were very small and did not represent features significantly different from those in one or more of the adjacent zones and it was considered that they were unlikely to provide individually meaningful areas.

Consequently, several of these were removed by merging the isohyet boundaries with those which are more permanent features of the landscape (eg.drainage basins). The natural region and river basin boundaries were only subject to reshaping where differences in vegetation associations and drainage characteristics between zone boundaries were very small. In a few cases adjustments were made to Beard's natural region boundaries where they coincided with the agricultural boundary.

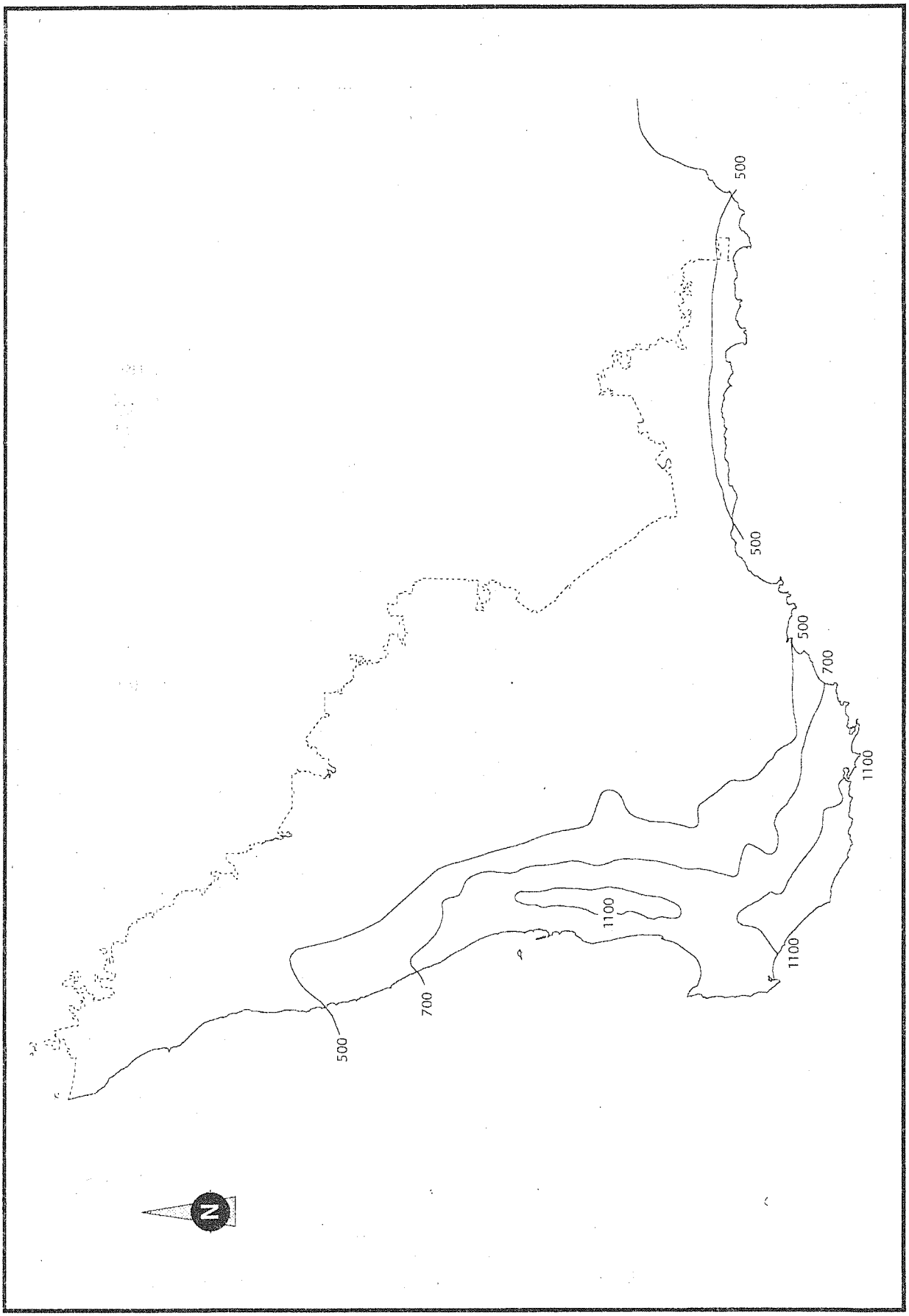

Figure 4. Isohyets and the South West Land Division boundary

Merging boundaries reduced the number of zones to 84 (Figure 1), each of which is considered to represent a unique set of biological, physical characteristics . Each zone is identified by a number and a code consisting of six characters, these are listed in Table 1. The first two characters identify the natural region (Table 2) within which the unit is located. The second two characters identify the drainage division or river basin (Table 3), and the third identifies the rainfall zone (Table 4). Figure 5 shows an example, the Natural Resource Zone with the code 'AvBlR4' is made up of part of the Avon Botanical District (Av) part of the Blackwood River Basin (Bl) and part of the <500mm Rainfall Zone (R4). Zones with identical code are distinguished by the use of a roman numeral in brackets at the end of the code.

