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Name: Lot 5 & PT Lot 1 Boyanup Road, Bunbury – Submission Greater Bunbury Region Scheme
Date: 03/05/2006
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Western Australian Planning Commission Act, 1985

Greater Bunbury Region Scheme
Submission Form

To: The Secretary
Western Australian Planning Commission
61 Victoria Street
Bunbury WA 6230

OFFICE USE ONLY

SUBMISSION NUMBER	PROPOSAL NUMBER	REFER EPA
151		

I/We. RIZZO ASSOCIATES (on behalf of V & V Walsh) (Please print clearly)
(NAME)

of Level 4, The Gledden Building
731 Hay Street (cnr William St), PERTH WA Postcode 6000
(ADDRESS)

make a submission in relation to the Greater Bunbury Region Scheme. The submission is as follows:

SEE ATTACHED REPORT

(Please attach additional plain sheets if necessary. Any attachments should be loose. Do not bind)

Sketch 324, 327

Where the submission relates to a specific parcel of land, please indicate:

Lot number 5 and Pt 1 Street address Boyanup Road

Locality (suburb) BUNBURY

My interest is (please circle) owner/occupier; registered proprietor; lessee, mortgagor; other.

Please turn over to complete your submission

Greater Bunbury Region Scheme

Hearing of Submissions

There will be an opportunity for people who have made written submissions to discuss matters by commenting in person to a hearings committee.

These "hearings" are arranged so that the Western Australian Planning Commission can listen to a person should he or she wish to explain or expand upon their written submission. In the case of a group, a spokesperson to represent the group must be appointed. A hearing is for listening to points of view and planning rationale, and is not a forum of general public debate. All hearings are recorded and transcribed. The transcripts of "private" hearings remain confidential. All written submissions, transcripts of public hearings, and the Commission's Report will become public documents and be presented to Parliament.

You do not have to attend a hearing

The comments presented by you in this written submission will be taken into account in the determination of the proposed Region Scheme.

Please complete the following:

[ ] NO. I do not wish to speak at the hearings. (Please go to the end of the form and sign).

or

[X] YES. I do wish to speak at the hearings. (Please complete the following details. You will be contacted to arrange a time for your hearing).

I will be represented by:

[ ] MYSELF. My telephone number (business hours): .....

or

[X] MY AGENT or SPOKESPERSON (an agent may be from a local group)

Agent's name: (Dr, Mr, Mrs, Ms, Miss) ...MR. SAM. RIZZO.....

Group name: .....RIZZO. ASSOCIATES.....

Agent's telephone number (business hours): .....9226. 5000.....

Mailing address: .Level. 4,. The. Gledden. Building,. 731. Hay. St.,
(cnr William St), Perth WA 6000

I would prefer my hearing to be conducted in:

[ ] PUBLIC (with a public hearing other persons, including the media, may attend).

or

[X] PRIVATE (a private hearing is conducted behind closed doors and only persons nominated by you and the Hearings Committee will attend. Material presented at a private hearing will remain confidential.)

TO BE SIGNED BY PERSON(S) MAKING THE SUBMISSION

Signed ..... Date 12 · 12 · 00

NOTE: Submissions MUST be received by the advertised closing date, being close of business (5.00pm) on 28 November 2000. Late submissions will NOT be considered.

Contacts: Bunbury Office - Telephone (08) 9791 0577, Fax. (08) 9791 0576.
Internet http://www.planning.wa.gov.au

RIZZO ASSOCIATES

12 December 2000

Western Australian Planning Commission
South – West Regional Office
Sixth Floor, Bunbury Tower
61 Victoria Street
BUNBURY WA 6230

File Ref: 086-003/RF

Attn: Brod Meredith

Dear Mr Meredith

SUBMISSION TO DRAFT GREATER BUNBURY REGION SCHEME

Please find enclosed for your attention a submission to the draft Greater Bunbury Region Scheme. The submission has been prepared on behalf of V & V Walsh and relates to the abattoir at Lot 1 and Part Lot 5 Boyanup Road, Bunbury.

The enclosed report outlines the grounds on which the proposed reservation of part the property for "Regional Open Space" is contested. We have also requested the opportunity to present to the hearings committee.

Should you wish to discuss any aspect of this submission further, please do not hesitate to contact either Rachel Falls or Sam Rizzo on 9226 5000.

Yours sincerely

R Falls

RIZZO ASSOCIATES

TOWN PLANNERS • LAND DEVELOPMENT SOLUTIONS • PROJECT MANAGERS
Level 4 The Gledden Building 731 Hay Street Cnr of William Street Perth Western Australia 6000
Telephone: (618) 9226 5000 Facsimile: (618) 9226 5001 Email: admin@rizzo.com.au
Rizzo and Associates Pty Ltd ACN 066 582 232 as Trustee for the Strategic Planning Trust

LOT 5 & PT LOT 1 BOYANUP ROAD, BUNBURY

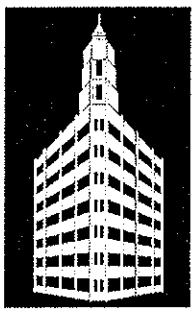
SUBMISSION

GREATER BUNBURY REGION SCHEME

on behalf of

V & V WALSH

prepared by



RIZZO ASSOCIATES

TOWN PLANNERS • LAND DEVELOPMENT SOLUTIONS • PROJECT MANAGERS

12 December 2000

1.0 INTRODUCTION

V & V Walsh WA Pty Ltd has commissioned Rizzo Associates, Urban and Regional Planning Consultants, to lodge a submission to the draft Bunbury Region Scheme (BRS). The submission relates to Lot 5 and Part Lot 1 Boyanup Road, Bunbury.

The purpose of the submission is to request the southern portion of the landholding be included in the "Industrial" zone under the BRS and not reserved for "Regional Open Space". The property is currently used as an abattoir.

Specifically, this submission seeks to demonstrate that:

1. The local zoning and function of this property is best suited to an "Industrial" zoning under the BRS;
2. Reservation of land for "Regional Open Space" to the extent proposed is not warranted and considered inequitable;
3. Reservation of the land for "Regional Open Space" will be detrimental to the existing operations of the abattoir;
4. Existing controls are in place under the local Town Planning Scheme specific to the abattoir use; and
5. The proposed "Industrial" zoning will not have any detrimental impact on the amenity of the locality and is not contrary to the orderly and proper planning of the area.

Changes to the proposed BRS zoning, in accordance with the comments made in this submission, will rationalise the existing land use practices and local level zoning with the regional level zoning, in turn enabling the land to be used for its intended purpose and providing security for the landowners.

2.0 SUBJECT LAND

2.1 Regional Context

The property is situated between the South Western Highway and the Preston River approximately 8kms south of the Bunbury town site.

2.2 Site Description

The subject land, legally described as Lot 5 and Part Lot 1, is held in Certificate of Title Volume 1302 and 1313, Folio 706 and 487, respectively. The land has a total area of 78.169 hectares and is accessed off Boyanup Road.

(See Appendix 1 – Location & Site Plan)

2.3 Land Use & Improvements

Improvements to the land includes infrastructure associated with the abattoir operations. This comprises the abattoir buildings, administration offices, grazing paddocks, holding yards and irrigation areas.
Most of the site has been cleared, however, some stands of remnant vegetation remain at the periphery.

2.4 Surrounding Land Uses

The site adjoins industrial and rural zoned land. Bunbury aerodrome is located to the south of the site. The property is bound to the east by the Preston River, beyond which lies a mix of industrial, farming and bush land areas.

A larger parcel of industrial zoned land known as the Davenport Industrial Area surrounds the subject lots. There is a policy in place over this area that governs any industrial development.

3.0 BACKGROUND

The abattoir has been in operation on this site since the early 1960s. The current owners, V & V Walsh, purchased the property and associated improvements in June 1993.

Prior to 1993 the land was zoned "Rural" under the City of Bunbury Town Planning Scheme No. 6, with the abattoir operating as a non-conforming use. In 1993 a proposal was made which sought the rezoning of the land from "Rural" to "Special Use – Abattoir."

This amendment was adopted in June 1994 rezoning the lots from "Rural" to "Special Use Abattoir – Primary Zone" and " Special Use Abattoir – Secondary Zone."

4.0 ZONING

4.1 City of Bunbury Town Planning Scheme No. 6

The subject land is zoned "Special Use – Abattoir" under the City of Bunbury Town Planning Scheme No.6.

The "Special Use - Abattoir" zoning has been divided into two distinct areas being the Primary and Secondary Zones. The actual slaughtering and processing component of the abattoir operations is restricted to the Primary Zone and is required by EPA policy to have a 500m buffer to the adjoining properties. The Secondary Zone provides this buffer and is restricted to rural type uses.

(See Appendix 2 – City of Bunbury TPS Zoning)

4.2 Draft Bunbury Region Scheme

The subject land is proposed to be zoned "Industrial" and partially reserved for "Regional Open Space" under the draft BRS. Specifically, the land abutting the Preston River, in addition to the southern portion of both lots, is proposed to be reserved for "Regional Open Space."

In the immediate vicinity, the balance of land is included in a combination of Rural, Industrial and Public Purpose zones and reserves. The South Western Highway to the west is proposed to be reserved as a Primary Regional Road.

(See Appendix 3 – Proposed BRS Zoning)

5.0 GROUNDS OF SUBMISSION

The purpose of this submission is to request the WAPC reconsider the reservation on the southern portion of the subject site for "Regional Open Space" under the BRS. The grounds of this request are detailed below.

5.1 Existing Function of Property

The abattoir has been operating on this site since the early 1960s. This includes the primary abattoir operation in addition to the ancillary irrigation area and grazing land, which provides a buffer to the processing areas. The whole of the site forms part of a comprehensive integrated business

As a regional facility, the abattoir provides significant employment and income for the Bunbury region. The company provides meat to the local market in addition to undertaking export processing. The property is suitably zoned and designed to enable the abattoir to operate in a manner that meets the strict requirements of the Environmental Protection Authority, the Water and Rivers Commission and the City of Bunbury.

Extensive research and planning has been undertaken to ensure the abattoir is appropriately designed and located given the nature of the land use in this context. This has included considerable discussions with the respective agencies and considerable financial input to ensure the operations are effective and compliant with the stringent controls in place.

5.2 Proposed Reservation

The proposed "Regional Open Space" reserve under the BRS does not recognise the importance of the subject land as part of the abattoir operations and is inequitable in light of the approved use and land requirements for this property. The need for the reservation is unsubstantiated given a buffer to surrounding landuses is currently provided within the subject landholding.

The owner recognises the importance of the "Regional Open Space " reserve along the banks of the Preston River in terms of its environmental and recreational significance. The protection of the foreshore area was considered and land set aside at the time of the rezoning under Town Planning Scheme No. 6.

This submission and objection relates specifically to the proposed reserve extending along the southern portion of both lots. The proposed reserve consumes in excess of a quarter of Lot 5, in addition to a significant portion of Part Lot 1. Resumption of this land is likely to jeopardise the operation of the abattoir through removing the landholding presently used for the irrigation of pastures, which concurrently acts as a buffer to adjoining land uses.

Our enquiries indicate there is no explanation for the proposed reservation across the southern portion of Lot 5 and Part Lot 1. The Greater Bunbury Region Scheme Environmental Review identifies the Preston River foreshore as an area for wetland conservation, however, does not make specific mention of the additional land proposed for reservation. We were not able to identify any environmental function of the southern portion of the subject lots, worthy of reservation for "Regional Open Space." It can only be assumed that the land is being reserved to provide a buffer, the need for which has been demonstrated as being unsubstantiated.

5.3 Irrigation Area

An important part of the operation of the abattoir includes the land proposed to be reserved for "Regional Open Space", which is located at the southern portion of the Walsh landholdings. This part of the property is used for irrigation, the total area of which has been calculated based on the amount of wastewater produced and absorption rates.

The irrigation area is a critically important part of the abattoir operation in its provision for the management of wastewater. The land is irrigated with treated liquid waste from various stages of the production process.

Pasture irrigation is carefully monitored to ensure nutrient levels are maintained and effluent from the abattoir does not impact on the adjoining Preston River. The resumption of this land from the owners will jeopardise the irrigation system in place and result in a potentially detrimental impact on the surrounding environment.

5.4 Buffer Zone

Noise and odours emitted as part of the operation of the abattoir, whilst carefully managed, are an impact resulting from the nature of this business. To date these emissions have been monitored and controlled in a manner that there has been no implications for adjoining land users.

The Western Australian Planning Commission have advised the proposed "Regional Open Space " reserve on the southern portion of the landholding may be required to be resumed in order to provide a buffer to the adjoining rural area. Provision of this buffer has already been undertaken within the landholding. Furthermore, the buffer land is also used for irrigating pasture in order to reduce the nutrient loading from wastewater from the abattoir operations.

The logic of this is also unfounded given the subject portion of land is restricted to rural type land uses. Permitted uses in the "Special Use Abattoir - Secondary Zone" of the abattoir is restricted to;

"all uses associated with the abattoir that are permitted in the Primary Zone with the exception of those uses requiring a 500 metre buffer in accordance with the EPA policy requirements. Such uses may include rural uses approved by Council and/or uses ancillary to the abattoir operation approved by Council."

The abattoir operations under the present management regime are effective and require no changes. That is, no adverse impacts, environmental or other, have or will occur to the Preston River or adjoining land users. Resumption of the land to provide a buffer to the adjoining rural area by way of a "Regional Open Space " reserve is unwarranted given a buffer already exists as part of the existing landholding and removal of this will hinder the work being undertaken to preserve the environment in the area.

5.5 Orderly and Proper Planning

The "Industrial" zoning is not considered to be contrary to the orderly and proper planning of the area. Specific controls are currently in place as part of the zoning of the land under the City of Bunbury Town Planning Scheme to ensure land use practices are appropriate to the context of the site and its surrounds.

A buffer between the abattoir operations and adjoining landholdings is provided for under the existing Town Planning Scheme zoning. The allocation of primary and secondary special use areas prevent the expansion of the operations across the landholding thus preventing the abattoir impacting on adjoining properties.

The owner appreciates the reasoning for the proposed "Regional Open Space" reservation along the Preston River, however, contests the need for the additional reservation on the southern portion of the subject landholdings.

5.6 Management Plan

As part of the rezoning of the subject lots under the City of Bunbury Town Planning Scheme, a Management Plan was prepared to satisfy the requirements of the Environmental Protection Authority and Water Authority of Western Australia.

The Management Plan addresses issues relating to general operation of the abattoir, including matters specific to its impact on surrounding land users and the environment. Wastewater from the abattoir operations, and the impact of this on the Preston River and Leschenault Inlet downstream, is addressed in the conditions of the EPA licence and the Management Plan.

Part of the wastewater management program includes irrigation of an area of the property with treated water pumped from an oxidation pond. The irrigation area occupies a portion of the landholding denoted by the EPA, which allows a 50m buffer to the Preston River and its

tributaries, and excludes flooded areas. This highlights the specific requirements and importance of the irrigation area in the abattoir operation.

The operation of the abattoir as outlined in the management plan has resulted in no adverse environmental impacts occurring on the Preston River or adjoining land users. In addition, operations in accordance with the management plan ensure compliance with the licence for the abattoir issued by the EPA. Resumption of part of the landholding will jeopardise the effective manner in which the abattoir currently operates.

6.0 CONCLUSION

This submission clearly demonstrates the inclusion of the southern portion of the lots within the "Industrial" zone under the BRS can be supported. The importance of the "Regional Open Space" reserve along the Preston River is recognised, however, the additional wedge along the southern boundary of the property is seen to be excessive and a hindrance on the existing abattoir operation and the surrounding natural environment.

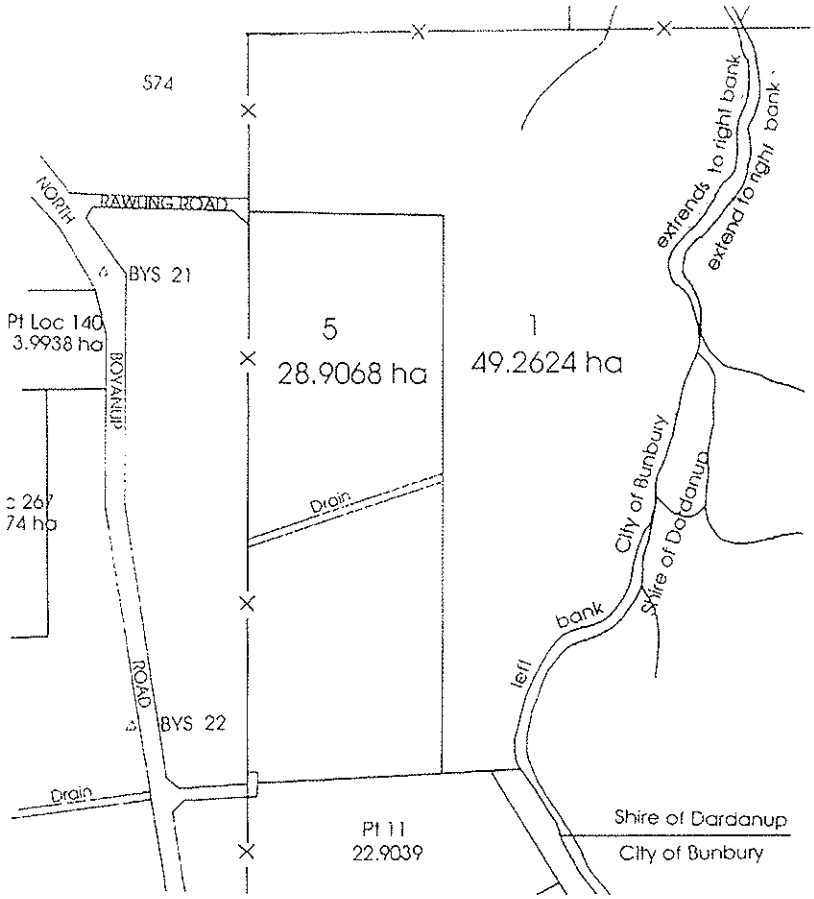
Inclusion of the land in the "Industrial" zone under the BRS will ensure the abattoir remains operational in its present location with minimal impact on the adjoining land uses and environment.

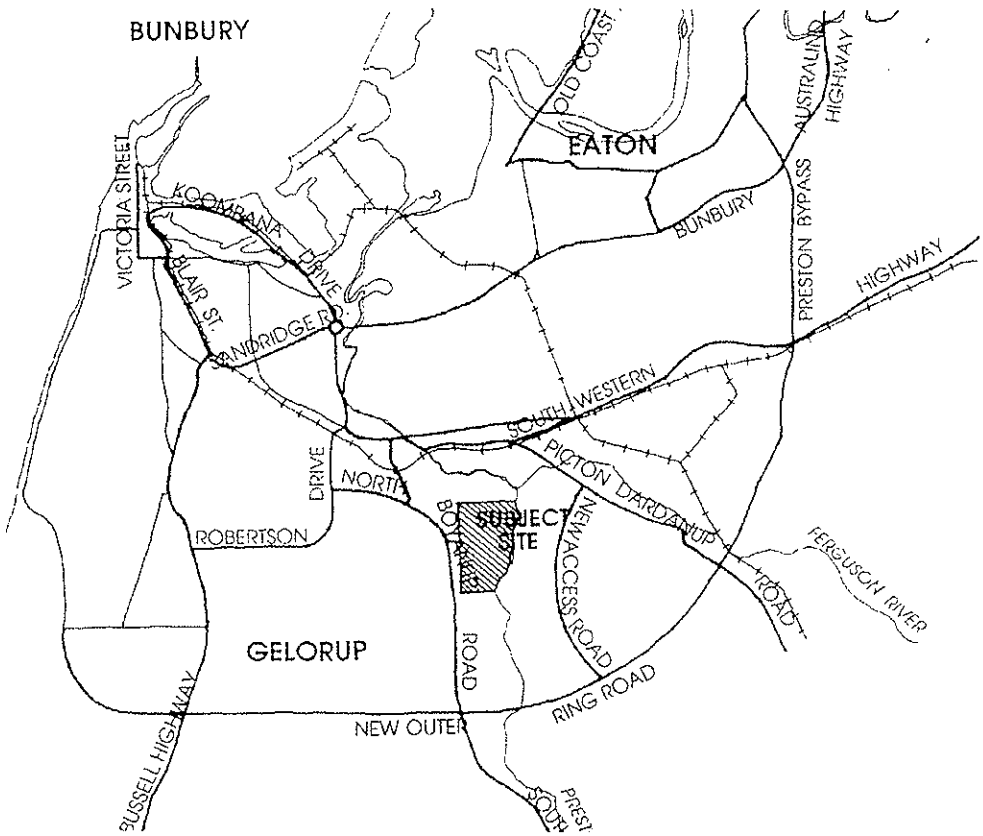
In the event that the subject land is reserved for "Regional Open Space" significant claims for compensation will be made due to the Special Value of the land as an abattoir. This is recognised in the City of Bunbury zoning for the land as "Special Use – Abattoir" as opposed to a more broad based "Industrial" zoning.

In light of the above comments, the Western Australian Planning Commission is requested to reconsider the proposed reservation of the southern portion of Lot 5 and Part Lot 1 for "Regional Open Space" under the BRS and the implications of this on the operation of the existing abattoir.

APPENDIX 1 –

Location and Site Plan





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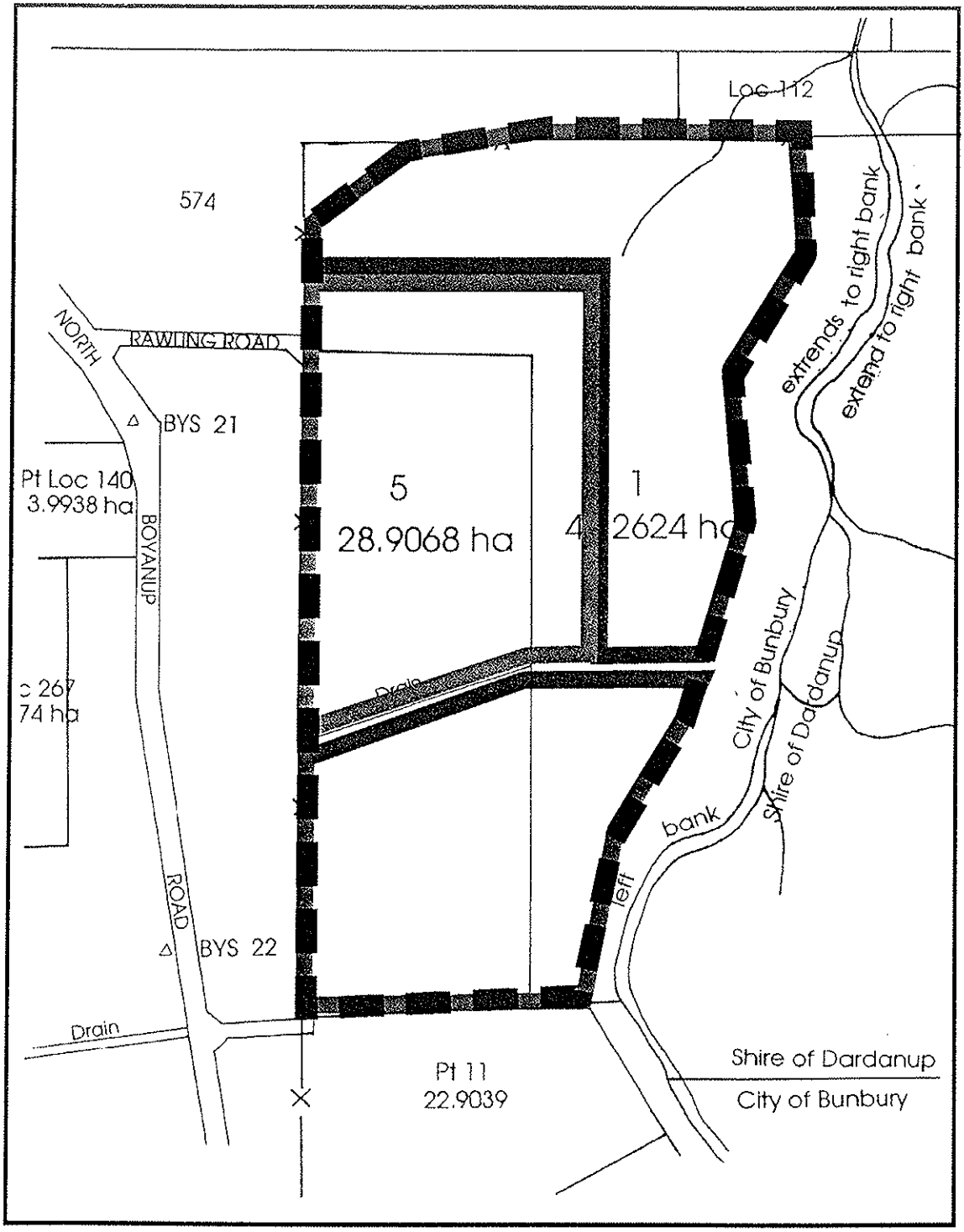
Project			
Bunbury Abattoir			
Title			
Location & Site Plan			
Figure No	Date	Scale	Job No
1	Dec 2000	N/A	86-003

N

APPENDIX 2 –

Local TPS Zoning



Scheme Map

Zones

Special Use.
Abattoir Primary Zone.

Special Use.
Abattoir Secondary Zone.

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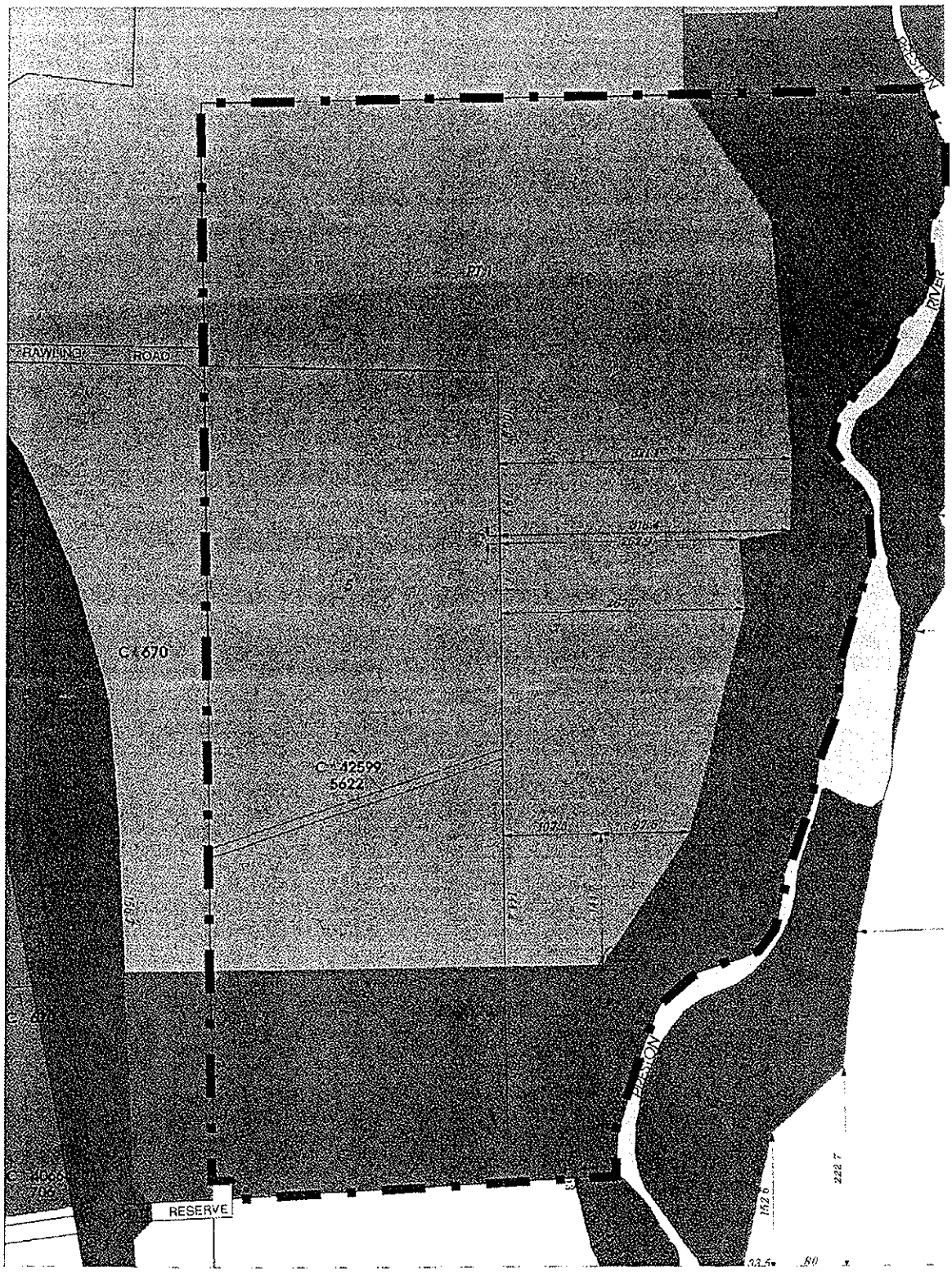
Project			
Bunbury Abattoir			
Title			
City of Bunbury Town Planning Scheme			
Figure No	Date	Scale	Job No
2	Dec 2000	N/A	86-003

N

APPENDIX 3 –

Proposed BRS Zoning



REGIONAL OPEN SPACE
INDUSTRIAL
RURAL
WATERWAYS
PRIMARY REGIONAL ROAD

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Project: Bunbury Abattoir			
Title: Greater Bunbury Region Scheme.			
Figure No: 3	Date: Dec 2000	Scale: N/A	Job No: 86-003

N

or proposed reserves) in the Greater Bunbury region. A significant area (about 243 ha) of remnant vegetation of primarily Forrestfield Complex in good condition occurs south and east of the site, and is currently reserved for Recreation under the Shire of Harvey Town Planning Scheme No. 1.

Conservation Estate

The site abuts land to the south and east currently reserved for Recreation under the Shire of Harvey Town Planning Scheme No. 1, and is proposed for reservation as ROS under the Greater Bunbury Region Scheme. Developers of the site adjoining land proposed to be reserved will be required to manage edge effects in accordance with Environmental Management Measure 1.

5.10 Industry Zones at Davenport

Relevant factors:

- *Regionally significant vegetation*
- *Estuaries*

5.10.1 Background

Two small parcels of land in Davenport totalling about 16 ha are to be rezoned from Rural to Industry, as shown on Figure 23. These parcels are currently relict rural zones in an area that has largely been rezoned for industry under the City of Bunbury Town Planning Scheme No. 6.

The Davenport-Preston area is an established industrial area that contains a range of general and light industry together with farming, housing and other uses. The area has been earmarked for further industrial development for a number of years by various planning studies including the *Bunbury-Wellington Region Plan* and the *Greater Bunbury Structure Plan.*

Industry 2030 (WAPC, 2000) recommends that the land use of the site should comprise a Mixed Use Precinct in the northern portion and a Transitional Industry Precinct in the southern portion.

5.10.2 Impacts and Management

Regionally Significant Vegetation

The small northern parcel is fully cleared while the larger southern parcel supports about 8 ha of remnant vegetation of the Southern River Complex. The Southern River Complex is not well represented and poorly reserved in the Greater Bunbury Region, with only 22% of its original extent remaining and only 3% in existing or proposed conservation reserves.

One Declared Rare Flora (DRF) species, *Villarsia submersa,* is known to occur in the area, although none have been found in the proposed Industry zone.

The vegetated southern parcel forms part of the odour buffer of an abattoir located immediately to the east. It is therefore unlikely that vegetation from this area will be removed for development until such time as operations at the abattoir cease. Currently, there are no plans for closure of the abattoir.

Estuaries

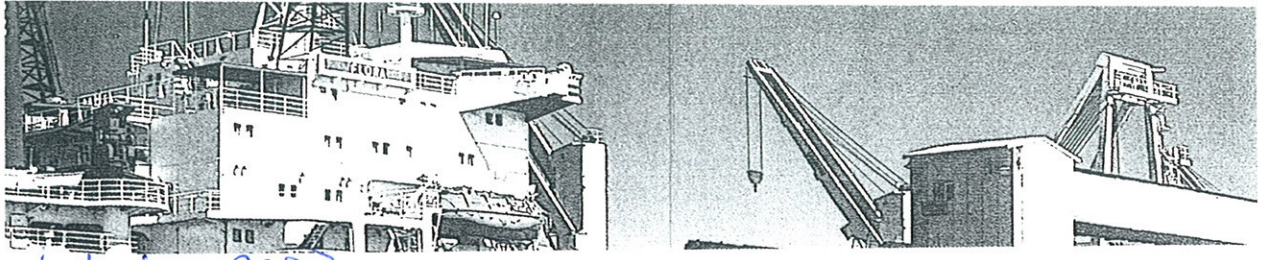
Most of the site is situated on palusplain and drainage/filling will be required to provide clearance above the maximum groundwater level for construction. As the site is within the catchment of Leschenault Inlet, drainage and nutrient management measures will be required.

In line with current WRC policy, drainage in the new industry areas will be addressed by incorporation of water sensitive design principles including:

- all industries will be sewered;
- subsoil drains will be set at no lower than the average annual maximum groundwater level (AAMGL);
- peak and total water discharge from the site will not be increased; and
- on-site retention of drainage and stormwater will be maximised.

① Davenport Industrial Zone, Preston River foreshore to Davenport Industrial area ??

Lot 5 and Part 1 Boyanup Rd.
③



Industry 2030

This Interim Strategy Plan is an indicative plan, and should be treated as such in the decision-making process, until the following additional technical investigations are carried out and the Plan is finalised:

- Land use studies in the South Western Highway (Boyanup Road) - Bunbury airport area.
- Environmental impact modelling.
- Water and drainage management strategy. (incorporating liquid waste disposal).
- Vegetation survey.
- Wetlands survey.
- Road access studies.

EATON
AUSTRALIND BYPASS
WWTP
POSSIBLE METROPOLITAN MARKETS
POSSIBLE REGIONAL RECREATION CENTRE
1-10 ha SMALL LOT LOW IMPACT GENERAL INDUSTRY
1-10 ha SMALL LOT GENERAL INDUSTRY
BARRETTI PARK SHOWGROUND AND RECREATION
PICTON
50-80 ha POSSIBLE TECHNOLOGY PARK
1-5 ha SMALL LOT GENERAL INDUSTRY
10-20 ha GENERAL MANUFACTURING AND FABRICATION INDUSTRY
1-10 ha SMALL LOT GENERAL INDUSTRY
GLEN IRIS
50-100 ha LARGE LOT POSSIBLE BONDED
50-100 ha POSSIBLE BIOTECHNOLOGY PARK
EXPORT ZONE
2000m² - 5 ha SMALL LOT GENERAL INDUSTRY
50-100 ha POSSIBLE RAIL FREIGHT TERMINAL & DISTRIBUTION CENTRE
RAILWAY
2000 m² SMALL LOT GENERAL INDUSTRY
2000 m² - 10 ha GENERAL INDUSTRY
1-5 ha SMALL LOT GENERAL INDUSTRY NON GROUNDWATER POLLUTING
1-10 ha SMALL LOT LOW IMPACT TRANSITIONAL INDUSTRY
CITY OF BUNBURY
SHIRE OF DARDANUP
POTENTIAL RAIL CLOSURE UNDER CONSIDERATION
DAVENPORT
50 ha+ LARGE LOT GENERAL INDUSTRY
50 ha+ LARGE LOT GENERAL INDUSTRY
2-10 ha SMALL LOT GENERAL FABRICATION INDUSTRY
FP
FURTHER INVESTIGATION REQUIRED IN THIS AREA
BUNBURY AIRPORT EXTENSION
SMALL-MEDIUM 2-30 ha LOTS NON GROUNDWATER POLLUTING INDUSTRIES PORTIONS HEIGHT RESTRICTED
5-20 ha LOTS MANUFACTURING AND FABRICATION
2-10 ha LOW IMPACT TIMBER RELATED TRANSITIONAL INDUSTRY
5-20 ha TIMBER RELATED GENERAL INDUSTRY
CITY OF BUNBURY
SHIRE OF CAPEL
2-10 ha LOW IMPACT TIMBER RELATED TRANSITIONAL INDUSTRY
February 2000

NORTH BOYANUP DISTRICT STRUCTURE PLAN

ENVIRONMENTAL STUDY

On behalf of :

DEPARTMENT FOR PLANNING AND INFRASTRUCTURE

Prepared by:
ENV Australia
ABN. 72 091 839 52 0
Level 7
182 St George's Terrace
Perth WA 6000
Telephone (08) 9289 8360 Facsimile (08) 9322 4251

03.137/RP001 MAY 04	DRAFT 2:

Australia

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APPENDICES

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EXECUTIVE SUMMARY

This report details the assessment of environmental values within the North Boyanup District Structure Plan study area which has been identified as a potential urban corridor extending from the Bunbury along the west side of the Preston River. The information obtained during the course of this environmental study, and associated studies will be used to guide future district level land use planning and will assist developers, landowners, local government and Government agencies in coordinating development of the area.

The environmental study has involved the assessment of the hydrology, vegetation complexes, threatened ecological communities, flora, fauna and wetlands of the North Boyanup area. The results obtained during the course of the study support the status of a previously identified ecological linkage and have allowed the identification of select areas as being regionally significant based on EPA (2002) criteria. Areas considered suitable for conservation based on their regional significance and importance as part of the ecological linkage have been identified. The status of important wetlands within the area has also been updated.

Opportunities and constraints within the study area have been highlighted. The main constraining factors are the high water table over the general area and the conservation value of remnant vegetation and wetlands. It is recommended that more detailed hydrological studies be carried out to ensure the hydrology of the study area can be managed in a sustainable way if broad scale land use changes occur.

1. INTRODUCTION

1.1 PROJECT BACKGROUND

This report has been compiled at the request of the Department of Planning and Infrastructure and details the assessment of identified environmental values within the North Boyanup District Structure Plan study area and forms one component of the entire Structure Plan Study. The main aim of the environmental study is to make recommendations for the protection and management of environmental values with particular emphasis on justifying regionally significant areas and areas capable for other land uses. The information provided will be used to guide future district level land use planning and will assist developers, landowners, local government and Government agencies in coordinating development of the area..

The Greater Bunbury Structure Plan states that the North Boyanup area could form part of a future urban corridor extending from the Bunbury along the west side of the Preston River and number of planning documents have previously identified portions of the study area as being suitable locations for future residential or special development areas (WAPC - State Planning Strategy, Shire of Capel Land Use Strategy, Bunbury-Wellington Region Plan and Greater Bunbury Structure Plan). Some of the above mention planning documents also highlighted areas with significant natural values that should be considered for conservation. The location of the North Boyanup District within the Greater Bunbury Region Scheme area is shown in Figure 1.

The North Boyanup District Structure Plan will help to determine a framework for sustainable land use and services for North Boyanup; and will aim to balance the conservation of biodiversity (remnant vegetation, flora, fauna, wetlands), natural landscape features and water resources, land capabilities with competing land uses (such as agriculture, rural and urban residential) in addition to maintaining access to basic raw materials and strategic mineral resources where consistent with protection of other values.

1.2 SCOPE

In summary the scope of works required to fulfil the requirements of the environmental study were:

1. Description of the biodiversity

- Vegetation
- Flora
- Threatened Ecological Communities
- Declared Rare Flora, Priority Flora and other significant flora
- Wetlands
- Fauna

2. Biodiversity protection

- Wildlife corridor(s)
- Other linkages
- High value conservation areas.

- Hydrology
- Ground and surface water flow
- Water quality characteristics
- Constrained areas from flood risk

4. Summation

- Review and update opportunities and constraints from preliminary environmental study
- Identify existing environmental values for conservation.

5. Implementation

- Define environmental management objectives
- Provide environmental guidelines for potential development areas.

The natural values of the area were evaluated in a regional context according to the assessment in EPA (2002). This strategy document upgraded Bush Forever (Department of Environmental Protection, 2000) so that it is relevant to the Greater Bunbury Region (GBR). Additional information has been provided by the Environmental Protection Authority (2003a) when they responded to the Western Australian Planning Commission on the Greater Bunbury Region Scheme.

This final report is intended to contain information sufficient to support the assessment of any resultant structure plan or amendment to the Greater Bunbury Region Scheme (or to the Shire of Capel District Planning Scheme) by the WAPC, DoE and DCLM.

1.3 STUDY AREA

The study area is located in the Shire of Capel and is bounded by Bussell Highway to the west, Preston River to the east, Centenary Avenue to the north and the West Boyanup Road to the south (see Figure 2). The study area covers approximately 99 km^2.

The area is predominantly zoned "Rural" under the Shire of Capel District Planning Scheme No. 7, and under the draft Greater Bunbury Region Scheme. There are two pockets of rural residential development located west of South West Highway. Three basalt quarries operate east of the existing Gelorup "Special Residential" zone. The existing residential areas were not assessed as part of this study. The majority of the area is used for broad-acre grazing.