Table 1. Natural Resource Zones numbers and codes

No Code	No Code	No Code	No Code	No Code
1 WaBuR2	18 MeWrR2	35 DlMrR1	52 IrMoR3	69 RoFrR4
2 Wa BlR2	19 MeWrR3	36 DlMrR2	53 IrMoR4	70 RoAlR4
3 WaDoR1	20 MeShR2	37 DlMrR3	54 IrYaR4	71 RoBlR4
4 WaWrR1	21 MeFrR2	38 DlHaR1	55 IrGrR3	72 RoSlR4(i)
5 WaShR1	22 MeFrR3	39 DlCoR1	56 IrGrR4	73 RoSlR4(ii)
6 WaFrR1	23 MeKnR2	40 DlCoR2	57 AvFrR3	74 RoEsR4(i)
7 WaKnR1	24 MeKnR3	41 DlBlR3	58 AvFrR4	75 RoEsR4(ii)
8 WaDnR1(i)	25 MeDnR2	42 DlWrR3	59 AvAlR4	76 RoEsR4(iii)
9 WaDnR1(ii)	26 MeAlR2	43 DlFrR3	60 AvBlR4	77 EyAlR3
10 WaAlR1	27 MeAlR3	44 DuBuR2	61 AvMrR4	78 EyAlR4
11 MeBuR2	28 DlMoR3	45 DuPeR2	62 AvAvR4	79 EyFrR4
12 MeBlR2	29 DlAvR3(i)	46 DuCoR2	63 AvMoR4	80 EyAvR4
13 MeBlR3	30 DlAvR3(ii)	47 DuHaR2	64 AvNiR4	81 EyEsR3
14 MeDoR2	31 DlSwR1	48 DuMrR2	65 AvYaR4	82 EyEsR4
15 MePeR2	32 DlSwR2	49 DuSwR2	66 AvGrR4	83 EySlR3
16 MeCoR1	33 DlSwR3(i)	50 DuMoR2	67 CoAvR4	84 EySlR4
17 MeCoR2	34 DlSwR3(ii)	51 DuMoR3	68 RoAvR4	

Table 2. Beard's natural regions

Code	Phytogeographic districts	Natural region
	Darling Botanical District	South-West Forest
Du	Drummond Subdistrict	Swan Coast Plain
Dl	Dale Subdistrict	Northern Jarrah Forest
Me	Menzies Subdistrict	Southern Jarrah forest
Wa	Warren Subdistrict	Karri Forest
Ir	Irwin Botanical District	Northern Sandplains
Av	Avon Botanical District	Wheatbelt
Ro	Roe Botanical District	Mallee
Ey	Eyre Botanical District	Esperance Plains
Co	Coolgardie Botanical District	Southwestern Interzone