2. STUDY AREA BACKGROUND INFORMATION

2.1 GEOLOGY & GEOMORPHOLOGY

The study area consists of a coastal plain about 15km wide and can be subdivided into three major physiographic units consisting of the alluvial Pinjarra Plain which is covered by the discontinuous, irregular and mostly subdued Bassendean Dunes. The western margin of the study area is dominated by the prominent Spearwood Dune System. These physiographic units can be further subdivided into seven distinctive landform units (Department of Agriculture, Western Australia, 2003; Churchwood and McArthur, 1978). These are:

Spearwood Dune System

1. Karrakatta Unit – undulating, well drained landscape with deep yellow brown and grey siliceous sands over limestone.

2. Yoongarillup Unit – plains with low ridges and swales; shallow yellow and brown sands over marine limestone.

Pinjarra Plain

1. Guildford Unit – flat plain with medium textured deposits.

2. Swan Unit – alluvial terraces with red earths and duplex soils.

3. Serpentine River Unit – poorly drained plain with fine textured alluvial deposits.

Bassendean Dune System

1. Southern River Unit – sandplain with low dunes and many intervening swamps: iron and humus podzols, peats and clays.

2. Bassendean Unit – sand plains with low dunes and occasional swamps; iron or humus podzols.

The characteristics of the various landform units are linked directly to the underlying geology. The geology of the North Boyanup area has been described by Playford et al (1976), Baxter (1977) and Commander (1984) and is summarised here.

The area occurs within the Bunbury Trough, a deep graben defined by two north south striking faults: the Busselton Fault to the west; and the Darling Fault to the east. The Bunbury Trough contains at least 10,000m of Phanerozoic sediments, though only the near surface formations have been described here. In the study area, these formations range in age from Jurassic to Holocene, as indicated below:

- Yarragadee Formation - conformably overlies the Cockleshell Gully Formation (not described here) and was developed in the Middle to Late Jurassic in a high energy,

fluviatile environment. The Yarragadee consists mainly of medium to very coarse grained quartz sand, with abundant fine pebbles, minor thin interbeds of clay and rare, thin coal seams and is at least 700m thick.

- Bunbury Basalt - this unit unconformably overlies the Yarragadee and represents early Cretaceous lava flows which can be up to 85 metres thick. In some areas the Basalt has been weathered from a fresh micro-porphyritic basalt into a green clay. The basalt represents at least two valley-filling flows, separated by several metres of alluvial sediment. The flow started offshore, south of Black Point, east of Augusta and extended to over 60km west of Bunbury. The basalt dips east and north from the only outcrop in the study area at Gelorup.

- Leederville Formation - deposited during the early Cretaceous in a nearshore non-marine environment and unconformably overlies the Bunbury Basalt or Yarragadee Formation. This formation consists mainly of medium to very coarse-grained feldspathic quartz sand and gravel with thin interbedded clay and rare carbonaceous clay and coal. The Leederville Formation fills a synform that has resulted from differential subsidence of the underlying formations. As a result the Formation wedges out to the west and is absent in most of the project area.

- Superficial Formations - four Quaternary units are evident in the North Boyanup area and unconformably overlie the underlying pre-Quaternary units or each other.

1. The Guildford Formation is a layer of lenticular interbeds of sand, silt, clay and conglomerate generally of a fluvial origin but with estuarine and shallow marine incursions of variable thicknesses. Exposure of this formation corresponds with lower lying, more water logged areas that dominate the area. Over a large proportion of the study area the Guildford Formation is widely covered by a layer of washed or blown sand (eroded Bassendean Dunes) of variable thickness. These units make up the Pinjarra Plain physiographic unit.

2. The Bassendean Sand consists of a fine to medium grained sand - very light grey at the surface grading into yellow at depth with some localised coffee rock development. The unit forms a series of discontinuous weathered dunes with interdunal depressions; many characterised by swamps or fined grained humic sands with internal drainage. This unit forms the Bassendean Dune physiographic unit.

A sub unit of the Bassendean Sand, up to 5m thick, covers a large portion of the study area and reflects the subdued topography of the underlying Guildford Formation. It is considered to be an erosional remnant of a formerly more extensive dune cover and because of its subtle topography and apparent thinness is often mapped as part of the Guildford Formation and included in the Pinjarra Plain physiographic unit.

3. The Spearwood Sand/Tamala Limestone is largely a eolian calcarenite that forms the elongate dunes bordering the western edge of the study area and forms the Spearwood Dune physiographic unit. The formation ranges from coarse grained

unconsolidated quartz sand (Spearwood Sand) to lithified calcarenite (Tamala Limestone). The unit overlies the Yarragadee Formation, sections of the Bunbury Basalt and the Bassendean Sands.

The surface geology is shown in Figure 3. A colour coded relief map is shown as Figure 4 and illustrates the topography of the study area.

2.2 HYDROLOGY

2.2.1 Surface Water

The project area is located within three major surface catchment areas. These are the Preston River catchment, The Capel River (via Gyundup Brook) catchment and the Five Mile Brook catchment (see Figure 5). With the exception of the perennial Preston River, surface water flow within the project area is seasonal, generally flowing along natural and man made drainage lines through the respective catchment areas to the major watercourses. Due to winter flooding over large parts of the area drainage patterns often become indistinct.

The Five Mile Brook is one of two main artificial drainage channels that have been created to reduce winter inundation and the high water table of the agricultural land over the majority of the project area. Five Mile Brook ultimately drains into the ocean through cuts in the Spearwood and near coastal dune systems. O'Neil's Drain connects a number of wetlands, naturally occurring drainage depressions and artificial drains to the head of Five Mile Brook.

There are numerous wetlands within the study area none of which are permanent. All the wetlands in the area represent topographical depressions that expose the water table during the wetter months of the year. Further details on the distribution and classification of the wetlands present are given in section 2.4

2.2.2 Groundwater

Previous knowledge on the hydrology and hydrogeology of the study area is largely based on data gathered during the Bunbury Shallow Drilling Groundwater Investigation conducted by the Geological Survey of WA and reported on by D.P.Commander (1984). During this study the main freshwater aquifers were identified as the unconfined Superficial formations and the confined Leederville and Yarragadee Formations.

Commander found the Superficial formations formed a shallow (generally less than 2m in low lying areas), thin and predominately clayey unconfined aquifer, in which groundwater flow is generally in a westerly direction though vertical flow is significant in areas of low relief where there are often substantial vertical hydraulic gradients in both upwards and downwards directions. Water flow is discontinuous near Gelorup where the Quaternary sediments thin over the Bunbury Basalt. The numerous wetlands in the area are

hydraulically connected to the superficial aquifer (Waters and Rivers 2001) and reflect topographic low points.

Recharge of water within the superficial aquifer is dominated by the effects of infiltrating rainfall and through upward leakage from the Leederville formation in the eastern section of the study area. The superficial aquifer forms an integral part of the surface water system and during winter rainfall periods, recharge produces surface inundation and consequent flows in drainage channels. Superficial groundwater discharge occurs by direct evaporation from wetlands, existing streams and drains and by downward leakage into the Yarragadee Formation which underlies the majority of the study area. Elsewhere, groundwater is lost by evapotranspiration from vegetation and also by way of domestic or farm water supplies, where wells or bores have been installed.

The seasonal variation in the elevation of the water table within the superficial formation ranges from about 0.5 metres to 2 metres (Water Authority, 1995). Variation is greatest in clayey sediments which are generally found further inland.

Commander found that groundwater tended to be fresh in areas of sand and brackish in areas of clay. Within the Bassendean sands the salinity was recorded as less than 500 mg/L while in clay rich areas of the Guildford formation salinities exceeded 1000 mg/L. In the vicinity of wetlands, where the water table is partially exposed, anomalous high salinities can occur due to the cumulative effect of evaporation.

The Leederville aquifer is an interbedded, multilayered aquifer that is present only along the eastern edge of the study area.

Recharge occurs in areas outside the study area by direct infiltration of rainfall on the Blackwood Plateau and by downward leakage from the Superficial aquifer adjacent to the Whicher Scarp (marine erosional feature cut into the Leederville Formation which, south of Boyanup, defines the inland extent of the coastal plain). Within the study area the aquifer discharges into the overlying Superficial formations and into the underlying Yarragadee formation.

Potentiometric heads within the Leederville aquifer vary greatly both laterally and vertically. This indicates the existence of a number of local groundwater flow systems. Overall there is a general northerly flow direction which is, within the study area, laterally restricted by the Bunbury Basalt and confined by the clays of the Guildford Formation (Commander, 1984).

Groundwater salinity in the Leederville aquifer tends to increase in the direction of flow, ranging from less than 300 mg/L near the Whicher Scarp, to over 1000 mg/L near the coast. There is however no simple relationship between salinity, depth or location (Water Authority, 1995).

The Yarragadee aquifer, over a large part of its extent is overlain by the Leederville aquifer however within the majority of the study area the Leederville is absent and the

Yarragadee is overlain directly by the Superficial sediments or the Bunbury Basalt. In areas where the Yarragadee is overlain by sandy Superficial sediments it is unconfined.

Recharge of the aquifer occurs mostly outside of the study area but the work carried out by Commander (1984) shows potential for downward leakage from the overlying Superficial or Leederville aquifers, its rate being determined by the nature of any confining layers present. Discharge from the Yarragadee occurs via the Superficial formations into the ocean southwest of Bunbury where the confining layers of the Leederville formation and Bunbury Basalt are absent.

Hydraulic gradients within the Yarragadee have been found to be very low resulting in slow groundwater flows. Groundwater flow is in a north to north west direction.

Groundwater salinity within the Yarragadee varies between 180 mg/L and 900 mg/L. Iron and manganese values are high and generally require treatment before use (Water Authority, 1995).

2.3 VEGETATION AND FLORA

North Boyanup is in the Drummond Botanical Subdistrict of the Southwest Botanical Province (Beard, 1990). This subdistrict is mainly Banksia low woodland on leached sands with Melaleuca swamps where the area is poorly drained. Woodlands of *Eucalyptus gomphocephala* (Tuart), *Eucalyptus marginata* (Jarrah) and *Corymbia calophylla* (Marri) occur on less leached soils. Beard (1981) records the natural vegetation as b1,2Li/e2,3Mi/mLi – a mosaic of *Banksia attenuata* and *Banksia menziesii* low woodland/*Eucalyptus marginata* and *Corymbia calophylla* Woodland/Teatree woodland. The pre-European extent of this vegetation was 119,340ha, of which 29,396ha remains vegetated which is 24.6% of the original area, 13% is protected in IUCN Class I-IV Reserves and 8.9 % in other reserves (Shepherd et al., 2002).

Heddle et al., (1980) in their study of the Darling System mapped 7 vegetation complexes as occurring within the study area (see Figure 6). These are:

Spearwood Dune System

Karrakatta Complex – Central and South described as predominantly an open forest of *Eucalyptus gomphocephala* (Tuart) - *Eucalyptus marginata* (Jarrah) – *Corymbia calophylla* and woodland of *Eucalyptus marginata* – Banksia species.

Yoongarillup Complex a woodland to tall woodland of *Eucalyptus gomphocephala* (Tuart) and *Agonis flexuosa* in the second storey. Less consistently an open forest of *Eucalyptus gomphocephala* (Tuart) – *Eucalyptus marginata* (Jarrah) - *Corymbia calophylla* (Marri)

Pinjarra Plain

Southern River Complex an Open woodland of *Corymbia calophylla – Eucalyptus marginata* – Banksia species with fringing woodland of *Eucalyptus rudis – Melaleuca rhaphiophylla* along creek beds.

Serpentine River Complex a Closed scrub of Melaleuca species and fringing woodland of *Eucalyptus rudis – Melaleuca rhaphiophylla* along streams.

Swan Complex a fringing woodland of *Eucalyptus rudis – Melaleuca rhaphiophylla* with localised occurrence of low forest of *Casuarina obesa* and *Melaleuca cuticularis*.

Bassendean Dune System

Bassendean Complex – Central and South the vegetation ranges from a woodland of *Eucalyptus marginata – Allocasuarina fraseriana – Banksia* species to low woodland of *Melaleuca* species and sedgelands on the moister sites.

Guildford Complex is a mixture of open forest to tall open forest of *Corymbia calophylla – Eucalyptus wandoo – Eucalyptus marginata* and woodland of *Eucalyptus wandoo*. Minor components include *Eucalyptus rudis* and *Melaleuca rhaphiophylla*.

Within the area surveyed, the small area of Yoongarillup Complex, is now included in the Gelorup development. Most of this complex occurs to the west of the survey area. The Swan Complex was confined to the Preston River but there was very little remnant vegetation along this river within the study area. The Serpentine River Complex was a small area on the western side near the southern boundary but did include some wetlands in excellent condition as discussed below. There are four major complexes within the study area - Karrakatta Complex – Central and South, Bassendean Complex – Central and South, Guildford Complex and Southern River Complex.

The natural areas in the GBR have been significantly reduced and/or altered. The total remnant vegetation of the above vegetation complexes is provided in EPA (2002) and tabulated below in Table 1.

Table 1: Total remnant vegetation remaining in the Greater Bunbury Region (GBR) and southern Swan Coastal Plain as recorded by EPA (2002).

VEGETATION COMPLEX	ORIGINAL GBR ha	REMAINING GBR ha	REMAINING % GBR	%SECURE TENURE GBR	REMAINING % SCP	%SECURE TENURE SCP
Spearwood Dune System						
Karrakatta – Central and South	11686	6091	52	16	29.5	9
Yoongarillup	13448	4437	33	12	45	31
Pinjarra Plain						
Southern River	16070	3320	21	6	20	8
Serpentine River	6990	1129	16	49	11	27
Swan	5646	906	16	0	16	0
Bassendean Dune System						
Bassendean Central and South	23969	9430	39	1	27	2
Guildford	33294	1470	4	1	5	3

For the Greater Bunbury Region the objective of the EPA (2002) and Commonwealth of Australia (Environment Australia, 2001) is to retain 30% or more of the pre-clearing extent of each ecological community if the biodiversity is to be protected. Referring to Table 1 Karrakatta Central and South, Yoongarillup and Bassendean Central and South all have 30% or more remaining vegetated in the Greater Bunbury Region but as these assessments are made for the Swan Coastal Plain as a whole the only complex in excess of the 30% is Yoongarillup. These three vegetation complexes are higher ground and as is obvious from the aerial photograph it is the lower ground that has been developed for agriculture. These lower areas are preferred for stock as due to the higher water table the pasture stays green for a longer period.

However (Shepherd et al., 2002) state that less than 25% of the natural vegetation described by Beard (1981) remains vegetated. This has been assessed for the whole of the complex which is associated with the Swan Coastal Plain.

2.4 WETLANDS

Wetlands are defined 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*" (Wetland Advisory Committee 1977)

Wetland types and consanguineous suites have been mapped over a large portion of the Swan Coastal Plain north of Bunbury by Hill et al. (1996a). Those within the southern Swan Coastal plain have been map and classified by the V & C Semenuick Research Group (1998). The global geomorphic classification system developed and used in this review is shown in Table 2 below.

Table 2: Wetland Classification System (from Semenuik 1987)

WATER LONGEVITY	LANDFORM				
	BASIN	CHANNEL	FLAT	SLOPE	HIGHLAND
permanent inundation	lake	river	-	-	-
seasonal inundation	sumpland	creek	floodplain	-	-
intermittent inundation	playa	wadi	barkarra	-	-
seasonal waterlogging	dampland	trough	palusplain	paluslope	palusmont

Wetland evaluation is a separate process and uses the results of mapping and classification to describe a wetlands existing and potential values (V & C Semenuick Research Group, 1997). The information gained during the evaluation process also allows for wetlands to be assigned a management category. Table 3 defines the various categories currently used in WA..

A number of wetlands of the Swan Coastal Plain have also been listed under the *Environmental Protection (Swan Coastal Plain Lakes) 1992 Policy* and are referred to as EPP lakes. These wetlands are afforded special protection from unauthorised filling, mining, effluent disposal and drainage.

Table 3. Categories assigned to wetlands (EPA, 1993 and Water and Rivers Commission, 1991)

EPA, (1993).	Water and Rivers Commission (1991)		
Category	**Management Category**	**General Description**	**Management Objectives**
H – High conservation C - Conservation	C – Conservation (incorporates EPA Bulletin 686 categories H and C)	Wetlands support a high level of ecological attributes and functions.	Highest priority wetlands. Objective is preservation of wetland attributes and functions through various mechanisms including: • reservation in national parks, crown reserves and State owned land, • protection under Environmental Protection Policies, and • wetland covenanting by landowners. These are the most valuable wetlands and the Commission will oppose any activity that may lead to further loss or degradation. No development.
O – Conservation and recreation R – Resource enhancement	R - Resource enhancement (incorporates EPA Bulletin 686 categories O and R)	Wetlands which may have been partially modified but still support substantial ecological attributes and functions.	Priority wetlands. Ultimate objective is for management, restoration and protection towards improving their conservation value. These wetlands have the potential to be restored to conservation category. This can be achieved by restoring wetland structure, function and biodiversity. Protection is recommended through a number of mechanisms.
M – Multiple Use	M - Multiple use (aligned with EPA Bulletin 686 category M)	Wetlands with few important ecological attributes and functions remaining.	Use, development and management should be considered in the context of ecologically sustainable development and best management practice catchment planning through landcare. Should be considered in strategic planning (e.g. drainage, town/land use planning).

Wetlands are a common natural feature of the North Boyanup study area. Based on data obtained from the DPI, the study area contains ten conservation category wetlands, 15 resource enhancement wetlands and over 30 multiple use wetlands. Twenty nine of the wetlands have also been gazetted as EPP wetlands. An important facet of the North Boyanup Environmental study was to re-evaluate the classification of wetlands in the area. Due to limitations of previous studies inaccurate and inconsistent classifications have occurred.

Figure 7 shows the location and extent of the various wetlands and their respective management categories prior to commencement of this study.

2.5 FAUNA

The vertebrate fauna of Western Australia can be broadly classified as having affinities to one of three biogeographical zones that have been defined across the continent. These are the Torresian (Northern), Eyrean (Central) and Bassian (Southern) divisions. These biogeographical patterns of fauna distribution have arisen due to interactions between fauna species and communities and all the components of their environment over time. The North Boyanup study area is likely to contain a strong Bassian element with species present being adapted to regular winter rainfall patterns with cool temperatures and infrequent summer droughts typical of South Western Australia.

Due to the obvious separation of a number of species between the Swan Coastal Plain and the Darling Range it has been possible to further subdivide the South West Bassian division into bioregions. The study area falls totally within the Swan Coastal Plain bioregion (Thackway & Cresswell 1995), to which some fauna species are totally restricted.

No detailed systematic fauna surveys in the North Boyanup area have been undertaken. The most recent broad scale work involving a desktop study and brief field visit, undertaken on behalf of Pioneer Construction Materials Pty Ltd by MBS Environmental (2003), concluded that a rich vertebrate fauna along with several species of conservation significance could be expected to occur.

2.6 LAND CAPABILITY

The assessment of land capability requires the consideration of the specific requirements of the land use and the associated risks of degradation. Five land capability classes are used when assessing an areas capability (Table 4).

Table 4: Land capability classes (from van Gool, Moore and Tille, 2003)

Capability class	General description
1 very high	Very few physical limitations present and easily overcome. Risk of land degradation is negligible
2 high	Minor physical limitations affecting either productive land use and/or risk of degradation. Limitations overcome by careful planning
3 fair	Moderate physical limitations significantly affecting productive land use and/or risk of degradation. Careful planning and conservation measures required
4 low	High degree of physical limitation not easily overcome by standard development techniques and/or resulting in high risk of degradation. Extensive conservation measures required
5 very low	Severe limitations. Use is usually prohibitive in terms of development costs or the associated risk of degradation

To gain an idea of the capability class ratings within the North Boyanup study area, the Western Australian Department of Agricultures AGMAPS Land Profiler data has been utilised (Department of Agriculture, 2003) in addition to data obtained during the course of this study.

2.6.1 Rural Residential Zones

While there are several land capability factors of importance when establishing new residential developments, one of the most important planning considerations in unsewered rural areas relate to the soils ability to be used sustainably for the disposal and treatment of domestic liquid waste. Most rural residential developments in WA use septic tank effluent disposal and therefore land capability for septic tanks is a minimum requirement.

Successful functioning of any effluent disposal system is only achieved if the receiving soil absorbs the volume of effluent produced and if it is purified by the process of filtration,

absorption and oxidation which occur as effluent moves through the soil pores (Wells, 1987).

Van Gool, Moore and Tille (2003) recommend the use of six land quality factors when assessing an areas capability class rating for the use of conventional septic tank systems in a rural residential development (i.e. a single family dwelling on a block of 1 ha or larger) (Table 5). The most limiting land quality determines the capability class for any defined area.

Table 5. Land capability for septic tanks for rural residential developments. (from van Gool, Moore and Tille, 2003)

Land quality	Land capability class				
	1	2	3	4	5
Ease of excavation	H	M	L	VL	
Flood hazard	N		L	M	H
Land instability	N	VL	L	M	H
Microbial purification ability	H	M	L	VL	
Soil absorption	H	M	L	VL	
Waterlogging/inundation	N,VL	L	M	H	VH

Notes: Waterlogging/inundation. Insufficient soil above seasonal water tables to purify septic tank effluent may cause problems. Preferred management options include alternative methods for handling household effluent such as aerobic treatment units some of which utilise leach drains with the soil amended with bauxite residue, or small local treatment plants. Less desirable is the provision of a large sand pad to elevate leach drains 2 m above the maximum water table. Microbial purification ability assesses whether a particular soil can purify added effluent. Management options are similar to waterlogging. Any land subject to flood hazard or instability is not suited to septic tanks or housing developments. Management will depend on the nature and extent of the problem.

Western Australian Department of Agricultures AGMAPS Land Profiler data has been used to produce a map (Figure 8) to illustrate the overall land capability class ratings (with respect to rural residential developments) of the various land units in the North Boyanup area.

Figure 8 shows that the majority of the study area has a low land capability rating with respect to rural residential developments. This capability rating can be attributed to the presence of seasonally high water tables in low lying areas and to the low purification

ability of the Bassendean sands which form the majority of the higher ground in the central portions of the study area.

Current Government Policy (Draft Country Sewerage Policy, Department of Health, 2003) does not allow for on site waster water disposal systems in areas where the groundwater is within 0.5 metres of the natural surface without acceptable, corrective measures being employed. The Health (Treatment of Sewerage and Disposal of Effluent and Liquid Waste) Regulations 1974 also restricts the installation of septic tank systems to areas where the depth to the highest known groundwater level from the underside of a septic tank or effluent drainage receptacle is less than 1.2 metres. The Department of the Environment (DOE) recommends a 2 metre vertical separation be maintained from the base of the system to the highest known ground water level or impermeable layer/bedrock, in addition to a 50m horizontal separation from the nearest wetland.

Figure 9 shows the portion of the study area that is probably unsuitable for the installation or use of any type of on-site wastewater disposal system due high water tabes and annual inundation. For these areas to be considered for development the implementation of environmentally acceptable, engineered drainage solutions that will increase the clearance between the natural surface and the highest known groundwater level would be required.

The low microbial purification ability and high permeability of the Bassendean Sands is also a factor that will have to be addressed when determining options of effluent disposal. Solutions to this problem included the use of Alternative Treatment Systems such as ATU's, compositing toilet/greywater systems and septic tanks with amended soils in the disposal field.

Additional restrictions are employed for the onsite disposal of waste water in areas that are in public drinking water source areas (PDWSA's) and capture zones of environmentally significant water bodies (Draft Country Sewerage Policy, Department of Health, 2003). These restrictions do not necessarily prevent development taking pace in certain areas but require appropriate buffers and lot sizes be employed when in defined areas or within close proximity to important wetlands and watercourses. The buffer zones and lot sizes required is dependent on the environmental susceptibility of the wetland or area, the type and location of on-site waste water disposal system and the soil characteristics of the proposed disposal field.

The Water and Rivers Commission has defined three levels of priority classification for the protection of water resources in PDWSAs. These three levels are:

- Priority 1 (P1) source protection areas are defined to ensure that there is no degradation of the water source. P1 areas are declared over land where the provision of the highest quality public drinking water is the prime environmental value. P1 areas would typically include land under Crown ownership. P1 areas are managed in accordance with the principle of risk avoidance.
- Priority 2 (P2) source protection areas are defined to ensure that there is no increased risk of pollution to the water source. P2 areas are declared over land

where low intensity development (such as rural) already exists. Protection of public water supply sources is a high priority in these areas. P2 areas are managed in accordance with the principle of risk minimisation.

- Priority 3 (P3) source protection areas are defined to manage the risk of pollution to the water source. P3 areas are declared over land where water supply sources need to co-exist with other land uses such as residential, commercial and light industrial developments. Protection of P3 areas is achieved through risk management, for example, by developing management guidelines for land use activities. If the water source does become contaminated, then water may need to be treated or an alternative water source found.

2.6.2 Urban Residential Zones

Assessment of land capability for sewered residential developments result in much larger areas of land being assessed with a higher capability class due to the fact that land qualities relating to effluent disposal have much less bearing on site selection (Figure 10). Because developments of this type are an intensive land use, various land use and land development assumptions are highly variable; so it is not possible to generate a standard land capability table as can be done for rural residential developments which are very much controlled by effluent disposal related land qualities.

Because large scale urban developments necessarily have large capital inputs engineering solutions to land capability restrictions can be utilised. As a result, considerations such as the relative land values and proximity to existing infrastructure play a much larger role in the ultimate selection of urban land irrespective of initial land capability (van Gool, Moore and Tille, 2003).

2.7 STRATEGIC MINERAL & BASIC RAW MATERIAL RESOURCE AREAS

The North Boyanup study area contains a significant, unmined titanium mineral resource and three basalt quarries (see Figure 11) of which two are operating. To ensure that the potential utilisation of these essential resources is not compromised by future planning of land uses the Greater Bunbury Region Scheme: Agriculture and Minerals and basic Raw Materials Strategic Resource Areas Policy was formulated and released as part of the Greater Bunbury Region Scheme in August 2000 (WAPC, 2000). Part of the titanium mineral resources are already sterilised by the Gelorup Special Rural development and are not considered further (M.Freeman, GSWA 2004).

The aim of the policy is to ensure that relevant authorities are aware of the existence of the resources, their importance to the economy and that when considering town planning schemes, amendments, subdivisions and development applications, due consideration is given to the need for long term security of access. While protecting the resources from

competing uses, the Policy does not provide any approval for mining, which would be the prerogative of the Mining Act processes and, potentially the Environmental Protection Act.

The Policy places constraints on new developments and land uses within defined areas namely:

i) the Policy Areas and Basalt Extraction Area shown in Figure 11

ii) land adjacent or in close proximity (generally 500 metres or less) to the Policy Areas shown on Figure 11, where the WAPC or the local government is of the opinion that the type or form of the proposed land use or development would potentially be incompatible with or sensitive to mining activities or extraction of basic raw materials within the Policy Areas, or vice versa; and

iii) land within the Basalt Extraction Referral Area (currently under review) shown on Figure 11.

The Policy allows for consideration to be given to approving rezoning, subdivision or development within, adjacent to or in close proximity to the Policy Areas where, following detailed investigations and consultations with the relevant Government Departments, it can be demonstrated that the proposed rezoning, subdivision or development would not prejudice current or future mining of mineral resources or extraction of basic raw materials within the Policy Areas.

The study area is also underlain by a very thick sequence of sediments, the Perth Basin that elsewhere produces gas and oil. The study area is not currently regarded as having a high potential, but there are petroleum exploration permits covering the whole area, and exploration may be proposed in the future. Such activities are regulated by the Petroleum Act.

3. NORTH BOYANUP STUDY AREA ASSESSMENT

3.1 GEOLOGY & GEOMORPHOLOGY

3.1.1 Methodology

To gain a better understanding of the near surface geology of the study area exploration drill logs were obtained from mineral sand companies that had carried out close spaced drilling programs across the study area. Drilling in this area has generally targeted titanium mineral deposits located within fossil shoreline and dunal deposits. Drill samples are typically taken and logged every 0.5 to 3.0 meters and provide a good description of the lithology including colour, grainsize and clay content. The drill logs were plotted as cross sections and examined in detail with various geological units being identified.

3.1.2 Results

The drill data clearly shows well defined lithological changes occurring within the superficial formations that cover the study area. The data illustrated that the geology across the majority of the low lying areas is made up of a surface sandy layer of variable thickness (Bassendean Sand) and then two well defined layers within the underlying Guildford formation – a clay layer (Guildford Formation – Clay Member) and then a sandy layer of similar thickness (Guildford Formation – Sand Member). Underlying the Guildford Formation the Yarragadee, the Bunbury Basalt or the Leederville occur depending on the drill hole location.

3.2 HYDROLOGY

3.2.1 Methodology

To obtain a snapshot of some of the general hydrological characteristics of the North Boyanup area a survey of a subset of the existing bores, wells, windmills and wetlands of the area was carried out in late November, early December 2003. In addition to this work, water level staffs were also installed in nine wetlands.

Due to the variation and nature of some of the sample sites, in addition to time and budgetary constraints field water samples were not collected and analysed to any recognized standard. The aim of the field and sampling program was to obtain data from as many sites as possible to allow for general trends in water quality to be determined across the site. For this reason conclusions based on individual results should not be made without further more detailed work being carried out.

Eighty sites were sampled in the field, with conductivity, pH and depth to water being measured and recorded on site. Conductivity and pH were measured with a calibrated electronic measuring device. Depths were measure with a electronic "dipper" attached to a tape measure. Water samples from seventeen of these sites also had a detailed chemical analysis carried out off site at a NATA registered laboratory. Samples were

analysed for alkalinity, chloride, conductivity, metals, nitrate-N, Nitrite-N, total kjeldahl nitrogen, total nitrogen, filtered reactive phosphorous, total phosphorous, sulphate, total dissolved solids, and total dissolved solids.

To enable a comparison of relative water levels across the study area the surface ground level relative to AHD was measure using DGPS equipment at 48 of the sample sites. The relative levels of the nine water staffs placed in wetlands were also recorded.

3.2.2 Results

The results for all sites are held in Appendix A. This provides details of the sample site type, coordinates and the various results recorded. The distribution of the sample sites across the study area is shown in Figure 12.

3.2.2.1 Groundwater Quality

The salinity (Total Soluble Salts mg/L) of groundwater within the study area is shown in two figures (Figures 13 and 14). Figure 13 shows salinity values for sites that are less than 15m deep and largely represent the water quality of the Superficial aquifer. Figure 14 is for water sampled from deeper sources and represents the water quality of water from within the sandy member of the Guildford Formation, the Yarragadee or Leederville aquifers, depending on the location and depth.

Salinity within the Superficial aquifer ranges form 94 mg/L to 3130 mg/L but is generally between 200 to 700 mg/L which is considered fresh to moderately brackish. The very high values (>1500 mg/L – Brackish (high) to Salty) are all from Wetlands and probably illustrates the effect of salt accumulation due to evaporation. Increases in salinity can be expected where through flow is inadequate to flush out salts concentrated by evaporative processes. This has generally resulted in higher salinities in areas where soil has a higher clay content and lower salinities in sandier lithologies across the study area

Salinity within the deeper (<15m) aquifers ranges from 94 mg/L to 1650 mg/L but largely ranges between about 450mg/L and 900 mg/L which like the Superficial aquifer can be consider to be fresh to moderately brackish.

The pH values recorded for sites taken from sources less than 15m deep shown in Figure 15. Most of the values fall in the range of 5 to 8.5 and can be considered normal. The highest reading of 9.16 west of the Bussell Highway and outside the study area could be associated with limestone within the Spearwood Dunes. The cause of slightly anomalous values (<8.00) at sites sampled in the northwest of the study area is unknown.

The pH of samples from sites greater than 15m deep are shown in Figure 16 and can, except for two anomalous values, be considered normal. The two anomalous samples, both over a pH of 11, would need to be re-sampled before any conclusion can be drawn from the results.

The most notable results obtained from the detailed chemical analysis carried out on 17 samples are shown below:

- Filtered Reactive Phosphorus 0.01 - 0.53mg/L
- Total Nitrogen <0.2 – 15mg/L
- Total Iron 0.01 – >20mg/L

Phosphate results are shown in Figure 17 and are generally low (<0.01). Three locations had elevated phosphate readings, two of which can be considered extreme (>2.0 mg/L).

Total Nitrogen results are shown in Figure 18. A wide variation in values is apparent with about half being elevated above what can be considered good (<0.5 mg/L). One result is extreme (15 mg/L).

It is recommend that, as part of any more detailed hydrological studies in the area, more stringent sampling be carried out at the sites containing the anomalous values obtained during this work.

3.2.2.2 Groundwater Levels

The relative levels of the water table at sample sites less than 15m deep are shown in Figure 19. The values indicate the generally westward to north westward slope of the Superficial water table. More complex localised flow patterns are likely to occur in the Superficial aquifer due to geological and topographical variation.

The relative levels of bores that are deeper that 15m (Figure 20) show a similar west to north-west trend in the groundwater flow and also illustrate the difference in potentiometric head between the two aquifers and a consequent potential for downward leakage of water from the Superficial aquifer in areas where the confining Guildford clay member is absent or weakly developed.

The depth to the superficial groundwater is shown in Figure 21. A large percentage of the sites measured show the ground water level to be within 1.5m of the surface with higher values generally corresponding to topographic highs.

3.3 VEGETATION AND FLORA

Botanical field work was undertaken between 3rd and 14th November 2003.

3.3.1 Methodology

The remnant vegetation in the area was surveyed using the methods stated in the EPA Guidance Statement No 51 (2003b). Where the vegetation had an understorey with remnant native species a 10m x 10m quadrat was set up using a compass and oriented N,S,E,W. Most were temporary with the 4 pegs being removed at the end of the data

collection due to the concern for injury to stock etc. Permanent quadrats were left at three locations with the permission of the owner. Where the understorey had been replaced with weeds the dominant trees or shrubs were noted and will be included in the vegetation maps.

The vegetation, flora and weed surveys were conducted concurrently. For each quadrat, the following was recorded in the field:

- GPS reading (WGS84, equivalent to Geocentric Datum of Australia 1994 (GDA94)) at NW corner.
- Digital photograph taken at the NW corner.
- Soil type.
- Presence, size and type of any outcropping rocks.
- Topography – eg. Ridge, upper slope, middle slope, lower slope, drainage line, minor creek, major creek, wetland.
- Aspect where this is applicable.
- Percentage litter cover divided into bark, leaves, twigs and logs.
- Vegetation condition using the scale in Bush Forever (Department of Environmental Protection, 2000).
- Presence of any Declared Rare or Priority Flora or other significant flora.
- Additional information including dieback, age since fire, predators, erosion, weeds, grazing, tracks etc.
- All species will be listed together with their percentage cover and average height within the quadrat.

The area outside of the quadrat was also surveyed to record additional (opportunistic) species for that vegetation unit. All species unknown in the field were collected, pressed and identified later using appropriate keys and by comparison with collections housed at the Western Australian Herbarium. A collection of each Rare or Priority Flora was made and forms will be completed and sent to the Rare Flora section of the Department of Conservation and Land Management. The pressed and dried specimens will be sent to the Western Australian Herbarium for inclusion in their collection. A list of Rare and Priority Flora had been obtained from the Department of Conservation and Land Management and provided in the report by ATA Environmental (2003).

The locations of the quadrats are shown in Figure 22.

3.3.2 Results

3.3.2.1 Quadrats

10m x 10m quadrats were established in representative areas of the various vegetation units observed in the field. A total of 48 quadrats were recorded. Quadrats were only placed in vegetation where the condition was good or better (see Table 8), except for one listed as NB100. This was a common vegetation unit, which was always observed to be degraded. In this case a quadrat was placed so that the common species could be listed.

Typically this vegetation unit recorded a better condition along the road verge than in the surrounding vegetation but the verge was too narrow to establish a quadrat.

The species associated with each quadrat are recorded in Appendix B and the field data gathered during the survey is provided in Appendix C.

3.3.2.2 Vegetation

The vegetation units recorded during the survey were described using the vegetation layers as given in Table 6. The location of each vegetation unit is shown in Figure 23. As one of the requirements of the original brief was to describe the vegetation associated with each of the vegetation complexes recognised in the area this section will be discussed under each complex.

Due to a large amount of the North Boyanup area being developed, the remnant vegetation remaining is small in size and often isolated from other areas of vegetation. This makes a decision on what the original vegetation in some of these units difficult as the understorey in many has been highly modified.

Table 6: Vegetation Layers - Adapted from: Bush Forever (Department of Environmental Protection, 2000)

Life Form/ Height Class	Canopy Cover			
	100-70%	70-30%	30-10%	10-2%
Trees over 30m	Tall Closed Forest	Tall Open Forest	Tall Woodland	Tall Open Woodland
Trees 10-30m	Closed Forest	Open Forest	Woodland	Open Woodland
Trees under 10m	Low Closed Forest	Low Open Forest	Low Woodland	Low Open Woodland
Tree mallee (8m tall)	Closed Tree Mallee	Tree Mallee	Open Tree Mallee	Very Open Tree Mallee
Shrub mallee (under 8m tall)	Closed Shrub Mallee	Shrub Mallee	Open Shrub Mallee	Very Open Shrub Mallee
Shrubs over 2m	Closed Tall Scrub	Tall Open Scrub	Tall Shrubland	Tall Open Shrubland
Shrubs 1-2m	Closed Heath	Open Heath	Shrubland	Open Shrubland
Shrubs under 1m	Closed Low Heath	Open Low Heath	Low Shrubland	Low Open Shrubland
Grasses	Closed Grassland	Grassland	Open Grassland	Very Open Grassland
Herbs	Closed Herbland	Herbland	Open Herbland	Very Open Herbland
Sedges	Closed Sedgeland	Sedgeland	Open Sedgeland	Very Open Sedgeland

Spearwood Dune System

Yoongarillup Complex

Open Forest of Tuart (*Eucalyptus gomphocephala*) over Low Closed Forest of Peppermint (*Agonis flexuosa* var. *flexuosa*), Narrow leaf Banksia (*Banksia attenuata*), Jarrah (*Eucalyptus marginata* subsp. *marginata*) and Woody pear (*Xylomelum occidentale*) over a Herbland/Sedgeland of Prickly conostylis

(*Conostylis aculeata* subsp. *gracilis*), Sword sedge (*Lepidosperma squamata*), Twine rush (*Loxocarya cinerea*) and *Phlebocarya ciliata* in grey sand.

Quadrat: NB20.

The vegetation condition was very good to good. The area had been logged and a lot of the understorey was sparse, but the Priority 3 species, *Lasiopetalum membranaceum* was recorded. Within the North Boyanup boundary this remnant vegetation was the only area of this Complex where the understorey had not been completely cleared.

Within the boundary of the North Boyanup area, this area indicated on the vegetation map as EgAf. It is an isolated area surrounded by development and at the time of survey had been pegged for subdivision.

Karrakatta Central and South Complex

i High areas

Low Open Forest of Narrow leaf Banksia (*Banksia attenuata*), Marri (*Corymbia calophylla*), Jarrah (*Eucalyptus marginata* subsp. *marginata*) and Woody pear (*Xylomelum occidentale*) over an Open Low Heath dominated by Buttercup (*Hibbertia hypericoides*) in grey sand with buff yellow sand at depth.

Quadrats: NB02, NB06, NB18.

The vegetation condition of NB18 was excellent to very good condition and NB02 and NB06 were good to very good. The understorey in all these quadrats was diverse and worthy of conservation. Most of this vegetation unit within the North Boyanup area has had the understorey replaced with pasture species. At NB06 the Jarrah had been logged previously and several of the Banksias were dying. Dieback was suspected by as the Jarrahs were not affected there could be some other cause eg dry winter.

Where this vegetation unit occurs in slightly lower ground there is also a Tall Open Scrub of Teatree (*Kunzea glabrescens*) above the Open Low Heath dominated by Buttercup (*Hibbertia hypericoides*), adding further to the diversity of this unit.

This vegetation subunit was recorded at quadrat: NB01, NB19. Both these quadrats recorded the vegetation condition as very good although they had been logged many years previously.

This vegetation unit and the subunit are indicated on the vegetation map as BaHh and BaHh2 respectively. This vegetation unit forms a large area at the south east side of the North Boyanup area.

Low Open Forest of Narrow leaf Banksia (*Banksia attenuata*) and Jarrah (*Eucalyptus marginata* subsp. *marginata*) over a Sedgeland dominated by Small flowered mat rush (*Lomandra micrantha*) and Twinerush (*Loxocarya cinerea*) in grey sand.

Quadrat NB05

This vegetation unit is indicated on the vegetation map as BaLm. It was restricted in size but as it was adjacent to the vegetation unit described above, namely a Low Open Forest of Narrow leaf Banksia (*Banksia attenuata*), Marri (*Corymbia calophylla*), Jarrah (*Eucalyptus marginata* subsp. *marginata*) and Woody pear (*Xylomelum occidentale*) over an Open Low Heath dominated by Buttercup (*Hibbertia hypericoides*) it increases considerably the botanical value of the BaHh/BaLm area indicated on the vegetation map.

ii Low areas

Low Closed Forest of Flooded gum (*Eucalyptus rudis* subsp. *cratyantha*), Moonah (*Melaleuca preissiana*), Peppermint (*Agonis flexuosa* var. *flexuosa*) and Swamp banksia (*Banksia littoralis*) over a Tall Open Shrubland of River pea (*Oxylobium lineare*) over Open Sedgeland of Jointed rush (*Baumea articulata*) and Bare twigrush (*Baumea juncea*) in damp to wet grey sand.

Quadrat NB08.