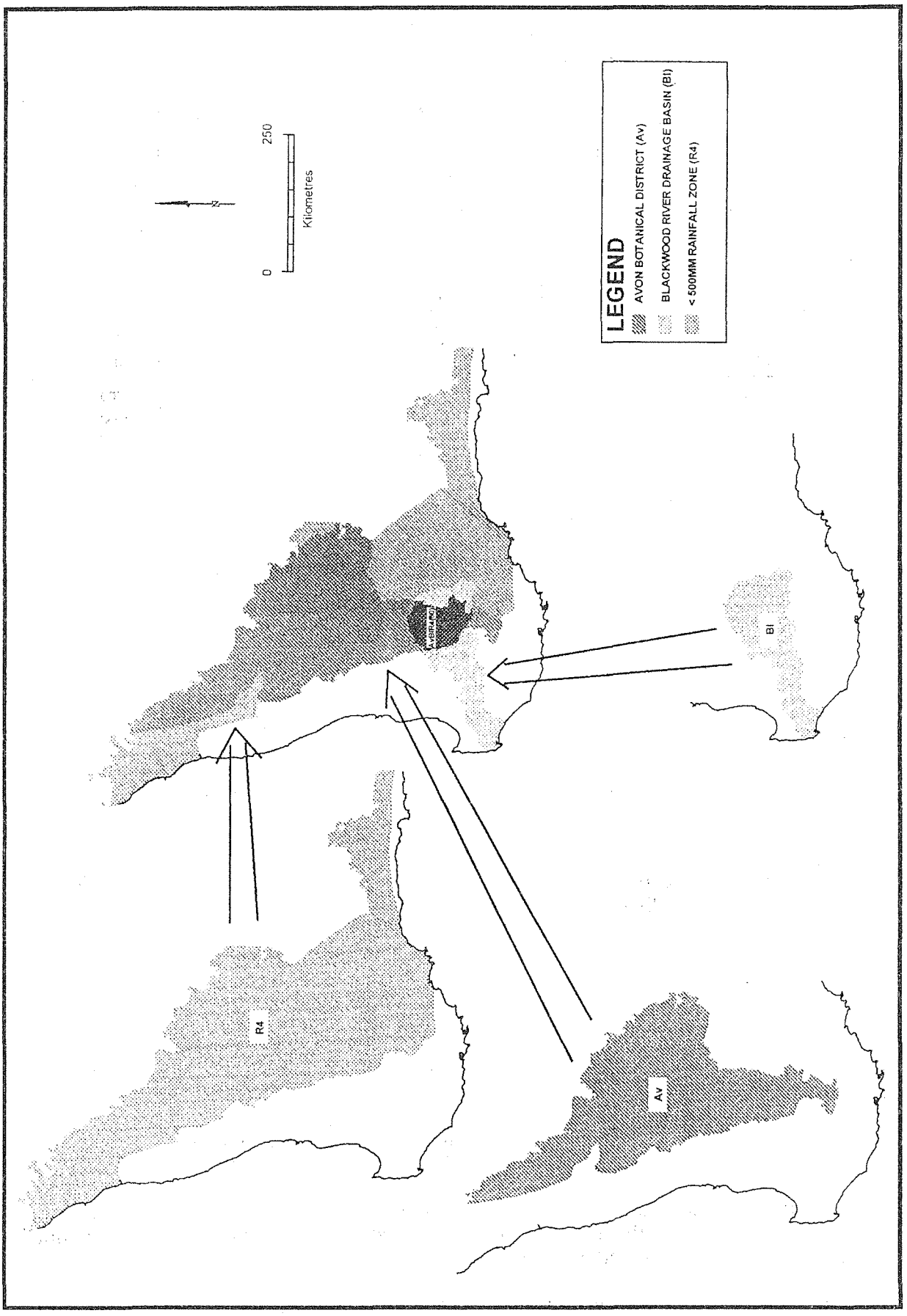

Figure 5. An example of the coding system (AvB1R4)

Table 3. Drainage divisions and river basins

Code	Drainage division/ river basin	Code	Drainage division/ river basin	Code	Drainage division/ river basin
Al	Albany Coast	Es	Esperance Coast	Ni	Ningham River
Av	Avon River	Fr	Frankland River	Pe	Preston River
Bl	Blackwood River	Gr	Greenough River	Sh	Shannon River
Bu	Busselton Coast	Ha	Harvey River	Sl	Salt Lake Basin
Co	Collie River	Kn	Kent River	Sw	Swan Coast
Dn	Denmark River	Mo	Moore-Hill River	Wr	Warren Coast
Do	Donnelly River	Mr	Murray River	Ya	Yarra Yarra Coast

Table 4. Rainfall zones and codes

Code	Rainfall zone
R1	greater than 1100mm
R2	700-1100mm
R3	500-700mm
R4	less than 500mm

3. Discussion

The Natural Resource Zoning system shows how data can be used in a Geographic Information System (GIS).

In its simplest form a geographical information system may be a series of maps referenced to the same geographic projection, in this example the Universal Transverse Mercator Projection (UTM). This allows the display and plotting of various combinations of map themes. The Natural Resource Zone system described here was established with the view to carrying out analysis of various data sets with the zones. Thus all map bases were feature coded, linked to an Oracle database and built into topological data structures. This allows the Natural Resource Zones to be queried against all of the data sets held in the WADA's Pastoral and Agricultural Geographic Information System (PAGIS). The example of remnant native vegetation given in Section 4 illustrates this functionality of the approach.

The Natural Resource Zones described here have the advantages that:

- they can be used in conjunction with other databases to analyse and report the data with in ecological boundaries as compared with shire boundaries which are often currently used;
- because the boundaries are based on biophysical information data generated for each of the zones will help identify the different areas of the State which are characterised by similar nature conservation needs and problems;
- adopting the boundaries of these scientifically accepted biological and physical domains obviated any confusion associated with the development of a new set of boundaries;

- the zones are a useful educative tool to help people understand the natural boundaries of the landscape. This enables the dissemination of information on native vegetation and related land and nature conservation issues on a more meaningful basis.

The decision to develop the Natural Resource Zones was not taken without due consideration of the potential disadvantages of such a system. These invariably related to a questioning of the need to develop a new system for the identification of regions when other regional classifications were available which could possibly be adapted for investigating native vegetation information. One of the advantages of this system is that it was developed on a GIS, a technique which was not used by or was unavailable when previous regional classifications were developed. Consequently the Natural Resource Zones system is more comprehensive and flexible than previous systems. The disadvantages of introducing a new system such as the Natural Resource Zones were seen to be outweighed by the benefits of planning on an ecological unit basis.

Tinley (1986) discussed options for regional classifications and identified that the criteria to be used was dependant on the objective of each system. Gentilli (1979) identified a variety of regions based on physical criteria as well as regions identified by human use purposes eg agricultural lands and rangelands. Tinley (1986) describes a hierarchical structure of hydrologic ecosystems for Western Australia made up of regions, subregions, the hydrologic unit (individual drainage basins) and subunits (or subcatchments). He did identify the South West as one of the major ecological regions of Western Australia. The system presented in this report specifically uses hydrologic units as one of its criteria.

The Natural Resource Zones will be available to all organisations within Western Australia through the digital network of the Integrated Land Information Program.

Potential values and uses for the Natural Resource Zones

The Natural Resource Zones and its information will be useful to organisations with responsibilities for the protection and management of natural resources in a range of ways,as listed below.