The vegetation condition was very good. This vegetation unit fringed the eastern side of a wetland below the vegetation unit, Low Open Forest of Narrow leaf Banksia (*Banksia attenuata*), Marri (*Corymbia calophylla*), Jarrah (*Eucalyptus marginata* subsp. *marginata*) and Woody pear (*Xylomelum occidentale*) over an Open Low Heath dominated by Buttercup (*Hibbertia hypericoides*).

This vegetation unit was the interzone between the Karakatta and Serpentine River Complexes. It is recorded as ErMp on the vegetation map.

Low Closed Forest of Moonah *Melaleuca rhaphiophylla* over Low Shrubland of Banbar *Melaleuca teretifolia* and Grey honeymyrtle *Melaleuca incana* subsp. *incana* over a Sedgeland dominated by Jointed rush *Baumea articulata* and Rush *Lepyrodia glauca* in dark grey silty loam. Previously inundated.

Quadrat NB04.

Approximately 50% of the area was very good to good and 50% had had the understorey replaced by weeds so the vegetation condition was degraded. The weeds were visible as the water was receeding. This is represented as MrBa on the vegetation map.

Low Woodland of Flooded gum (*Eucalyptus rudis* subsp. *cratyantha*) and Peppermint *Agonis flexuosa* var. *flexuosa* over a Tall Shrubland of Blister bush (*Rhadinothamnus anceps*), River pea *Oxylobium lineare* and Moonah *Melaleuca rhaphiophylla* over an Open Herbland/Sedgeland of Bracken fern (*Pteridium esculentum*) and Square sedge (*Lepidosperma tetraquetrum*) in dark grey silty loam.

Quadrat NB03.

The vegetation condition was good to very good. This is the fringing vegetation of the wetland and is a narrow band along the edge. This vegetation unit was small and included a mixture of wetland and high ground plant species. It is represented as ErRa on the vegetation map.

The vegetation of the Spearwood Dune system was restricted to the western edge, mostly following the higher ground. Where the remnant vegetation remains it varied between good to excellent and this together with the variety of vegetation units recorded makes it important as a conservation area.

Pinjarra Plain

Swan Complex

Open Forest of Flooded gum (*Eucalyptus rudis* subsp. *cratyantha*) and Marri (*Corymbia calophylla*) over a Low Open Forest of Peppermint (*Agonis flexuosa* var. *flexuosa*) over a Herbland/Grassland/Sedgeland of Bridal creeper (Asparagus asparagoides*), Bulbil watsonia (**Watsonia meriana* subsp. *bulbillifera*), *Poa serpentum*, Sword sedge (*Lepidosperma squamatum*) and Finger leaf oxalis (**Oxalis glabra*) in brown loamy clay.**

Quadrat NB47

This quadrat was on the western bank of the Preston River. Due to the large percentage cover of weeds the vegetation condition varied between good and degraded. It is represented on the vegetation map by ErCc. Generally the bank of the Preston River is degraded through weed establishment. Owners of properties that back onto the river should be encouraged to establish native species and to control the weeds along the banks.

Low Closed Forest of Peppermint (*Agonis flexuosa* var. *flexuosa*) over a Herbland dominated by (*Pteridium esculentum*) in grey sand.

Quadrat NB44.

This quadrat was recorded above the western bank of the Preston River where the vegetation condition was good to degraded. It is recorded as AfPe on the vegetation map. There were many weeds established in the bushland although there were tall trees of *Eucalyptus rudis* subsp. *cratyantha* and *Corymbia calophylla* on the river bank. As was found in the vegetation unit above, the area recorded a large cover of weeds in particular, Bridal creeper.

Woodland of Marri (*Corymbia calophylla*) and Jarrah (*Eucalyptus marginata* subsp. *marginata*)over a Low Open Woodland of Narrow leaf banksia (*Banksia attenuata*), Bull banksia (*Banksia grandis*), Holly leaf banksia (*Banksia ilicifolia*) and Woody pear (*Xylomelum occidentale*) over a Herbland dominated by *Phlebocarya ciliata* in grey sand.

Quadrat NB40

This quadrat was in an old school reserve above the western bank of the Preston River. Where the quadrat was recorded the condition was very good but most of the area was completely degraded. It is represented on the vegetation map as CcPc.

Serpentine River Complex

Tall Open Scrub of Banbar (*Melaleuca teretifolia*) and Swamp paperbark (*Melaleuca rhaphiophylla*) over a Herbland dominated by White flowered villarsia (*Villarsia albiflora*) or Milfoil (*Myriophyllum crispata*) in standing water.

Quadrat: NB07, NB10, NB11

The vegetation condition of this unit varied between good to excellent but mostly excellent. This wetland is indicated on the vegetation map as MtVa and was of a reasonable size. The landowner was concerned with its potential to be degraded by an adjoining land owner.

Closed Sedgeland of Jointed twig rush (*Baumea articulata*) and Bulrush (Typha orientalis*) over a Herbland dominated by Milfoil (*Myriophyllum crispata*) in standing water. (BaTo)**

Quadrat NB09

Although there were scattered plants of the introduced species of Bulrush the vegetation unit was in excellent condition.

This vegetation unit was surrounded by MtVa and a whole were is classified as a conservation wetland. It must be conserved.

Southern River Unit

i High areas

Woodland of Jarrah (*Eucalyptus marginata* subsp. *marginata*) and Marri (*Corymbia calophylla*) over Tall Open Scrub dominated by Candle hakea (*Hakea ruscifolia*) and *Melaleuca thymoides* over a Sedgeland dominated by Pineapple bush (*Dasypogon bromeliifolius*) and Semaphore sedge (*Mesomelaena tetragona*) in yellowish grey sand.

Quadrat NB 42 and NB43

The vegetation condition varied between good and very good. Many years previously there had been ring barking and felling of some Jarrahs. This vegetation unit was only recorded from Denton's property. They have destocked the property since they purchased it over 21 years ago. It is identified on the vegetation map as EmHr.

Low Open Forest of Marri (*Corymbia calophylla*) over a Tall Open Shrubland of Kingia (*Kingia australis*) over a Closed Grassland of weeds in brown sandy loam.

Quadrat NB36

This remnant of the above vegetation unit was recorded from one section of Brookdale Road where it was degraded. It is represented in the vegetation map as CcKa. The adjoining paddock still had a few scattered Kingias and Marris but the understorey had been completely replaced by pasture species.

Low Woodland of Marri (*Corymbia calophylla*) and occasional Jarrah (*Eucalyptus marginata* subsp. *marginata*) over an Open Heath of Grasstree (*Xanthorrhoea brunonis*) over an Open Herbland of Pineapple bush (*Dasypogon bromeliifolius*) in pale grey sand.

Quadrat 21

This vegetation unit recorded a vegetation condition of good to very good and was relatively common where recorded. It had been extensively grazed by kangaroos and stock. On the vegetation map it is recorded as CcXb. Previously this vegetation was more extensive as evidenced by the large number of remnant Grasstrees in the adjoining paddocks.

Low Woodland of Moonah (*Melaleuca preissiana*) over a Tall Open Scrub of Titree (*Kunzea glabrescens*) over an Open Sedgeland dominated by Lyginia (*Lyginia imberbis*) or Rope bush (*Hypolaena exsulca*) in grey sand.

Quadrat NB23, NB27

This was the common vegetation unit in the lower sandy areas. The vegetation condition of the quadrats sampled varied between good and very good but large areas of this vegetation unit had already been farmed. It is represented on the vegetation map as MpKg.

ii Low areas

Closed Heath of Astartea (*Astartea scoparia*) over an Open Low Heath of *Leptomeria furtiva* over a Very Open Sedgeland of *Meeboldina tephrina* and Pithy sword sedge (*Lepidosperma longitudinale*) in damp sandy clay.

Quadrat NB33

This vegetation community was only recorded from the one area. In this vegetation unit nearly all the *Astartea scoparia* shrubs were parasitised by *Leptomeria furtiva* a most unusual sight. This bushland was not grazed by stock at the time of the survey. The vegetation condition was very good to excellent. It is represented in the vegetation map as AsLf.

Low Woodland of Moonah (*Melaleuca preissiana*) over a Closed Low Heath of Swamp teatree (*Pericalymma ellipticum*) and Coconut ice (*Hypocalymma angustifolium*) over a Herbland of mixed species in grey sand.

Quadrats NB38 and NB39

This vegetation unit was recorded from 4 different areas, although quadrats were only placed in 2. It is recorded on the vegetation map as MpPe. All areas where it was located were in very good to excellent vegetation condition. Some areas included a herbfield of *Stylidium junceum* at the time of the survey. *Baxteria australis* was recorded from NB39. This is not a significant species but is not commonly recorded.

Low Open Forest of Peppermint (*Agonis flexuosa* var. *flexuosa*) and Moonah (*Melaleuca preissiana*) over a Tall Open Scrub of Teatree (*Kunzea glabrescens*) over a Sedgeland dominated by Pithy sword sedge (*Lepidosperma longitudinale*) in moist grey sandy loam.

Quadrat NB23

This vegetation unit was only located once and the vegetation condition was very good. It was unusual during the survey to locate areas where Pithy sword sedge was dense and is recorded on the map as AfMp.

Low Open Woodland of Swamp paperbark (*Melaleuca rhaphiophylla*) over a Shrubland dominated by Robin red breast bush (*Melaleuca lateritia*) and Grey honey myrtle (*Melaleuca incana* subsp. *incana*) over an Open Herbland of Birds foot trefoil (Lotus subbiflorus*) and Annual ryegrass (**Lolium rigidum*) in moist loam.**

Quadrat NB22

This unit is represented as MrMl on the map and consisted of a wetter area in the centre dominated by *Melaleuca rhaphiophylla*. Most of the species listed occurred on the drier edge, but several were not recorded at other sites during the survey. Where the water had evaporated the ground was covered with weeds.

Low Closed Forest of Swamp paperbark (*Melaleuca rhaphiophylla*) and Flooded gum (*Eucalyptus rudis* subsp. *cratyantha*) over weeds in black humus rich loam.

Quadrat 08, 24

The vegetation condition varied from very good in quadrat NB08 to good for quadrat NB24. The trees at NB24 were whipsticks, all of approximately the same age possible due to a fire or clearing of the land many years previously. It is represented on the map as MrEr.

Woodland of Flooded gum (*Eucalyptus rudis* subsp. *cratyantha*) and/or Peppermint (*Agonis flexuosa* var. *flexuosa*) over Tall Open Scrub dominated by Astartea (*Astartea scoparia*) over bare ground in damp sandy loam. (ErAs)

Quadrat NB26, NB30

Both the quadrats were degraded. NB26 had very few *Agonis flexuosa var. flexuosa*, mostly at seedling stage whereas the species was the dominant tree at NB30. *Eucalyptus rudis* subsp. *cratyantha* was dominant at NB26, not recorded at NB30 but *Astartea scoparia* was the dominant understorey species at both sites. Both areas were very small and only a remnant of their previous distribution.

Open Heath of Banbar (*Melaleuca teretifolia*), Robin red breast bush (*Melaleuca lateritia*) and Astartea (*Astartea scoparia*) over Herbland or Sedgeland of mixed species in damp to wet grey sandy clay.

Quadrats NB31, NB37, NB41

Both NB37 and NB41 recorded a vegetation condition of good to very good although NB37 had been burnt within the last 3 years. NB41 recorded several dead plants but younger ones were growing underneath. Although the shrub layer was dense at NB31 the herb layer had been replaced with weeds. NB31 recorded a vegetation condition of good to degraded. It is represented on the map as MtMl.

Open Sedgeland of Pale rush (*Juncus pallidus*) over weeds in wet loamy clay.

Quadrat NB25

This is degraded and prior to clearing would have had a shrub/tree cover. It is represented on the map as Jp.

Bassendean Central and South and Serpentine River Complex

Woodland of Jarrah (*Eucalyptus marginata* subsp. *marginata*) over a Low Open Forest of Slender banksia (*Banksia attenuata*) and Holly leaf banksia (*Banksia ilicifolia*) over a Shrubland dominated by Dwarf sheoak (*Allocasuarina humilis*), Titree (*Kunzea glabrescens*) and *Melaleuca thymoides* over a Herbland/Sedgeland of mixed species in grey sand.

Quadrats NB34, NB35, NB100

This was the dominant vegetation of the higher ground in this complex throughout the study area. Most of this vegetation unit within the North Boyanup area is degraded or completely degraded. There are only a few remnants remaining. NB34 and NB35 recorded a vegetation condition of excellent, and both locations of NB34 recorded the priority flora, *Franklandia triaristata*. This vegetation unit is recorded on the vegetation map as BaMt.

Bassendean Dune System
Bassendean Central and South Complex

i High areas

Open Forest of Peppermint (*Agonis flexuosa* var. *flexuosa*), Marri (*Corymbia calophylla*) and Jarrah (*Eucalyptus marginata* subsp. *marginata*) over a Herbland/Grassland of Flatweed (Hypochaeris glabra*) and Blowfly grass (**Briza maxima*) in pale grey sand.**

Quadrat NB14, NB29.

The vegetation condition varied between good and degraded as the understory had been nearly or completely replaced bvy weeds. The tree canopy was dense and due to there being limited areas of this vegetation unit it should be considered for retention. It is represented on the map as AfEm.

NB29 was a very degraded site due to cattle grazing, but this has not affected the condition of the tree canopy.

ii Low areas

Low Open Forest of Peppermint (*Agonis flexuosa* var. *flexuosa*), Flooded gum (*Eucalyptus rudis* subsp. *cratyantha*) and Moonah (*Melaleuca preissiana*) over an Open Heath of Astartea (*Astartea scoparia*) and/or Banbar (*Melaleuca teretifolia*) and a Herbland of Waterbuttons (*Cotula coronopifolia*) or Applemint (Mentha* x *suaveolens*) in damp, dark grey silty loam.**

Quadrats NB12, NB15, NB32

This vegetation unit surrounded open water and often several shrubs of *Melaleuca teretifolia* extended into the water. The vegetation condition was very good at NB15, but good to degraded at the other two quadrats. These three sites are wetlands and should be retained. It is represented on the vegetation map as AfMp.

Open Forest of Flooded gum (*Eucalyptus rudis* subsp. *cratyantha*) and Swamp paperbark (*Melaleuca rhaphiophylla*) over Herbland dominated by Waterbuttons (*Cotula coronopifolia*) and Pithy sword sedge (*Lepidosperma longitudinale*) in dark grey silty loam surrounding open water.

Quadrat NB16, NB17

Quadrat NB16 recorded a vegetation condition of very good, but NB17 varied between good and degraded. This is a damp area, inundated in winter and as recorded for NB16 an important breeding area for a species of small frog. It is recorded in the vegetation map as ErMr.

Tall Open Scrub of Banbar (*Melaleuca teretifolia*) over an Open Sedgeland of Common spikerush (*Eleocharis acuta*) and Common nardoo (*Marsilea drummondii*) in damp, previously inundated silty loam.

Quadrat NB13

This was the only location where the above combination of species was located. It recorded a vegetation condition of good due to the weed cover, but the presence of *Marsilea drummondii* was unique and the area should be conserved. At present cattle graze the area. It is recorded as MtEa on the vegetation map.

Guildford Complex

The vegetation of this complex has been completely cleared in the North Boyanup area. No quadrats were placed in this complex.

3.3.2.3 Vegetation Condition

As most of the North Boyanup area has been developed, especially the lower lying land, its vegetation condition is completely degraded (condition 6). In other areas the upper storey was in reasonable condition but the understorey had been completely or nearly completed replaced with pasture species – parkland cleared. This parkland cleared condition was recorded as degraded (condition 5). The system used for vegetation condition ratings is shown in Table 8.

Most of the remnant vegetation had been grazed previously so the best vegetation condition that could be applied to any of the quadrats and vegetation units described was excellent, condition 2. The vegetation condition of the area is shown in Figure 24.

Table 7: Explanation of Vegetation Condition Rating (Department of Environmental Protection, 2000)

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

The Environmental Protection Authority (2002) it is stated that the size and shape of remnants is important for maintaining ecological processes. Size is of key importance as generally the capacity of an area to support a full range of species diminishes with decreasing size. The shape determines the ratio of perimeter to area, being greater in elongated remnants. Elongated remnants may be important for corridors but they will be more susceptible to weed invasion and disturbance. Those remnants in largely undisturbed condition are preferred (vegetation condition 1-2); those where the basic

structure is intact are the next best (vegetation condition 3-4), but where there is no other choice then those in degraded condition (vegetation condition 5-6) should be considered.

In the North Boyanup area the vegetation in better condition occurred where the area of remnant vegetation is of a reasonable size, in particular the area of remnant vegetation from SW to NE in the Bassendean and Southern River Vegetation complex, the southern section of the Karrakatta Central and South Complex and most of the Serpentine complex. These areas should be considered for conservation for several reasons:

- Size – continuous blocks;
- Vegetation condition – varying between vegetation condition 2-4, with some areas of vegetation condition 5;
- Variety of vegetation units.

3.3.2.4 Floristic Community Type

The FCT of each structural unit was inferred from a desktop comparison of the survey data to Gibson et al. (1994), in particular Table 12 in this publication. This is a 2-way table where the species that occur with a frequency of at least 50% are recorded for each FCT.

FCT3a – *Corymbia calophylla – Kingia australis* woodlands on heavy soil was potentially recorded from one area where the vegetation unit was degraded. The species associated with this FCT are:

- trees – *Corymbia calophylla, Eucalyptus marginata* subsp. *marginata*
- shrubs – *Acacia willdenowiana, Baeckea camphorosmae, Bossiaea eriocarpa, Dryandra nivea, Gompholobium marginatum, Hibbertia hypericoides, Kennedia prostrata, Philotheca spicatus, Pronaya fraseri, Xanthorrhoea peissii*
- herbs: **Aira caryophyllea, Anigozanthos manglesii, *Briza maxima, *Briza minor, Burchardia umbellata, Caesia micrantha, Caladenia flava, Chamaescilla corymbosa, Conostylis juncea, Cyathochaeta avenacea, Desmocladus fascicularis, Drosera erythrorhiza, Drosera stolonifera, Haemodorum laxum, Homalosciadium homalocarpum, Hypolaena exsulca, *Hypochaeris glabra, Lagenophora huegelii, Lepidosperma angustatum, Lomandra hermaphrodita, Mesomelaena tetragona, Sowerbaea laxiflora, Stylidium piliferum, Tetraria octandra, Thysanotus thrysoideus, Xanthosia huegelii*

A large number of the drier wetlands or the fringe of deeper wetlands were representative of FCT4 – *Melaleuca preissiana* damplands. The typical species associated with this FCT are

- trees - *Melaleuca preissiana*
- shrubs - *Hypocalymma angustifolium, Pericalymma ellipticum, Xanthorrhoea preissii, Adenanthos obovatus, Astartea affin. fascicularis*; and

- herbs - **Briza maxima, Dampiera linearis, Dasypogon bromeliifolius, *Hypochaeris glabra, Hypolaena exsulca, Lyginia barbata, Phlebocarya ciliata, Schoenus rodwayanus, Stylidium brunonianum, Stylidium repens, Xanthosia huegelii*

FCT11 – Wet forests and woodlands was also recorded during the survey. The typical species associated with this FCT are:

- trees – *Eucalyptus rudis*
- shrubs – *Astartea affin. fascicularis*; and
- herbs - **Briza maxima, *Hypochaeris glabra, Lepidosperma longitudinale.*

A common FCT associated with many of the EPP wetlands is FCT12 – *Melaleuca teretifolia* and/or *Astartea* affin. *fascicularis* shrublands. The typical species associated with this FCT are:

- shrubs – *Astartea affin. fascicularis. Epilobium billardierianum, Melaleuca teretifolia, Oxylolium lineare;* and
- herbs - **Aira caryophyllea, Baumea articulata, Cassytha racemosa, Lepidosperma longitudinale, *Parentucellia viscosa, Siloxerus humifusus, Villarsia latifolia, Waitzia citrina.*

Some of the EPP wetlands were FCT13 – Deeper wetlands on heavy soils. The typical species associated with this FCT are:

- shrubs – *Hakea varia, Melaleuca lateritia, Melaleuca rhaphiophylla;* and
- herbs – *Cassytha racemosa, Triglochin huegelii.*

The Spearwood Dune higher ground vegetation was representative of FCT21a – Central *Banksia attenuata – Eucalyptus marginata* woodlands. The number of characteristic species is relatively high compared to other FCT. The typical species associated with this FCT are:

- trees - *Banksia attenuata, Eucalyptus marginata*
- shrubs – *Bossiaea eriocarpa, Conostephium pendulum, Gompholobium tomentosum, Hibbertia hypericoides, Macrozamia riedlei, Petrophile linearis, Philotheca spicatus*; and
- herbs – *Austrodanthonia occidentalis, *Briza maxima, Burchardia umbellata, Caladenia flava, Chamaescilla corymbosa, Conostylis aculeata, Conostylis juncea, Dasypogon bromeliifolius, Drosera erythrorhiza, Drosera stolonifera, *Hypochaerisglabra, Lagenophora huegelii, Lepidopserma angustatum, Lomandra caespitosa, Lomandra hermaphrodita, Lomandra sericea, Loxocarya flexuosa,*

*Lyginia barbata, Patersonia occidentalis, Phlebocarya ciliata, Trachymene pilosa, *Ursinia anthemoides, Xanthosia huegelii.*

The one area not devoid of the understorey in the Yoongarillup Vegetation Complex was representative of FCT25 – Southern *Eucalyptus gomphocephala – Agonis flexuosa* woodlands. The typical species associated with this FCT are:

- trees – *Agonis flexuosa, Eucalyptus gomphocephala*
- shrubs – *Acacia willdenowiana, Hardenbergia comptoniana, Hibbertia hypericoides, Leucopogon propinquus, Phyllanthus calycinus*
- herbs - **Aira caryophyllea, Austrostipa flavescens, *Briza maxima, *Briza minor, *Bromus diandrus, Caladenia flava, Caladenia latifolia. Conostylis aculeata, Daucus glochidiatus, Dichopogon capillipes, Drosera erythrorhiza, Geranium retrorsum, *Hypochaeris glabra, Lagenophora huegelii, Lepidopserma angustifolium Lomandra caespitosa, Microlaena stipoides, *Orobanche minor, Oxalis perennans, *Petrorhagia velutina, *Sonchus oleraceus, Sowerbaea laxiflora, Trachymene pilosa, Trifolium campestr.*

Table 8: Vegetation Units inferred for each Floristic Community Type

FCT	Vegetation Unit
3a	CcKa
4	ErMp, MpPe, AfMp, MtEa
11	ErRa, ErAs, ErCc
12	MtVa, AsLf, ErMr, Jp, MtMl, MtEa
13	MrMi, BaTo
21a	BaHh, BaLm, EmHr, BiDb, BaMt, AgBm, CcPc, AfPc, AfPe, AfEm
25	EgAf

3.3.2.5 Threatened Ecological Communities

Ecological communities are defined as naturally occurring biological assemblages that occur in a particular type of habitat (Department of Environmental Protection, 2000). English and Blythe (1997) have developed a procedure for identifying assigning TEC's to one of four categories depending upon the threat to the community (Table 9).

Table 9: Conservation categories for TEC recognised by CALM and the Minister of the Environment (English and Blythe, 1997)

CODE	DEFINITION
Presumed Totally Destroyed	An ecological community which has been adequately searched for but for which no representative occurrences have been located. The community has been found to be totally destroyed or so extensively modified throughout its range that no occurrences of it are likely to recover its species composition and/or structure in the foreseeable future.
Critically Endangered	An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or that was originally of limited distribution and is facing severe modification or destruction throughout its range but capable of being substantially restored or rehabilitated.
Endangered	An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or was originally of limited distribution and is in danger of significant modification throughout its range or severe modification or destruction over most of its range in the near future.
Vulnerable	An ecological community that has been adequately surveyed and is found to be declining and/or has declined in distribution and/or condition and whose ultimate security has not yet been assured and/or a community that is still widespread but is believed likely to move into a category of higher threat in the near future if threatening processes continue or begin operating throughout its range.

Commonwealth legislation also protects vegetation communities with the Environmental Protection and Biodiversity Conservation (EPBC) Act, 1999 (Environment Australia (2001). Under this Act a person must not take an action that is likely to have a significant impact on a listed threatened ecological community without approval from the Minister for the Environment and Heritage. The definitions of these categories of TEC are listed in Table 10.

Table 10: Conservation Categories for Threatened Ecological Communities under the EPBC Act, 1999

CODE	DEFINITION
Critically Endangered	A community can be included in the Critically Endangered category if, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future.
Endangered	A community can be included in the Endangered category if, at that time, it is not critically endangered and is facing a very high risk of extinction in the wild in the near future.
Vulnerable	A community can be included in the Vulnerable category if, at that time, it is not critically endangered or endangered, and is facing a high risk of extinction in the wild in the medium-term future.

A search of the CALM database recorded no TEC for the North Boyanup area. Potential Threatened Ecological Communities (TEC) that may occur within the Boyanup North area were identified as FCT2 – Southern wet shrublands; FCT10a – Shrubland on dry clay flats and FCT 15 – Forests and woodlands on deep seasonal wetlands (V. English pers. comm.). ATA Environment Australia (2003) listed a TEC recorded from the Preston River (FCT9) and a potential one that they observed during their brief overview, FCT3a.

A small area along the verge of Brookdale Road may be representative of *FCT3a – Corymbia calophylla – Kingia australis* woodlands on heavy soil. The vegetation on the verge was in good condition whereas the paddock was completely degraded. The verge is most likely a remnant of this FCT but it would have been much more extensive previously before becoming a paddock for stock which have succeeded in removing all the native understorey species. This TEC is listed as Critically Endangered by CALM and Endangered under the EPBC Act (1999). Although the vegetation is degraded the area where quadrat NB36 was recorded should be conserved.

None of the other FCT's listed in 4.2 are considered to be Threatened Ecological Communities by CALM or the EPBC Act (1999).

3.3.2.6 Flora

A total of 78 vascular plant families, 241 genera and 397 taxa were recorded during the survey. 83 of the taxa were weeds not surprising as most of the North Boyanup area is pasture. Table 11 summarises the dominant plant families recorded during the survey. Appendix B lists all the taxa recorded during the survey.

Table 11: Dominant vascular plant families recorded during the survey

FAMILY	No. GENERA	No. NATIVES	No. WEEDS	TOTAL TAXA
POACEAE	25	14	24	38
PAPILIONACEAE	22	26	11	37
ASTERACEAE	23	18	9	27
CYPERACEAE	10	24	3	27
MYRTACEAE	13	26	0	26
PROTEACEAE	10	17	0	17
ORCHIDACEAE	9	14	1	15
DASYPOGONACEAE	5	12	0	12
ANTHERICACEAE	8	12	0	12
TOTAL	**124**	**162**	**48**	**210**

These 9 families shown in Table 11 represent 11.5% of the vascular plant families, 51.5% of genera, 53% of taxa and 58.5% of the weeds recorded during the survey. 47.2% of the weed taxa recorded from the site are common pasture species in the Poaceae (grass family) and Papilionaceae (pea family).

3.3.2.7 Significant Flora

Species of flora are defined as rare or priority conservation status where their populations are restricted geographically or threatened by local processes. The Department of Conservation and Land Management recognised these threats of extinction and consequently applied regulations towards population and species protection. Rare Flora are gazetted under subsection 2 of section 23F of the Wildlife Conservation Act (1950) and therefore it is an offence to "take" or damage rare flora without approval from the Minister for the Environment.

Table 12: Code and description of Rare and Priority Flora categories

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

Table 12 presents the definitions of Declared Rare and the four Priority Flora ratings under the Wildlife Conservation Act (1950) as extracted from Department of Conservation and Land Management (2003). Table 13 presents the definitions of the threatened species under the EPBC Act, 1999.

Table 13: Categories of Threatened Flora Species (Environmental Protection and Biodiversity Conservation Act, 1999)

Code	Code Declared Rare and Priority Flora Categories
Ex	Extinct Taxa which at a particular time if, at that time, there is no reasonable doubt that the last member of this species has died.
ExW	Extinct in the Wild Taxa which is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; or it has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
CE	Critically Endangered Taxa which at any particular time if, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
E	Endangered Taxa which is not critically endangered and it is facing a very high risk of extinction in the wild in the immediate or near future, as determined in accordance with the prescribed criteria.
V	Vulnerable Taxa which is not critically endangered or endangered and is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
CD	Conservation Dependent Taxa which at a particular time if, at that time, the species is the focus of a specific conservation program, the cessation of which would result in the species becoming vulnerable, endangered or critically endangered within a period of 5 years.

Information obtained from CALM

The search undertaken by ATA Environmental (2003) of the Department of Conservation and Land Management (DCLM) rare flora database resulted in a list of nine Priority floras from within or in close proximity to the study area. One, *Acacia semitrullata*, was a Priority 3 flora and the remaining 8, *Acacia flagelliformis, Aponogeton hexatepalus, Caladenia longicauda* subsp. *clivicola, Caladenia speciosa, Drosera marchantii* subsp. *marchantii, Franklandia triaristata, Pultenaea skinneri* and *Villarsia submersa* were Priority 4 flora. The code and description is provided in Tables 14 and 15. Several of the above were recorded from the Franklandia Bushland Reserve, managed by a local friends group. No Declared Rare Flora (DRF) were recorded by CALM from the study area or from the immediate surrounding area.

The list obtained from the Department of Conservation and Land Management included 2 orchid species, *Caladenia longicauda* susbp. *clivicola* and *Caladenia speciosa* and a sundew, *Drosera marchantii* subsp. *marchantii* all of which, if present, would have completed flowering and the plants would have died down. One plant of *Caladenia speciosa* was tentatively identified at quadrat NB32. To determine the presence of these species a spring survey would need to be undertaken.

Two species were recorded from the wetlands, *Aponogeton hexatepalus* and *Villarsia submersa*, neither of which were recorded during this survey. Several other *Villarsia* species were recorded but not the priority species. The other species were shrubs and *Acacia flagelliformis, Acacia semitrullata* and *Franklandia triaristata* were recorded during the current survey. *Pultenaea skinneri* a plant associated with damp ground was not recorded during the survey. Where species had been recorded these areas were specifically searched during the current survey but most were not relocated. Some of the areas where the plants had been recorded were now degraded with cattle grazing the area. The collection may have been made before the area was as cleared as today.

Recorded during survey

During the field survey one Declared Rare Flora and eight additional priority flora were recorded. These are listed in Table 14. The locations of these species recorded during the current survey are listed in Appendix D and these, together with the locations recorded by CALM are shown in Figure 25.

Table 14: Declared Rare and Priority Flora recorded during survey

SPECIES
Declared Rare Flora
Caladenia huegelii
Priority 1
Boronia humifusa
Priority 2
Leptomeria furtiva
Mitreola minima
Schoenus loliaceus
Priority 3
Acacia semitrullata
Lasiopetalum membranaceum
Stylidium longitubum
Priority 4
Acacia flagelliformis
Eucalyptus rudis subsp. cratyantha
Franklandia triaristata
Jacksonia sparsa

One Declared Rare Flora, *Caladenia huegelii* was recorded from the quadrat NB08. This is listed as Endangered under the EPBC Act, 1999. As the current survey was undertaken at the end of spring and this was the only flower that could be positively identified it is recommended that an additional spring survey be undertaken in the same or similar vegetation unit to determine if more plants of these DRF species are present. To be able to undertake any clearing within this area written permission must be obtained from the Minister for the Environment.

Many of these species were unknown to be priority flora until the pressed plants were identified and compared with specimens at the Western Australian Herbarium. As a result no photographs were taken. A description of these plants, extracted from FloraBase (Western Australian Herbarium, 2004) is provided in Table 15.

Table 15: Priority Flora recorded from the North Boyanup study area CALM database and current survey.

Priority Flora	Category	Description
Caladenia huegelii	DRF	Tuberous, perennial, herb, 0.25–0.6 m high. Fl. green, cream, red, Sep–Oct. Grey or brown sand, clay loam.
Boronia humifusa	Priority 1	Low-growing, wiry perennial, herb, 0.1–0.2 m high. Fl. pink, red, Jun-Sep. Gravelly clay loam over laterite. Jarrah-Marri open forest.
Leptomeria furtiva	Priority 2	Lax, sprawling shrub, 0.2–0.45 m high. Fl. orange, brown, Aug–Oct. Grey or black peaty sand. Winter-wet flats
Mitreola minima	Priority 2	Slender, erect annual, herb, 0.025–0.04 m high. Fl. white, Oct–Dec. Grey sand. Peaty swampy areas.
Schoenus loliaceus	Priority 2	Annual, grass-like or herb (sedge), 0.03–0.06 m high. Fl. Aug–Nov. Sandy soils. Winter-wet depressions.
Acacia semitrullata	Priority 3	Slender, erect, pungent shrub, (0.1–)0.2–0.7(–1.5) m high. Fl. cream, white, May–Oct. White-/grey sand, sometimes over laterite, clay. Sandplains, swampy areas.
Lasiopetalum membranaceum	Priority 3	Multi-stemmed shrub, 0.2–1 m high. Fl. pink, blue, purple, Sep–Dec. Sand over limestone.
Stylidium longitubum	Priority 3	Erect annual (ephemeral), herb, 0.05–0.12 m high. Fl. pink, Oct–Dec. Sandy clay, clay. Seasonal wetlands.
Acacia flagelliformis	Priority 4	Rush-like, erect or sprawling shrub, 0.3–0.75(–1.6) m high. Fl. yellow, May–Sep. Sandy soils. Winter-wet areas.
Aponogeton hexatepalus	Priority 4	Rhizomatous or cormous, aquatic perennial, herb, leaves floating. Fl. green, white, Jul–Oct. Mud. Freshwater: ponds, rivers, claypans.
Caladenia longicauda subsp. clivicola	Priority 4	Tuberous, perennial, herb, 0.3–0.5 m high. Fl. white, green, yellow, Sep–Oct. Clayey loam, gravel, sand. Granite outcrops.
Caladenia speciosa	Priority 4	Tuberous, perennial, herb, 0.35–0.6 m high. Fl. white, pink, Sep–Oct. White, grey or black sand.
Drosera marchantii subsp. marchantii	Priority 4	Erect tuberous, perennial, herb, 0.1–0.4 m high. Fl. pink, Aug–Oct. Lateritic soils. Damp, swampy areas.
Eucalyptus rudis subsp. cratyantha	Priority 4	Tree, 5–20 m high, bark rough, box-type. Fl. white, Jul–Sep. Loam. Flats, hillsides.
Franklandia triaristata	Priority 4	Erect, lignotuberous shrub, 0.2–1 m high. Fl. white, cream, yellow , brown, purple, Aug–Oct. White or grey sand.
Jacksonia sparsa	Priority 4	Erect & slender shrub, 1–3 m high. Fl. yellow, orange, red, Sep–Feb. White or grey sand.
Pultenaea skinneri	Priority 4	Slender shrub, 1–2 m high. Fl. yellow, orange, red, Jul–Sep. Sandy or clayey soils. Winter-wet depressions.
Villarsia submersa	Priority 4	Aquatic, extremely slender perennial, herb. Fl. white, Aug–Nov. In freshwater 0.05–0.6 m deep. Pools, lakes, swamps, winter-wet depressions, claypans.

Aponogeton hexatepalus was not located yet all wetlands with standing water were searched in an attempt to locate this species. The areas nominated in the Rare Flora database for its occurrence were specifically searched but according to Kim Williams (pers. comm.) this species can vary from one year to the next in its occurrence. It is possible that future searches may record this plant. Similarly, damp areas were also searched for *Villarsia submersa* but without success.

Leptomeria furtiva was an interesting species. It was only recorded from one site, but where it occurred nearly every *Astartea scoparia* plant was parasitised by it. It is illustrated in Appendix E under quadrat NB 33.

Eucalyptus rudis subsp. *cratyantha*. All the trees of this species recorded from the area are included in this subspecies. The buds and fruits are larger in this subspecies than in the typical subspecies, but the trees look alike.

Schoenus loliaceus was only recorded from one wetland but was distinctly different from other *Schoenus* species located during the survey. The long, filiform leaves greatly exceeded the inflorescence and although the plant is small in stature it was an obvious character.

Although not a priority flora, *Marsilea drummondii* plants formed a dense herbland at NB13, Carlingup Swamp. This is the most southern and western distribution of this species recorded by the Western Australian Herbarium. It is recommended that this area be fenced to exclude the cattle, which currently graze the area.

3.3.2.8 Weeds

A total of 82 weeds (as calssified by CALM (1999) were recorded from the site (Table 16). The rating allocated to each weed by CALM is based on three criteria:

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

Ratings indicate the following.

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

Table 16: Weeds recorded during the survey classified according to CALM (1999)

SCIENTIFIC NAME	COMMON NAME	CALM RATING	INVASIVENESS	IMPACTS
**Asparagus asparagoides*	Bridal creeper	High	✓	✓
**Bromus diandrus*	Great brome	High	✓	✓
**Cortaderia selloana*	Pampas grass	High	✓	✓
**Ehrharta calycina*	Perennial veldt grass	High	✓	✓
**Eragrostis curvula*	African love grass	High	✓	✓
**Lagurus ovatus*	Hare's tail grass	High	✓	✓
**Lupinus cosentinii*	Western Australian blue lupin	High	✓	✓
**Moraea flaccida*	Cape tulip	High	✓	✓
**Romulea rosea*	Guildford grass	High	✓	✓
**Typha orientalis*	Bulrush	High	✓	✓
**Watsonia meriana* var. *bulbillifera*	Bulbil watsonia	High	✓	✓
**Zantedeschia aethiopica*	Arum lily	High	✓	✓
**Aira caryophyllea*	Silvery hairgrass	Moderate	✓	
**Anagallis arvensis* var. *caerulea*	Pimpernel	Moderate	✓	
**Anthoxanthum odoratum*	Sweet vernal grass	Moderate	✓	
**Arctotheca calendula*	Cape weed	Moderate	✓	
**Avena barbata*	Bearded oats	Moderate	✓	
**Briza maxima*	Blowfly grass	Moderate	✓	
**Briza minor*	Shivery grass	Moderate	✓	
**Callitriche stagnalis*	Common starwort	Moderate	✓	
**Carduus pycnocephalus*	Slender thistle	Moderate	✓	
**Carex divisa*	Divided sedge	Moderate	✓	
**Crassula natans* var. *minus*		Moderate	✓	
**Cynodon dactylon*	Couch	Moderate	✓	
**Cyperus tenellus*	Tiny flat sedge	Moderate	✓	
**Disa bracteata*	South African orchid	Moderate	✓	
**Ehrharta longiflora*	Annual veldt grass	Moderate	✓	
**Galium murale*	Bedstraw	Moderate	✓	
**Glyceria declinata*	Reed sweet grass	Moderate	✓	
**Gomphocarpus fruticosus*	Swan plant	Moderate	✓	
**Holcus lanatus*	Yorkshire fog	Moderate	✓	
**Hordeum leporinum*	Barley grass	Moderate	✓	
**Hypochaeris glabra*	Flat weed	Moderate	✓	
**Isolepis prolifera*	Budding club rush	Moderate	✓	
**Ixiolaena viscosa*		Moderate	✓	
**Juncus bufonius*	Toad rush	Moderate	✓	
**Lolium rigidum*	Annual ryegrass	Moderate	✓	
**Lythrum hyssopifolia*	Lesser loosestrife	Moderate	✓	
**Orobanche minor*	Lesser broomrape	Moderate	✓	
**Pennisetum clandestinum*	Kikuyu	Moderate	✓	
**Phalaris minor*	Lesser canary grass	Moderate	✓	
**Pinus radiata*	Radiata pine	Moderate	✓	
**Polypogon monspeliensis*	Annual barbgrass	Moderate	✓	
**Pseudognaphalium luteoalbum*	Jersey cudweed	Moderate	✓	
**Solanum nigrum*	Nightshade	Moderate	✓	
**Sonchus oleraceus*	Sow thistle	Moderate	✓	
**Trifolium campestre* var. *campestre*	Hop clover	Moderate	✓	
**Trifolium glomeratum*	Cluster clover	Moderate	✓	

**Trifolium subterraneum*	Subterranean Clover	Moderate	✓	
**Ursinia anthemoides*	Ursinia	Moderate	✓	
**Vicia sativa* subsp. *nigra*	Common vetch	Moderate	✓	
**Vulpia bromoides*	Squirrel's tail fescue	Moderate	✓	
**Wahlenbergia capensis*	Cape bluebell	Moderate	✓	
**Chamaecytisus palmensis*	Tagastaste	Mild		
**Juncus caespiticius*		Mild		
**Juncus microcephalus*		Mild		
**Ornithopus compressus*	Yellow seradella	Mild		
**Oxalis glabra*	Finger leaf sorrel	Mild		
**Oxalis pes-caprae*	Soursob	Mild		
**Petrorhagia dubia*	Velvet pink	Mild		
**Phytolacca octandra*	Inkweed	Mild		
**Poa annua*	Winter grass	Mild		
**Rumex crispus*	Curled dock	Mild		
**Acetosella vulgaris*	Sheep sorrel	Low		
**Aira praecox*	Early hairgrass	Low		
**Chenopodium glaucum*	Oak leaf goosefoot	Low		
**Conyza albida*	Tall fleabane	Low		
**Conyza bonariensis*	Flaxleaf fleabane	Low		
**Cynosurus echinatus*	Rough dog's tail	Low		
**Hedera helix*	Ivy	Low		
**Lolium perenne*	Perennial ryegrass	Low		
**Lotus subbiflorus*	Slender birdsfoot	Low		
**Mentha* x *piperita*	Eau de Cologne mint	Low		
**Nothoscordum gracile*	False onion weed	Low		
**Ornithopus pinnatus*	Slender seradella	Low		
**Oxalis purpurea*	Four o'clock	Low		
**Phalaris angusta*	Canary grass	Low		
**Ranunculus muricatus*	Sharp buttercup	Low		
**Salix babylonica*	Willow	Low		
**Spergula arvensis*	Corn spurrey	Low		
**Trifolium hirtum*	Rose clover	Low		
**Trifolium hybridum* var. *hybridum*		Low		

(✓if applicable)

Twelve of the weeds are rated as High and are therefore the species that should be targeted for removal. Three species, Bridal creeper, Pampas grass and Arum lily were not common in the area and should be removed. CSIRO has released a rust, which is controlling Bridal creeper, and the possibility of obtaining some of these spores should be pursued. The largest outbreak of Bridal creeper was along the banks of the Preston River. Another weed, Cape tulip was confined to one of the wetlands surveyed where the farmer is attempting to control it on his property.