1. The Natural Resource Zones will provide a system to aid in the development of a centralised data base of Western Australia's biological resources. Biological attribute information which is currently available in digital format and which can be used in conjunction with the framework includes:

    - natural areas listed with the Australian Heritage Commission;
    - vertebrates (excluding birds), spiders, mites, land snails and other selected invertebrates listed with the WA Museum;
    - vegetation maps prepared at scales 1:3 000 000, 1:1 000 000 and 1:250 000 by Beard;
    - plant specimens held at the WA Herbarium;
    - declared rare flora data base held by CALM;
    - *Banksia spp.*, rare eucalypts and selected orchids listed with CALM;
    - proposals funded through National and State grants eg National Landcare Program (Save the Bush and One Billion Trees), State Landcare, Remnant Vegetation Protection Scheme

2. The Natural Resource Zones can be queried against any data sets referenced to the Australian Map grid. Examples of these held in the WADA's Pastoral and Agricultural Geographic Information System (PAGIS) are:-

    The Atlas of Australian Soils (CSIRO).
    Regional Soil Survey of WA (WADA).
    Public land data set.
    Shire boundaries.

This allows the Natural Resource Zones to:-

- provide a information on natural resources in the South West Land Division of Western Australia to any organisation that needs it (EPA, WADA, CALM, WAWA, DPUD, Land Conservation Districts, Waterways Commission, Office of Catchment Management, local Government authorities);

- provide a useful tool for the dissemination of information about natural resources within an ecological context such as the shire basis now commonly used (WADA, CALM, WAWA, Land Conservation Districts).

The Natural Resource Zoning system will become more useful as more information is transformed into GIS format and information updated, for example, land tenure information. Striving for a perfect system must be balanced with a need to address important and urgent conservation issues using the best information that is currently available whilst continuing to improve and update the information.

4. Remnant vegetation data as an applied example

Native vegetation has been degraded in various ways as a consequence of altered land use throughout Western Australia since the arrival of Europeans more than 150 years ago. In the South West Land Division, where the diversity of native flora is greatest and the impact of clearing for broadacre agriculture has been the most significant, 85-95% of the native vegetation has been removed (Select Committee into Land Conservation, 1990; Hamilton *et al.*, 1991; Coates, 1987). Native vegetation associated with the most productive soils has been removed preferentially, resulting in little of this vegetation remaining.

This problem is compounded by inadequate coverage by nature reserves in Western Australia of all habitats and species found throughout the State (CALM, 1992). Thus, in the agricultural areas of the South West Land Division remnants of native vegetation on private land are an important component of the State's biodiversity and a great conservation resource.

It is widely accepted that it is now essential to protect and manage remnant native vegetation on private property in the South West Land Division for its land and nature conservation values. These issues have been the subject of a number of reports. Whilst some of these have dealt specifically with native vegetation on farmland in the South West Land Division of Western Australia (Mulcahy, 1986; Coates, 1987; Hamilton *et al.*, 1991), others have considered native vegetation in a broader, land conservation context (Select Committee into Land Conservation, 1991).

As discussed earlier, the Remnant Vegetation Steering Committee recommended a State-wide zoning of remnant vegetation should be established. However, it was decided first to develop a system for the South West Land Division because in this region native vegetation has reached low levels. This is the agricultural area, identified as the land to the south west of the border between the agricultural and pastoral regions (Figure 4). Information on the extent of native vegetation in this area has been reported on a Shire basis by Beeston *et al* . (in press).

The advantages of having the information on a Shire basis is that the units are well known and therefore easily identified. However, using this approach the shires straddle catchment divisions and cross different natural regions and vegetation types. The result of this is that it makes biological interpretation of the results difficult because the data is the result of averages of two or more totally different ecological situations. However, using the Natural Resource Zones the statistics on remnant native vegetation can be reported and interpreted within their ecological boundaries.

Let us take the Blackwood River catchment as an example. Figure 7 shows the Natural Resource Zones of the Blackwood River catchment overlaid on a map of the shires. It can be

seen that on a Shire basis the Blackwood River catchment is made up of the whole or parts of 18 shires. Using the Natural Resource Zones as a framework, it divides the catchment into 6 zones, based on five different natural regions and three rainfall zones. Table 5 shows the codes and composition of these zones. Shire boundaries tend to cross natural boundaries, for example the Shire of Augusta-Margaret River is half within the Blackwood River catchment and half outside it. Also the part of this shire that is within the Blackwood River catchment is made up of two Natural Resource Zones (Nos 2 and 12) which have two distinct vegetation types, the Karri Forest and the Southern Jarrah Forest. It is the knowledge of these natural difference which would cause us to make different management decision in the two zones.

It can also be seen that Natural Resource Zones Nos 2 and 12 are shared between the Shires of Augusta-Margaret River and Nannup and therefore decisions on natural resources made in one shire have implications for decisions made in the other. A concern for these shared resources coupled with a good neighbour policy is essential for good land management and the protection of land and water.

The three zones uppermost in the catchment (Nos 41, 60 and 71) have less than 10% remnant native vegetation on private land whilst the three zones in the lower catchment have greater than 20% remnant native vegetation on private land. Native vegetation is an important part of the agricultural environment and so it is important to incorporate it into land use management plans such as farm and catchment plans.