3.4 WETLANDS

3.4.1 Methodology

Each of the wetlands where there was remnant native vegetation present was surveyed. Many of the vegetation units at the wetlands were too small to establish 10m x 10m quadrats so relevees recorded the vegetation units present. Where the vegetation was

of a large enough dimension a 10m x 10m quadrat was established and the results are included in the quadrat data. The dominant species of each stratum within the different vegetation units was recorded, together with the presence of standing water. As the field work was undertaken each wetland or section of wetland was allocated a letter and the different vegetation units present within this recorded. The locations of the wetlands are shown in Figure 22.

The wetlands were described using the classification system developed by Semenuik (1987), an overview of which was provided in Table 2.

A requirement of this survey was that the wetlands were to be evaluated using the questionnaire in Environmental Protection Authority (1993). A level of significance and therefore the appropriate management category are assigned on the above evaluation.

3.4.2 Results

3.4.2.1 Wetland Types in the area

Two areas of palusplain were recorded during the survey but most of the wetlands were sumplands or floodplains (see Table 17). Many of the sumplands were surrounded by an area of floodplain, which varied considerably between the wetlands dependent predominantly on the area that was already cleared and under pasture. Although the pasture area was a floodplain it was devoid of natural vegetation and not of conservation value.

Table 17: Wetland types recorded during the survey

Wetland type	Wetland Identifier
Palusplain	II, JJ, KK,
Damplands	B, O2, V, X, BB, LL
Floodplain	A, E, G, H, L, N, O2, P, R, S, T, W, FF
Sumpland	A, C, D, F, I, J, K, L, M, N, O1, O3, P, Q, R, S, T, U, Y, Z, AA, CC, DD, EE, GG, HH

The results show that the three areas of palusplain identified during this survey are not common in the North Boyanup area and as a result should be considered for conservation. One of these is a small area at the western end of the Franklandia Reserve, but the other two areas were on private property. In addition these are all in very good to excellent condition.

3.4.2.2 Wetland Classification

Quadrats were established at several of the wetlands but where this did not occur each wetland was assigned a letter as it was surveyed and the vegetation described. This information is provided in Appendix F. The classification assigned to each wetland by the Water and Rivers Commission is provided below. Each wetland was assessed using the classification provided in Bulletin 686 (Environmental Protection Authority, 1993) and the results obtained for each wetland are provided in Table 18 and shown in Figure 26. Many

of the wetlands in the area are listed as Environmental Protection Policy (EPP) wetlands as they include standing water for a period.

EPP wetlands are those that have standing water in them. This need not be permanent but temporary during the winter months. These are protected from unauthorised filling, mining, effluent disposal and drainage.

Table 18: Management Category of wetlands using Water and Rivers (2001) classification

WETLAND	Classification				WETLAND	Classification			
	WRC		Survey			WRC		Survey	
	Cat+	EPP	Cat+	EPP		Cat+	EPP	Cat+	EPP
A	M	✓	R	✓	T	R	✓	C	✓
B	M	✓	M		U	M		R	✓
C	M	✓	R	✓	V	M		R	✓
D	M	✓	R	✓	W	M		M	✓
E	M	✓	M	✓	X	M		M	✓
F	M		R	✓	Y	C		R	✓
G	M	✓	M		Z	M		M	✓
H	M		M		AA	C	✓	M	✓
I	M		M	✓	BB	R/M	✓	M	
J	M		M	✓	CC	M		R	✓
K	C		C	✓	DD	R		R	✓
L	R	✓	M	✓	EE	C	✓	C	✓
M	R		R	✓	FF	C		M	
N	R	✓	C	✓	GG	M		M	✓
O	M	✓	R-M	✓	HH	M		R	✓
P	R	✓	M	✓	II	Not Asses s-ed		C	
Q	M		M	✓	JJ			C	
R	M		M	✓	KK			R	
S	S	✓	C	✓	LL	C		C	

Cat+ = Management Category see Table 3

Some of the wetlands classified as EPP by Waters and Rivers (see Appendix H) were not assessed during this survey as they were degraded with little or no native vegetation. In most instances the EPP wetlands as mapped by the Department of the Environment (Appendix H) were found to be the case but the vegetation surrounding many of the wetlands was degraded and in some cattle wandered through. With cattle exclusion some of the wetlands could recover to a condition vaguely representative of the original. Some owners had fenced the wetlands to keep stock out, occasionally with an electric fence and others had destocked their property. Typically those land owners who had wetlands in good or better condition were proud of them and very interested to be provided information on how to manage and improve the condition.

The Preston River was not included in this survey. There were a few areas of remnant vegetation beside the river that were included but not the river bed or steep banks.

The Department of the Environment at Bunbury provided information on the potential areas for the acid sulphate soils in the study area. All the wetlands in the area, including several that were not assessed as they were too degraded, have a high risk of acid

sulphate soils. The areas of acid sulphate soils, the original categories and those determined as a result of the field work are mapped in Appendix H.

Comments on Classification

Some of the wetlands in the field appeared to be worthy of conservation status but when they were scored according to EPA Bulletin (1993) they were often classified as Resource enhancement or Multiple use. The score sheets are provided in Appendix H.

The following were some of the comments on the scoring sheets:

- One wetland, Wetland LL recorded *Caladenia huegelii* a Declared Rare Flora so this wetland automatically becomes conservation category. The EPA classification is High conservation.
- As none of the individual wetlands are large in size they all received a low score for the Area of Wetland.
- Those wetlands that were classified as Conservation or Resource enhancement had several habitat types and therefore received a high score in this section.
- The emergent vegetation varied considerably with all the wetlands. Wetlands with 40-60% of emergent vegetation scored higher than those with little emergent vegetation.
- No adverse water quality was observed as all wetlands appeared healthy.
- Drainage at many of the wetlands was not a major issue for the area as there were only a few that were drained.
- Adjacent nutrient sources for all wetlands was the proximity to grazing land.
- Modification of the wetland. This was a common problem as most of the wetlands were being used as a water source for stock. There was the occasional damming of wetlands for stock water.
- As mentioned above the size of the wetlands were all relatively small. Where there are large buffer zones around the wetland proper they are less likely to be degraded than where the buffer zone is small. This was already apparent at some of the smaller wetlands where the area was already degraded with many weed species established.
- The Human Use section of the questionnaire for all of the wetlands scored very low. All are on private property and therefore only utilised by the owners and their families. If they became conservation areas open to the public some of the wetlands do have the potential to be used for several activities.
- Many of the original wetlands in the area are now under pasture and were not surveyed. All these areas will be allocated the category Multiple use. These areas of Multiple use have been mapped by Water and River.

- Acid sulphate soils are associated with all the wetlands surveyed because of the presence of fine-grained pyrite in reduced sediments and therefore any disturbance development within these areas should not be allowed unless stringent management precautions are put in place. Engineering solutions will be required in places, eg road or bridge building.

Comparison with previous Classification

The changes in classification are best seen by comparing with the map in Appendix G. The classification of many has been changed with most being down graded. Although several are listed as EPP wetlands due to their containing standing water for a period, several did not have many environmental attributes. EPP wetlands are important for birds when there is water in the wetland as a result of the high watertable.

Those wetlands that are listed as conservation categories should be maintained and the landowners encouraged to fence them off from stock. This should allow the vegetation to regenerate. There are grants available for fencing and funding should be sought to assist with this cost.

3.5 FAUNA

3.5.1 Methodology

A fauna habitat assessment was carried out specifically targeting the likely habitats of vertebrate species listed as threatened by CALM. The aim of the habitat assessment is to highlight specific areas that contain or may contain populations of threatened species so that any current or future activities likely to impact on the animals and their habitat can be managed accordingly.

A list of vertebrate fauna expected to occur within the study are (based on available habitat) was compiled from searches done on the WA Museum Database, the Department of Conservation and Land Managements Threatened Fauna Database, Department of the Environment and Heritage Departments Commonwealth Environment Protection and Biodiversity Conservation Database, published and unpublished reports and specialist books detailing fauna of the region. Species observed during field work have also been included.

The classification and protection of fauna species that are considered rare, threatened with extinction or having high conservation values is administered under the Wildlife Conservation Act 1950. The annually produced Wildlife Conservation (Specially Protected Fauna) Notice, published as a requirement of the Act, classifies threatened species into four schedules of taxa (Table 19).

Table 19: Western Australian Threatened Fauna Categories

Category	Code	Description
Schedule 1	S1	Fauna which is rare or likely to become extinct
Schedule 1	S2	Fauna which is presumed extinct
Schedule 3	S3	Birds which are subject to an agreement between the governments of Australia and Japan (JAMBA) relating to the protection of migratory birds and birds in danger of extinction
Schedule 4	S4	Fauna that is otherwise in need of special protection

In addition to the list of Scheduled Fauna the Department of Conservation and Land Management maintain a supplementary list of Priority Fauna, being species that are not considered threatened, those recently removed form the threatened list or species that are poorly known or infrequently recorded. The four classifications levels are shown in Table 20.

Table 20: CALM Priority Fauna Categories

Category	Code	Description
Priority 1	P1	Taxa with few, poorly know populations on threatened lands.
Priority 2	P2	Taxa with few, poorly know population on conservation lands.
Priority 3	P3	Taxa with several, poorly known populations , some on conservation lands.
Priority 4	P4	Taxa in need of monitoring

3.5.2 Results

3.5.2.1 Fauna Habitat

The vegetation communities present in the study area were used as the basis for its sun-division into fauna habitats. While the vegetation mapping reflects changes in the floristic composition of an area, habitat identification is based upon structural components of the vegetation, age class of the vegetation, specific habitat components and plant species composition. Therefore some habitats are smaller that the vegetation unit, while others will incorporate a number of units. Figure 27 shows the distribution of habitat types and brief description of each is given below.

Jarrah & Marri Open Forest

This habitat has an open to closed tree canopy with a sparse to moderately dense understorey. There are few to moderate numbers of tree hollows depending on the age diversity of tree species present. Fallen timber is common. This habitat classification falls within part of the Karrakatta Vegetation Complex – Central and South.

Jarrah/Banksia Woodland

This habitat has an open tree canopy with a very sparse understorey. Jarrah tends to be "stunted" and sparse. There are few tree hollows. Fallen timber is uncommon. This habitat corresponds largely with the Bassendean Vegetation (Central & South) Complex.

Wetland Associations

This habitat consists of a variety of wetland types (open water to dense thickets) and associated fringing vegetation (*Eucalyptus rudis*, *Melaleuca* sp, *Baumea* sp.) that would support a unique fauna assemblage. Generally few or no hollows are present. Includes the Preston River (Swan Vegetation Complex) which is the only natural, permanent water in the study area.

Jarrah/Marri/Banksia Open Woodland

This habitat has an open to closed tree canopy with a sparse to moderately dense understorey. There are few to moderate numbers of tree hollows depending on the diversity of tree species present. Fallen timber is common. In the study are this habitat unit corresponds to a great extent with the mapped Southern River vegetation complex.

Remnant Jarrah/Marri Open Forest

This habitat has a open to closed tree canopy with no understorey. There are few to moderate numbers of tree hollows depending on the diversity of tree species present. There is no fallen timber. This habitat type is scattered across the study area and represents degraded sections of the Southern River and Karrakatta Vegetation Complexes.

Tuart Open Forest

This habitat has an open to closed tree canopy with a sparse understorey. Peppermints and Banksia are common. Very limited extent in the study area. Few tree hollows and fallen timber uncommon. Forms a small part of the Karrakatta Vegetation Complex.

Peppermint Forest

This habitat has an open to closed tree canopy and generally little or no understorey. There are rare hollows, small in size. Fallen timber is uncommon. This habitat type

generally forms or would have formed small enclaves within the major vegetation complexes found across the study site.

Pine Forest

Dense canopy with no understorey, no hollows and no fallen timber. Very limited extent in study area

Pasture

Structurally simplistic, usually only herb layer though scattered trees may be present. Significant areas become flooded or water logged during the wetter months of the year providing additional habitat for a variety of wetland species.

3.5.2.2 Expected Vertebrate Fauna

Table 21 summarises the numbers of expected species based on vertebrate class. A complete list of fauna expected in the study area is held in Appendix I. Details on specially protected and priority species are given in the following section.

Table 21: Summary of Expected Vertebrate Species

CLASS	Total number of expected species	Number of specially protected species	Number of priority species	Number of species observed (opportunistic)
Amphibians	12	0	0	2
Reptiles	39	0	1	6
Birds	143	3	4	69
Mammals	30	3	5	7

3.5.2.3 Threatened Vertebrate Fauna

A search of CALM's Threatened Fauna Database and a comparison of expected species against listed Scheduled and Priority species identified six Scheduled and ten Priority Fauna species as potentially occurring in the study area. These are:\

Schedule 1 (Fauna which is rare or likely to become extinct)

Chuditch *Dasyurus geoffroii*

Western Ringtail Possum *Pseudocheirus occidentalis*

Quokka *Setonix brachyurus*

Carnaby's Black-Cockatoo *Calyptorhynchus latirostris*

Baudin's Black Cockatoo *Calyptorhynchus baudinii*

Schedule 4 (Fauna which is Otherwise Specially Protected)

Peregrine Falcon *Falco perigrinus*

Carpet Python *Morelia spilota imbricta*

Priority 2 (Taxa with few, poorly know population on conservation lands)

Barking Owl *Ninox connivens connivens*

Priority 3 (Taxa with several, poorly known populations, some on conservation lands)

Brush-tailed Phascogale *Phascogale tapoatafa*

Red-tailed Black Cockatoo *Calyptorhynchus banksii naso*

Masked Owl *Tyto novaehollandiae novaehollandiae*

Priority 4 (Taxa in need of monitoring)

Southern Brown Bandicoot (Quenda) *Isoodon obesulus fusciventer*

Western Brush Wallaby *Macropus irma*

Water Rat *Hydromys chrysogaster*

Western False Pipistrelle *Falsistrellus mackenziei*

Crested Shrike Tit *Falcunculus frontatus leucogaster*

An account of each species and their possible habitat preference within the study area is detailed within Appendix I.

4. AREAS OF CONSERVATION SIGNIFICANCE

As the rate of biodiversity loss in Australia and the World continues to increase, various alternatives to the traditional species-by-species approach to conservation have been developed. Focusing conservation efforts on higher levels of biological organisation, such as ecological communities, is thought to overcome the bias towards charismatic species, and protect undiscovered and lesser-studied species associated with the community using the limited resources available for conservation more efficiently.

This chapter discusses the significance of biodiversity conservation for the study area based on the information collected, and described in previous sections of this report.

4.1 CONSERVATION SIGNIFICANCE CRITERIA

4.1.1 Regional Context

The Swan Coastal Plain has high natural values but it is heavily cleared as is the most densely populated and settled area in Western Australia. The continuing pressure for urban development is an ongoing threat to the remnant bushland of the coastal plain, in particular to the natural values including diversity of vegetation units, fauna habitats and significant taxa.

A detailed assessment of the natural values and determination of significant bushland within the Perth metropolitan region was facilitated by the Bush Plan project (Government of Western Australia, 1998). A similar process has not been undertaken for the Bunbury Region. This relative lack of knowledge for the area limits the ability to make a detailed assessment of the natural areas within the regional context.

The study area is confined to the Swan Coastal Plain portion of the Region (Thackway and Cresswell, 1995). There are environmental differences between similar areas around Bunbury and Perth so it is expected there will be changes in vegetation mapped as a single landform unit over the entire coastal plain by Heddle *et al.* (1980). Beard (1981) for example, differentiated the Quindalup system into separate units – Guilderton system in the north and Rockingham system south of the Swan River.

Whilst vegetation corresponds generally to landform units there is a significant sub-(bio)regional variation both in vegetation and fauna species that utlise habitats over the latitudinal gradient along the coastal plain (Halpern Glick Maunsell Pty Ltd, 2002). The character of the southern section of the Swan Coastal Plain varies from areas in the north due to climatic factors, relative proportion of underlying factors (eg Tamala limestone) which ultimately dictate the distribution of landforms, soils, vegetation units and fauna habitats.

Since settlement there has been a loss and degradation of wetlands in Australia, and the coastal lowlands of southern Australia have suffered the greatest loss. Halse (1989) estimates that the Swan Coastal Plain has a wetland loss in the order of 70%. Wetlands

are particularly important for waterbirds, frogs and aquatic invertebrates, and support specific floristic vegetation units. Until the wetland mapping and designation of the wetland categories for the Region is published, determination of the significance of the wetlands is limited.

4.1.2 EPA Criteria

Environmental Protection Authority (2002) developed a strategy to be adopted for use when considering the regional significance of the Greater Bunbury Regional Scheme of the Swan Coastal Plain. This strategy has been adopted for this report to assess the significance of the North Boyanup area. The conservation significance of land within the study area has been assessed against a number of recognised measures using both the background information and the site specific information collected as a part of this study.

The criteria against which conservation significance has been assessed are those outlined in the EPA's (2002) strategy for the Greater Bunbury Regional Scheme. The criteria used in the scheme are based on the following key elements:

- Representation of Ecological communities – selected to represent the range of ecological communities and the places in which these communities merge.
- Diversity – areas where there is a high diversity of flora and fauna.
- Rarity – areas of Threatened Ecological communities, Declare Rare or Priority Flora, or species of restricted distribution.
- Maintaining Ecological Processes or Natural Systems – ensuring the maintenance of ecological or natural processes at a regional or national level.
- Protection of Wetland and Streamline – Conservation category wetlands including the fringing vegetation and associated upland vegetation.

4.1.3 Application of Criteria to North Boyanup area

The information pertaining to the application of these criteria in the North Boyanup area is summarised below:

A. Representation of Ecological Communities

"A number of areas selected to represent the range of ecological communities and the places in which these communities merge" (Environmental Protection Authority, 2002).

Seven Swan Coastal Plain vegetation complexes were recorded in the North Boyanup area. Within the Spearwood Dune System – Karrakatta Central and South and Yoongarillup complexes; within the Pinjarra Plain - Southern River,

Serpentine River and Swan complexes; and within the Bassendean dune system - Bassendean Central and South and Guildford complexes.

The total vegetation remaining of each vegetation complexes within the Swan Coastal Plain varies between 5 and 47% of their pre-European extent. The EPA uses the standard level of native vegetation retention, of at least 30% of the pre-clearing extent of the ecological communities on the Swan Coastal Plain. This level has been set as the necessary level to ensure that Australia's biological diversity is protected (Commonwealth of Australia, 2001). This level is also in keeping with the targets set by the EPA (2000) on the environmental protection of native vegetation with regard to clearing especially in agriculture areas.

For the Bunbury Region this means the objective is to retain at least 30% of the pre-clearing extent of the ecological communities, where more than 30% of each ecological community remains on the Swan Coastal Plain. Within the whole of the Swan Coastal Plain, Yoongarillup, which has the smallest representation in the North Boyanup area, is the only vegetation complex where more than 30% remains, the minimum goal for the retention of native vegetation of the Commonwealth of Australia (2001). It is the percentage remaining on the Swan Coastal Plain as a whole that is the figure that the EPA assesses, although within the Greater Bunbury Region the Karrakatta – Central and South, Yoongarillup and Bassendean Central and South complexes have greater than 30% of the complex remaining vegetated.

In addition the most southern extensions of the Bassendean Dunes are found in the Greater Bunbury Region (EPA, 2002). South of the North Boyanup area, they are reduced to isolated shallow sand ridges in a broader Pinjarra Plain. The Bassendean Dunes in the Greater Bunbury Region are broad, low relief dunes.

This indicates that the North Boyanup area represents a range of ecological communities.

B. Diversity

"Areas with a high diversity of flora and/or fauna species or communities in close assocation" (Environmental Protection Authority, 2002)

The Environmental Protection Authority recognises it is important to conserve areas of richness, diversity or complexity for their physical or biological attributes at a community, species or generic level.