If the data set of native vegetation on private land is queried against the Natural Resource Zones, for example, the percentage of native vegetation on private land in each of the zones can be extracted, this is presented in Table 6 and in Figure 6. The data presented here for native vegetation is the addition of two of the three vegetation categories identified by Beeston *et al.* (in press), and they are: remnant vegetation plus modified remnant vegetation, the scattered tree category was omitted because it was not considered to be viable vegetation in the long term. This shows that the majority of the Wheatbelt Region with its diverse vegetation has less that 10% native vegetation on private land

As another example of the versatility of the zoning system a comparison can be made of the extent of remnant native vegetation aggregated on the basis of rainfall (Table 7). In the higher rainfall zones (>700mm) there is approximately 20% remnant native vegetation on private land whereas in the lower rainfall zones (<700mm) there is between 12% to 16% remnant native vegetation on private land.

Such a zoning system is seen by the EPA as one of a number of strategies which, in co-operation with other organizations, agencies and individuals with an involvement in native vegetation, aims to ensure adequate assessment, management and protection of native vegetation throughout the South West Land Division of Western Australia. The system is limited only by the age and the degree of detail of the information captured by the various sources and the effort made to consistently update the information.

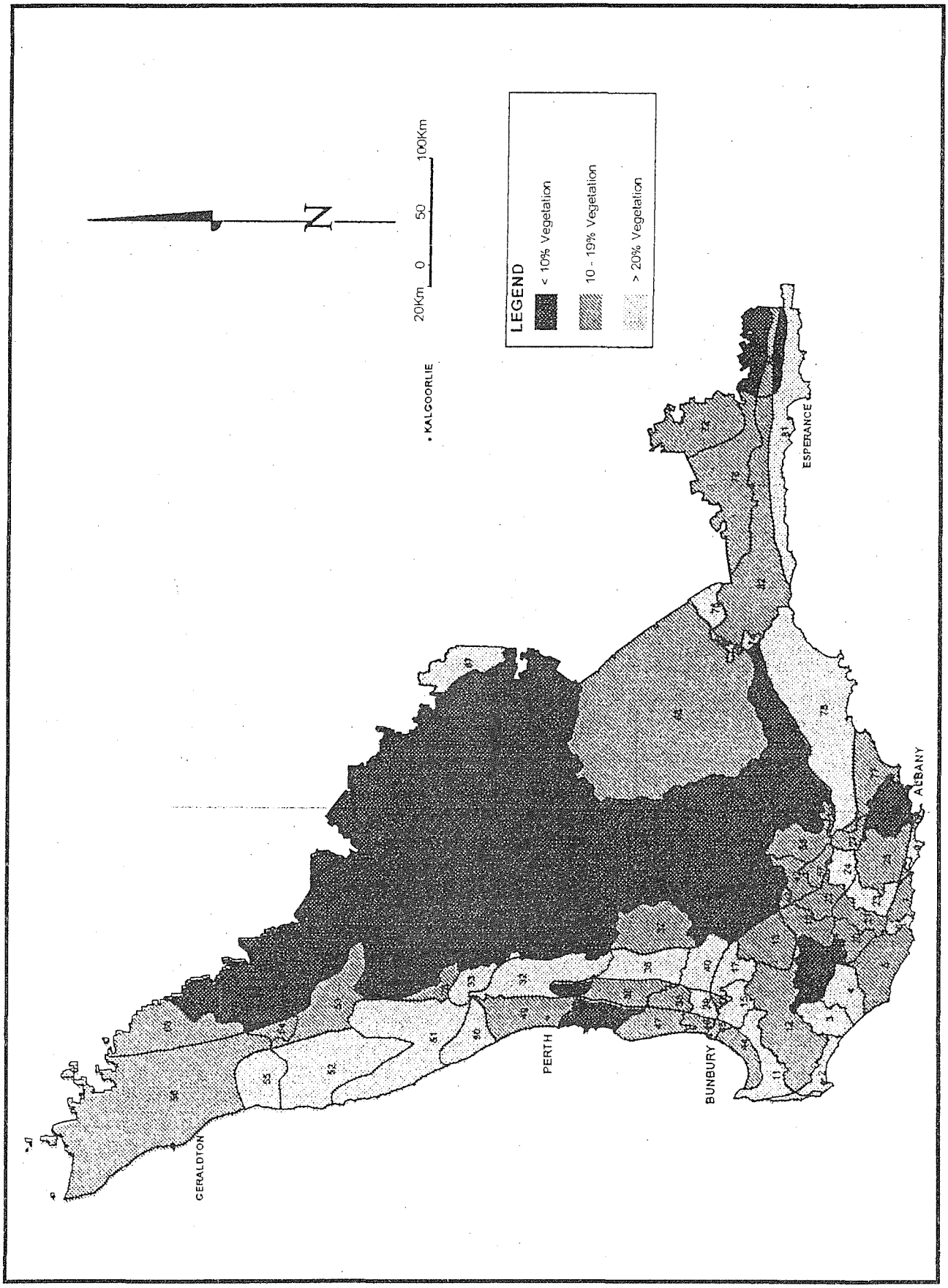

Figure 6. Percentage of remnant native vegetation on private land in each Natural Resource Zone

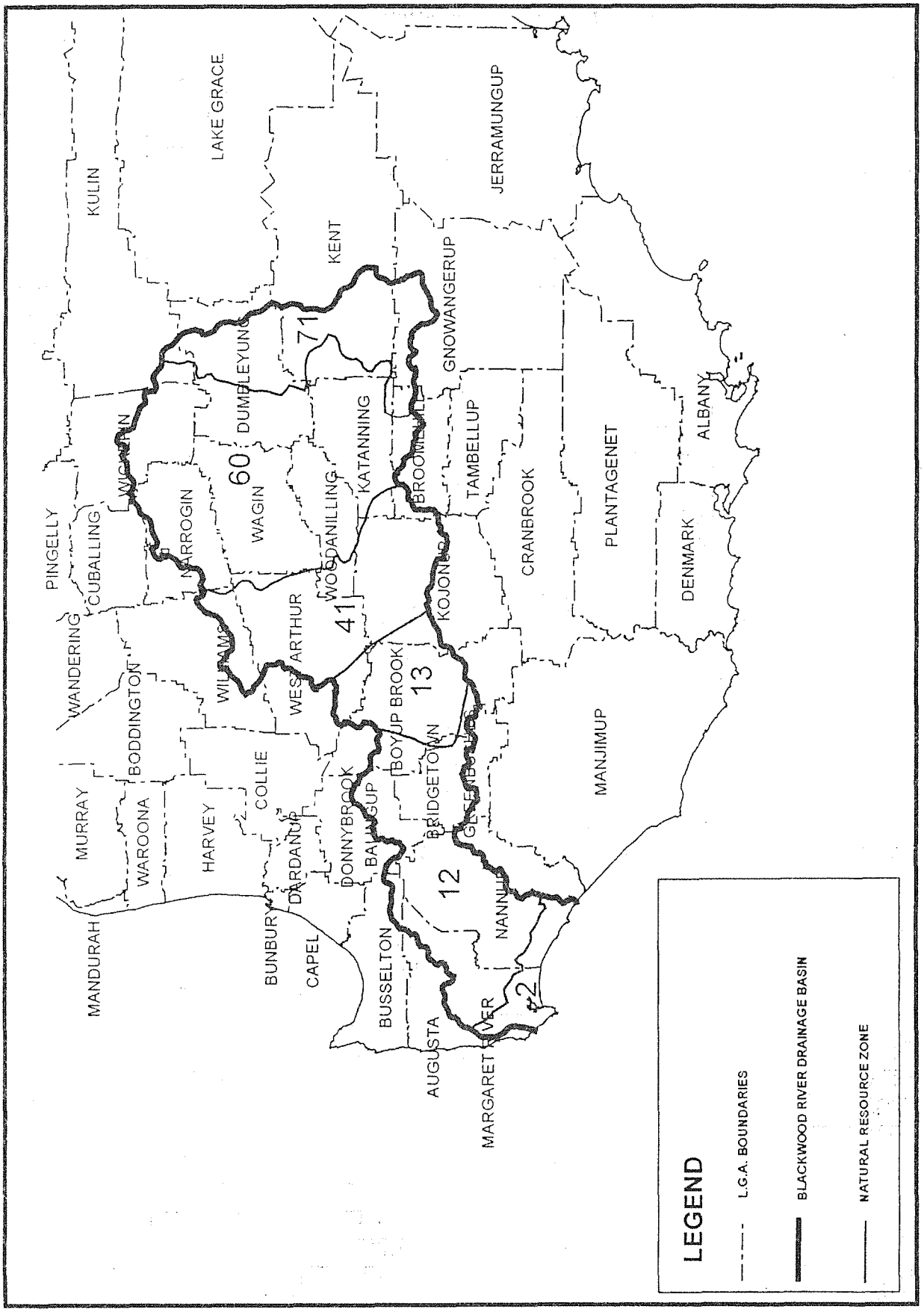

Figure 7. The Blackwood River catchment, the Natural Resource Zones and the shire boundaries

Table 5. Percentage of remnant native vegetation on private land in each Natural Resource Zone

Zone Code	Zone No	% native vegetation on private land	Zone Code	Zone No	% native vegetation on private land
WaBuR2	1	40	DlFrR3	43	11
WaBlR2	2	27	DuBuR2	44	19
WaDoR1	3	32	DuPeR2	45	12
WaWrR1	4	23	DuCoR2	46	16
WaShR1	5	13	DuHaR2	47	11
WaFrR1	6	22	DuMrR2	48	6
WaKnR1	7	19	DuSwR2	49	17
WaDnR1i	8	14	DuMoR2	50	26
WaDnR1ii	9	27	DuMoR3	51	28
WaAlR1	10	19	IrMoR3	52	23
MeBuR2	11	29	IrMoR4	53	14
MeBlR2	12	19	IrYaR4	54	18
MeBlR3	13	15	IrGrR3	55	22
MeDoR2	14	4	IrGrR4	56	13
MePeR2	15	20	AvFrR3	57	19
MeCoR1	16	15	AvFrR4	58	12
MeCoR2	17	27	AvAlR4	59	5
MeWrR2	18	9	AvBlR4	60	5
MeWrR3	19	16	AvMrR4	61	8
MeShR2	20	13	AvAvR4	62	7
MeFrR2	21	11	AvMoR4	63	6
MeFrR3	22	13	AvNiR4	64	9
MeKnR2	23	25	AvYaR4	65	10
MeKnR3	24	29	AvGrR4	66	13
MeDnR2	25	10	CoAvR4	67	22
MeAlR2	26	9	RoAvR4	68	12
MeAlR3	27	12	RoFrR4	69	10
DlMoR3	28	15	RoAlR4	70	5
DlAvR3i	29	9	RoBlR4	71	5
DlAvR3ii	30	10	RoSlR4i	72	17
DlSwR1	31	0	RoSlR4ii	73	7
DlSwR2	32	32	RoEsR4i	74	20
DlSwR3i	33	24	RoEsR4ii	75	20
DlSwR3ii	34	10	RoEsR4iii	76	17
DlMrR1	35	10	EyAlR3	77	15
DlMrR2	36	43	EyAlR4	78	21
DlMrR3	37	14	EyFrR4	79	12
DlHaR1	38	16	EyAvR4	80	23
DlCoR1	39	41	EyEsR3	81	25
DlCoR2	40	45	EyEsR4	82	18
DlBlR3	41	8	EySlR3	83	10
DlWrR3	42	12	EySlR4	84	12

Table 6. The Natural Resource Zones of the Blackwood River catchment and the percentage of remnant native vegetation in each zone.

Natural Resource Zone No and code	Phytogeographic region	Rainfall Zone (mm)	Percentage *remnant native vegetation on private land
2. WaBlR2	Warren subdistrict (Karri Forest)	700-1100	27
12. MeBlR2	Menzies subdistrict (Southern Jarrah Forest)	700-1100	21
13. MeBlR3	Menzies subdistrict (Southern Jarrah Forest)	500-700	22
41. DlBlR3	Dale subdistrict (Northern Jarrah Forest)	500-700	8
60. AvBlR4	Avon district (Wheatbelt)	<500	5
71. RoFrR4	Roe District (Mallee)	<500	5

*remnant native vegetation = intact vegetation + modified vegetation (Beeston *et al*. (in press))

Table. 7 Percentage of remnant native vegetation on private land within each rainfall zone

Rainfall zone	Rainfall mm	Percentage remnant native vegetation on private land
R1	>1100	19
R2	700-1100	20
R3	500-700	16
R4	<500	12

5. Acknowledgements

Thanks is extended to persons and agencies who have provided digitised data to the EPA and comments on the draft document. The EPA and the W A Department of Agriculture acknowledge the financial support from the Water Authority of Western Australia, Main Roads Department and Westrail. We are extremely grateful to Mr Norman Halse who provided editorial comments on the manuscript.

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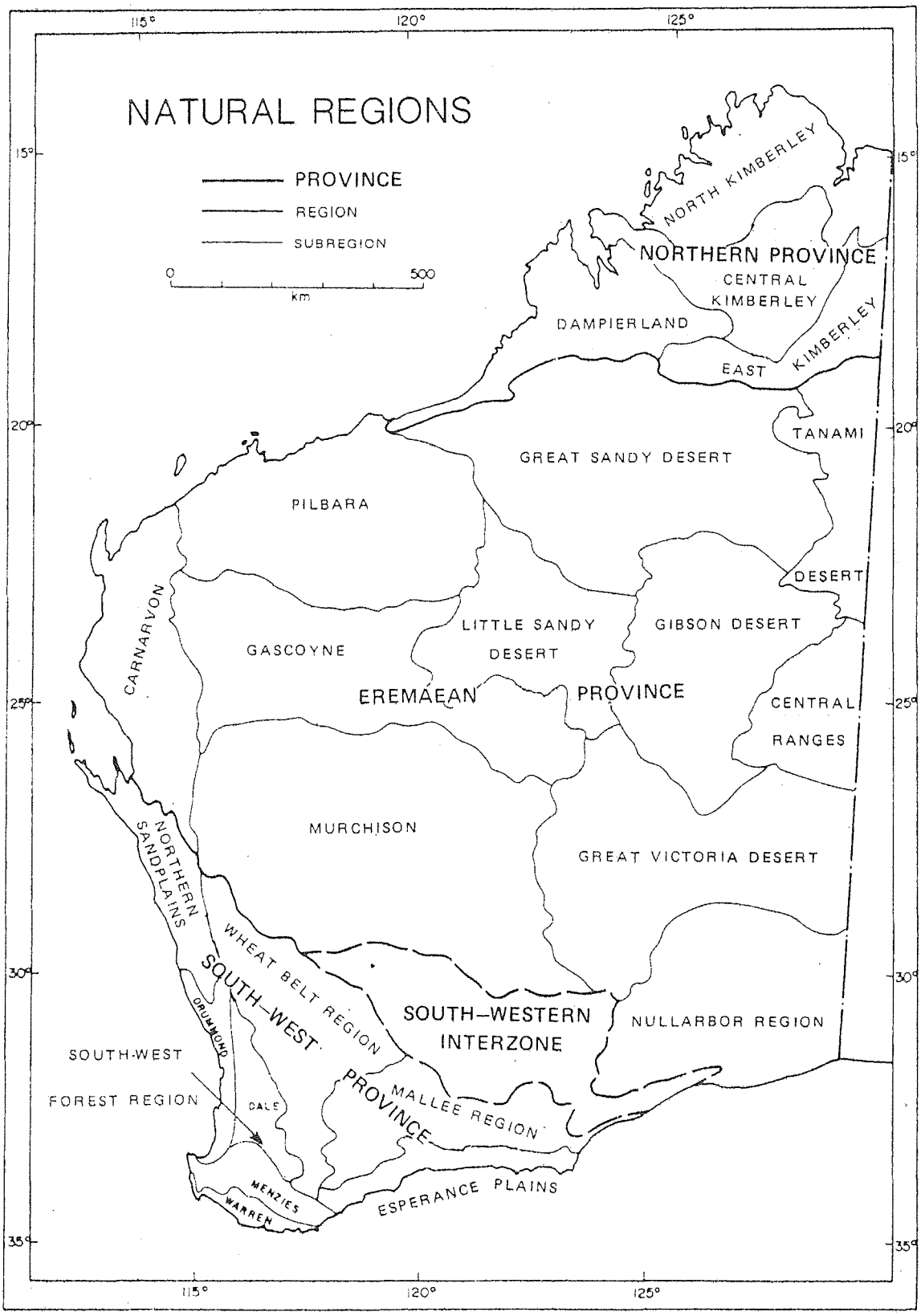
Appendix 1

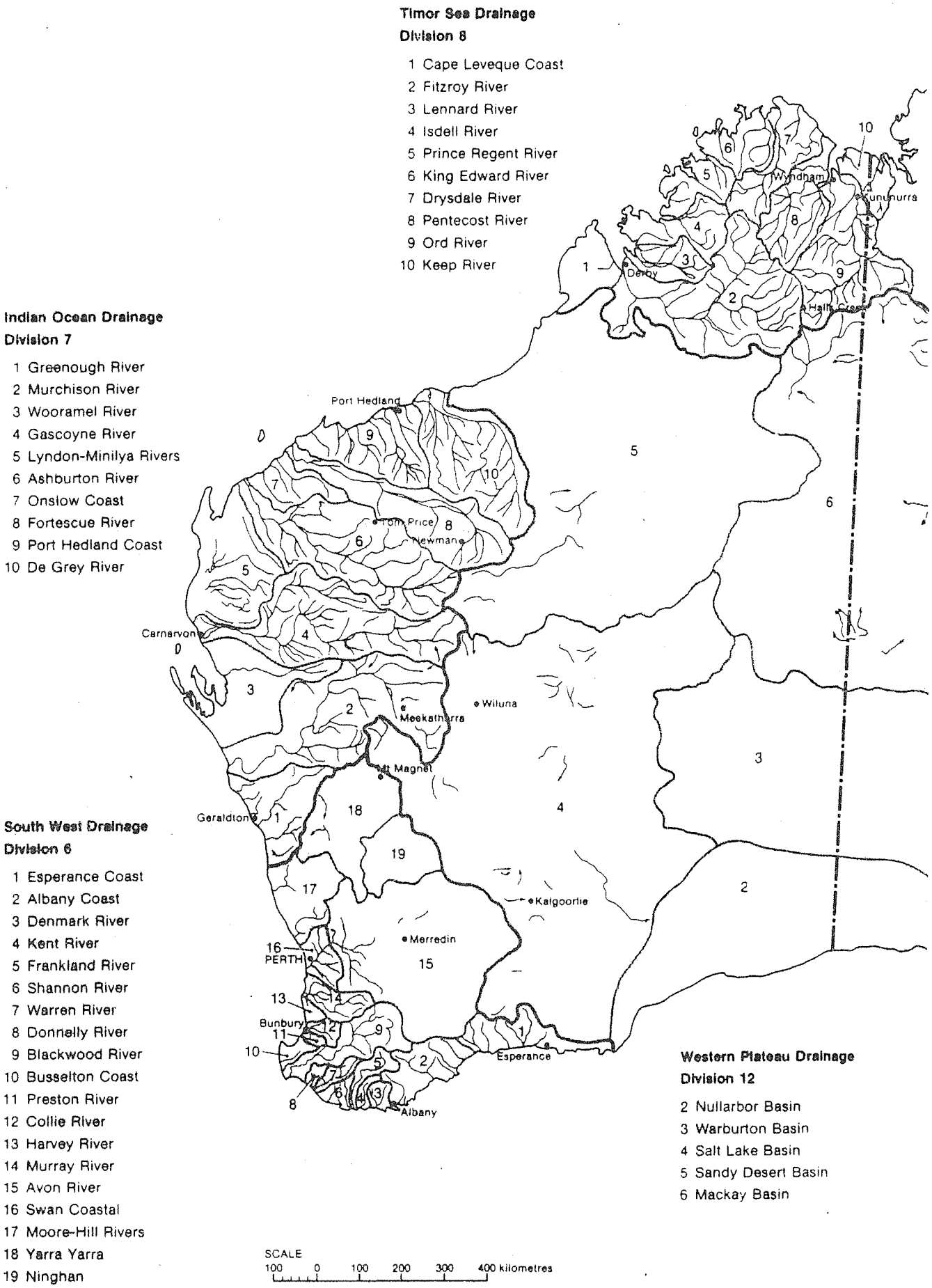
Beard's natural regions of Western Australia (Beard and Sprenger, 1984)



Appendix 1. Beard's natural regions of Western Australia (Beard and Sprenger 1984)

Appendix 2

Drainage divisions and river basins of Western Australia (Public Works Department, 1984)



Appendix 2. Drainage divisions and river basins of Western Australia (Public Works Department 1984)