A total of 28 vegetation units in seven floristic community types were described during the survey. These ranged from high ground on the Spearwood and Bassendean dunes to low ground. The remnant vegetation in the North Boyanup area exhibits a large amount of variation in both the soils and the associated vegetation units. The survey area includes representation of uplands and wetlands. Areas, which contain both ecological community groups, support the highest biodiversity and are a focus for protection.

A total of 78 vascular plant families, 241 genera and 397 taxa were recorded during the survey. 83 of the taxa were weeds. These species included those associated

with wetlands as well as high lands and within different vegetation complexes. More than 70% of the area has been developed for grazing, utilising predominantly the lower country and leaving the higher country as vegetation remnants, thus making any remnant wetland vegetation significant.

Wetland types recorded from the area included: palusplains, floodplains, damplands and sumplands. There were only a few examples of palusplains within the study area. Applying the categories in EPA (1998) it is very difficult to classify palusplains as having conservation category as the assessment utilises the presence of standing water, a feature absent from the palusplains of the area. Assessing the vegetation unit(s) present, those identified at the North Boyanup area are in very good to excellent condition. This degree of variation within the area, together with their condition, indicates the area is worthy of conservation. As stated earlier it is estimated there has been a 70% loss in wetlands since development, therefore any in good or better condition should be conserved. Using the classification of the Water and Rivers and the Environmental Protection Authority the wetlands present included EPP, conservation, resource enhancement and multiple use wetlands.

While detailed fauna surveys where not carried out as part of the North Boyanup study a number of broad fauna habits were identified based on the various vegetation complexes present. Based on these results it was estimated that about 224 vertebrate species could utilise the area. While a percentage of these species could survive in degraded habitats many species known to occur in the area require relatively undisturbed habitat to survive (eg Western Yellow Robin).

This indicates that the North Boyanup area has a high diversity of vegetation units, flora, wetlands and fauna.

C. Rarity

"Areas containing rare or threatened communities or species, or species of restricted distribution" (Environmental Protection Authority, 2002)

Rarity is considered from a community and species level. This includes Threatened Ecological Communities, and areas supporting threatened flora and fauna species.

A remnant of the Threatened Ecological Community *FCT3a – Corymbia calophylla – Kingia australis* woodlands on heavy soil, was recorded along the verge of Brookdale Road. The vegetation on the verge was in good condition whereas the adjoining paddock was completely degraded. This verge is most likely a remnant of FCT3a but it would have been much more extensive before becoming a paddock for stock. This TEC is listed as Critically Endangered by CALM and Endangered under the EPBC Act (1999). No other TEC's were recorded during the survey.

Areas that support rare, priority or uncommon species area of regional significance, includes species listed as Declared Rare Flora under the Wildlife Conservation Act 1950 and threatened flora under the EPBC Act 1999. The Department of Conservation and Land Management list Priority Flora.

One Declared Rare Flora, *Caladenia huegelii* was recorded during the survey from the edge of a wetland. This is listed as Endangered under the EPBC Act, 1999. As the current survey was undertaken at the end of spring and this was the only flower that could be positively identified it is possible that an additional spring survey may locate additional plants in the same or similar vegetation unit. To be able to undertake any clearing within this area written permission must be obtained from the Minister for the Environment.

Eleven Priority flora were recorded. These included: P1 – *Boronia humifusa*; P2 – *Leptomeria furtiva*, *Mitreola minima* and *Schoenus loliaceus*; P3 –*Acacia semitrullata, Lasiopetalum membranaceum* and *Stylidium longitubum*; P4 – *Acacia flagelliformis, Eucalyptus rudis* subsp. *cratyantha, Franklandia triaristata* and *Jacksonia sparsa*.

In addition, *Marsilea drummondii*, collected from location within the area has not previously been recorded from the vicinity. This is an important collection as it is the furthest south and west that this species has been collected.

The analyses of fauna habitats suggested that a number of threatened and priority fauna species could be utilising the remnant vegetation present within the North Boyanup study area. The Schedule 1 threatened Western Ringtail Possum *Pseudocheirus occidentalis* was sighted on several occasions and appears to widespread across the study area. Signs of the Priority 4 Southern Brown Bandicoot (Quenda) *Isoodon obesulus fusciventer* were also found.

D. Maintaining Ecological Processes or Natural Systems

"Maintenance of ecological processes or natural systems at a regional or national scale" (Environmental Protection Authority, 2002)

Size and Condition

It is important that for conservation the vegetation be in a suitable condition. The vegetation condition assessed at the time of the field work used the scale in Department of Environmental Protection (2000). Most of the area is recorded as having a vegetation condition of 2-4, which is good to excellent with most being very good to excellent. This indicates that the vegetation structure of the remnant is worthy of protection.

Fauna species vary in their ability to survive in remnants. Reptiles persist in relatively small remnants (How and Dell, 1994) and birds maintain populations in urban areas but mammals tend to disappear. Vegetation condition will to some extent determine the assemblage of fauna populations supported, and a greater structural diversity will increase the species diversity. Areas in lesser vegetation condition do appear to support a moderately diverse avifauna assemblage.

Size is of importance in determining the viability of natural areas for long term retention. A larger size is preferred as it is more likely to have a diversity in vegetation units and therefore fauna habitats. A larger size will be less prone to edge effects, allows fauna to have a large home range and can support several fauna territories.

If the total extent of the remnant bushland is considered the size is relatively large. It certainly exceeds the lowest size limit of 20ha (EPA, 2002). Size is important, as larger remnants are preferable to smaller ones.

Shape

A compact or consolidated shape is preferable to irregular or elongated shapes as the latter shape increase the potential for weed invasion. Fragmentation of natural areas is common due to vegetation clearing, resulting in only small remnant remaining on the Swan Coastal Plain. Fauna corridors are important where areas retain vegetation and can be used as corridors.

The remnant vegetation within the North Boyanup area consists of two long, reasonably wides areas, extending east-west across the area and a small off shoot to the south from the western end. The remnants are connected throughout and therefore act as a corridor as well as maintaining genetic diversity and assisting in the susceptibility of the area to localised extinction caused by fire, climatic fluctuations and predators.

Fauna Habitat Value

Fauna habitats provide functional requirements including areas for feeding and breeding. Most habitats provide a resource of some kind but the importance of specific habitats, eg wetlands is an important criterion. Other important habitat components include prevalence and size of tree hollows and the abundance and thickness of leaf litter. The introduction of feral predators such as the fox has reduced the distribution of some species to habitats with dense vegetation that provide better protection against predation (eg Quokka).

One of the more significant habits present within the North Boyanup area are the wetlands. During the wetter months of the year these areas provide valuable feeding, roosting and breeding habit for a variety of bird species. The importance of wetlands on the coastal plain is magnified by the fact that only about 20% of those present before European settlement still exist.

During the fauna habitat analyses tree hollows and hollow logs were identified as being important habitat components within certain areas of North Boyanup. Some of the rare bird and mammal species require hollows for nesting and shelter and their presence increases that areas habitat value.

Linkage

A key component in determining the regional and local significance of areas is its ability to function as a link between differing habitat types. As part of its assessment of the Greater Bunbury Region Scheme, the EPA identified sixteen preliminary ecological linkages in the Scheme area (EPA 2003c). The linkages are based on identified sequences of ecological communities that join or potentially join the major landform elements that occur in the region. One of the identified linkages, the Dalyellup/Gelorup/Crooked Brook Linkage passes through the centre of study area. The Preston River, which defines the eastern boundary of the North Boyanup Study area forms part of the Mclarty/Kemerton/Twin Rivers/Preston River/Gwindinup Ecological Linkage and a small section of the Capel Boyanup Linkage cuts the south east corner of the study area.

Linkage of vegetated units is important to sustain the genotype of an area and to ensure there are the necessary habitats and food environments for fauna. The study area includes representation of uplands and wetlands. Areas, which contain both ecological community groups, support the highest biodiversity and are a focus for protection.

The area is linked from east to west with a subsidiary link from the west to the south. These linkages include vegetation units representative of the Karrakatta Central and South, Southern River, Serpentine River, Swan and Bassendean Central and South vegetation complexes.

E. Scientific or evolutionary importance

"Areas containing evidence of evolutionary processes either as fossilised material or as relict species and areas containing unusual or important geomorphological or geological sites; areas of recognised scientific and educational interest as reference sites or as examples of the important processes at work" (Environmental Protection Authority, 2002)

This guideline is irrelevant to the area.

F. Protection of Wetland and Streamline

"Conservation category wetland areas including fringing vegetation and associated upland vegetation; coastal vegetation within the accepted coastal management zone" (Environmental Protection Authority, 2002)

Eight conservation category and thirteen resource enhancement wetlands were identified during the survey. The conservation category wetlands all included fringing vegetation and some had upland associated vegetation. The conservation wetlands are a focus for protection and the resource enhancement wetlands are worthy of rehabilitation as most of the wetland structure is still present.

A number of seasonally inundated areas occur in the south of the study area, though these are degraded from a vegetation and functional ecosystem perspective they form and important linkage and provide habitat for water birds.

The Preston River was degraded along its banks within the study area although the tree canopy was relatively dense. Several invasive weeds were recorded eg Bridal creeper and Watsonia, but all waterways are important and irrespective of how degraded the banks may be they must be conserved. The Preston River has been identified as an important river corridor (EPA, 2002).

4.1.4 Protection of Regionally Significant Areas

The above discussion has illustrated the environmental importance of the remnant vegetation in the North Boyanup area. The area consisted of low and high land vegetation units with 38 wetlands being described for their vegetation unit(s), vegetation condition and wetland classification. The Waters and Rivers Commission acknowledge that the wetland database cannot be 100% accurate due to difficulties in monitoring all

wetlands and changes that occur with time. During this survey the wetlands were assessed and the reassessed classification sent to the Perth office for endorsement.

There are specific management requirements associated with wetlands. Generally it is agreed there will be no approval for any activity that is likely to impact on resource enhancement wetlands, especially where the activity is likely to cause tis degradation. The Commission's position on conservation wetlands is no development.

Buffers are designed to protect wetland from potential deleterious impacts as well as to protect and maintain wetland functions. Buffers can, in some, instances protect the community, such as from mosquitos. Buffer distances are measured from the outside extent of the wetland dependent vegetation to the outside edge of any proposed development or activity. A minimum of 50 metres applies but can range up to 1,000 metres depending on the proposed land use. As the current land use of most of the area surveyed is cattle grazing, the purpose of the buffer would be to protect the wetland(s) from nutrient inputs (Water and Rivers Commission, 2001b). The buffer distance is 200m on transmissive soils and 100m on non-transmissive soils. Therefore all the wetlands described require a buffer of 200m away from the wetland dependent vegetation.

As wetlands are scattered through the remnant vegetation these and their associated wetlands are important. Thirteen were classified during the study as resource enhancement and eight as conservation. All these require protection at some level. Seventeen were classified as multiple use as they have limited ecological attributes remaining but do have importance for the drainage etc and therefore should be considered in the total ecology of the area. The Preston River is the only river in the study area and a 50m buffer at least should be the protection zone around its banks. One quadrat was placed on the bank of the Preston River, where the owner of the land was undertaking rehabilitation of the site through weed removal, but it was an enormous task as the Bridal creeper and Watsonia was thick, not only where the work was being undertaken but along the whole bank. A concerted effort would need to made to ensure that these weeds are controlled. CSIRO has released a rust to control Bridal creeper and the obtaining of these spores should be sought to assist with its control. Along the river bank the control of Bridal creeper will be difficult as birds eat the berries, sit in the trees and the seeds fall to the ground. It is only through a control mechanism such as the rust spores that this species stands any chance of control.

The upland vegetation is of regional significance for the many reasons outlined previously. Conserving vegetation is necessary for retaining the natural values of regional significance. There were two small reserves in the study area, one an old school site, the other was Franklandia Reserve managed by the Bunbury Naturalist Group. The remainder is in private ownership. Several of the land owners contacted during the survey are very proud of their remnant vegetation and are interested to know how to enhance what they have. These owners are and will continue to provide conservation and the land should stay under their control. Assistance should be provided in relevant species for propagation, fencing through grants etc.

Conserving vegetation through public or private efforts is essential to retain the natural biodiversity values of regional significance. Where land is in private ownership and the land holder is not interested in maintaining the vegetation there needs to be means in place to ensure this vegetation can be maintained, especially where it is of regional significance. The area of regional significance, including a buffer around the perimeter is illustrated in Figure 31. Basically it includes all vegetation in good or better condition, and all fauna habitats considered to be of importance. If landowners are willing it could be possible to gift their remnant vegetation to an appropriate organisation eg WA Landcare Trust or the National Trust. Another method would be to place a conservation covenant on the land.

A key component in determining the regional and local significance of areas is its ability to function as a link between differing habitat types. As part of its assessment of the Greater Bunbury Region Scheme, the EPA identified sixteen preliminary ecological linkages in the Scheme area (EPA 2003c). The linkages are based on identified sequences of ecological communities that join or potentially join the major landform elements that occur in the region. One of the identified linkages, the Dalyellup/Gelorup/Crooked Brook Linkage passes through the centre of study area. The Preston River, which defines the eastern boundary of the North Boyanup Study area forms part of the Mclarty/Kemerton/Twin Rivers/Preston River/Gwindinup Ecological Linkage and a small section of the Capel Boyanup Linkage, cuts the south east corner of the study area.

The linkage identified by the EPA corresponds roughly with the conceptual wildlife/vegetation corridor presented by ATA (2003). A significant difference between the two lies in the important inclusion of the Franklandia Reserve within the EPA's linkage. This area is bypassed by ATA's proposed linkage and a vegetated corridor slightly to the south is utilised. However, ATA's linkage has the advantage of directly running onto a vegetated corridor on the east side of the Preston River and it is recommended that a combination of these two previous identified linkages be adopted for the Dalyellup/Gelorup/Crooked Brook Linkage (see Figure 30).

The information gathered during this environmental study, in particular the vegetation, flora studies and broad scale fauna investigations has confirmed the importance of an ecological link along the vegetated central section of the North Boyanup Study area. Its importance is also magnified by the fact that during this study no other sections of the study area were found suitable as potential ecological linkages. In addition the vegetated corridor to the south of the western edge of this ecological link is also included. This secondary ecological link included conservation wetlands as well as a large area of higher ground vegetation.

It should also be noted that the EPA (2003c) specifically state that naturally vegetated areas (in particular larger relatively intact remnants) in the area of the linkages will be priorities for retention and protection, being expected to meet the criteria for regional significance against at least two criteria, that is "Representation of ecological communities" and "Maintaining of ecological processes or natural systems".

The EPA also suggests that sections of linkages that have degraded native vegetation could provide a focus for the restoration of ecological communities and landscape rehabilitation. Some sections of the proposed linkage are cleared or very degraded thereby limiting its effectiveness. These areas should be targeted for restoration if possible.

The integrity of existing connections need to be maintained to ensure movement of fauna continues and to limit genetic isolation.

4.1.6 Conservation Areas

Based on the analysis provided above a recpmmended area of high conservation is shown for the North Boyanup area in Figure 31. This area meets the Environmental Protection Authority (2002) requirements stated as selection criteria for conservation. These have been discussed in detail previously but are itemised below:

- Vegetation complexes with less than 30% of the original extent on the Swan Coastal Plain;
- Variety of vegetation units including lowland and high land;
- Location of *Caladenia huegelii* listed as Declared Rare Flora (Wildlife Conservation Act, 1950) and Vulnerable (EPBC Act 1999);
- Eleven priority flora as listed by the Department of Conservation and Land Management;
- A remnant of the Threatened Ecological Community 3a along Brookdale Road verge;
- Twenty eight vegetation units in seven floristic community types;
- Area of *Marsilea drummondii*, the most western and southern recorded location of this species;
- Wetland types palusplains, floodplains, damplands and sumplands
- 13 wetlands classified as resource enhancement, 8 as conservation category.
- EPP wetlands – those that retain water all year occur in the area;
- Large area of remnant bushland traversing from east to west and south of the western end;
- Fauna habitat value and presence of threatened and priority species

The conservation area selection can be justified by the results not only of the North Boyanup Environmental Study but by broader scale studies over the Greater Bunbury Region analysed in detail by the EPA (2003c). Areas of lower conservation value are also shown Figure 31 and aim to provide additional protection to the conservation area and to protect additional wetland areas from pressures of other land u ses.

In addition to the summary of details provided in section 4.1 on the Regional Significance of this section of the North Boyanup area the proposed high conservation area was also found to contain populations of Western Ringtail Possums and overall the area has been identified as having suitable habitat for a number of other threatened and priority fauna species.

5. OPPORTUNITIES & CONSTRAINTS

The identification of opportunities for changes in land use in the study area is based on defining areas which have similar constraints and hence require consistent or uniform management strategies. Excluding areas recommended for conservation, the review of land capability detailed in section 2.6 highlighted that the major land qualities that will constrain changes in land use from agricultural land within the study areas were the high risk of waterlogging/inundation, flooding and the low nutrient retention ability of some soils. Figure 9 highlights the areas that are most susceptible to waterlogging and inundation (based on AGMAP data). These factors will have a major impact on land use in the study area. Other land qualities such as ease of excavation, wind erosion and land instability will not limit land use in the study area and are not considered further. Conservation and EPP category wetlands not within the area recommended for conservation will also require a buffer from development which will also constrain land use change in certain areas.

Two illustrate opportunities and constraints three categories have been assigned to land in the study area: High Development Constraint, Medium Development Constraint and Low Development Constraint. These categories provide the basis for determining development opportunities and precincts and are shown in Figure 32.

A high development constraint means that the area generally should not be developed. In the study area this category has been applied mainly to the areas recommended for conservation, areas around wetlands and other areas with a high risk of inundation. If development were to proceed in areas of high ecological value, it could for example, result in local extinctions of threatened species populations or wetland degradation. Therefore, with the exception of existing dwelling entitlements, no new development is recommended in highly constrained areas.

A medium constraint classification has been applied to areas not recommend for conservation that have a medium risk of flooding or inundation. Development in medium constrained areas is possible, however careful planning and management of the identified constraint will be required. This is likely to include detailed hydrological studies and drainage assessments. All remaining areas contain low development constraints but will still require careful planning due to their proximity to areas of medium to high constraints. Other constraints not considered (e.g. visual amenity, bushfire risk) may need to be assessed at the subdivision development stage.

5.1 LAND USE IMPLICATIONS - HYDROLOGY

The presence of the high water table in the study area has been identified as a very important constraining factor and broad scale changes in land use have the potential to impact greatly on the hydrology of the study area. The impacts of current land use and potential changes in land use in relation to the water table and nutrients will require atre discussed below.

Native environmental systems in Western Australia typically have low nutrient inputs. Addition of nutrients can be disruptive to the functioning of these systems. Input of nutrients through sources such as animal manures and artificial fertilisers have the ability to disrupt the functioning of these systems. The risk posed by nutrient enrichment is particularly high in the study area due to the shallow water table and the presence of expressions of groundwater in shallow wetlands.

Broad acre farming has the potential to introduce nutrients through imported fertilisers, the manure of stock and the by products of any on-site processing. This is particularly important in relation to dairy properties, these operations often have high stocking rates and a requirement to dispose of manure collected during milking. In addition dairies require the disposal of wash down water from milking sheds, which contains diluted manure and waste milk.

Input of fertilisers should be minimised, of particular importance is elimination of direct discharges into water bodies, this includes both permanent, seasonal water courses and wetlands. This is best achieved by fencing areas and allowing a buffer strip of native vegetation. The fencing eliminates the ability of stock to access water bodies and the vegetated strip acts as a bio-filter for both surface and sub-surface discharges.

Direct discharge of process/wash down water to water bodies should be eliminated. The spreading of manure should be controlled so as not to exceed the nutrient holding capacity of soil and under no circumstances to be spread into waterbodies.

Replacing perennial native vegetation with annual species can cause modification to the water balance of a site. The impact is generally to increase recharge and thus groundwater levels. On heavier soils the removal of vegetation may also increase runoff, changing the hydrologic regime in water causing greater peak flows. Increases in runoff and groundwater levels also has the potential to cause nuisance flooding.

Due to the already shallow water tables in the study area any increase in water levels are likely to have an impact on existing conditions. Increases in groundwater levels will cause increase wetland levels thus altering the distribution of habitats, potentially causing the loss of species. If the changes occur more rapidly than ecosystems can adapt this effect will be more pronounced.

Broad scale changes to hydrology caused by land clearing are difficult to mitigate. Care needs to be taken to ensure that areas of vegetation are retained so that the hydrologic balance can be retained. As a large portion of the study are is already used for agricultural purposes the majority of the impacts associated with this activity have occurred.

Nutrient inputs from urban systems include direct application of fertilisers on gardens and parklands and through untreated wastewater discharges. The high water table in parts of the area make it particularly susceptible to nutrient enrichment particularly via untreated wastewater.

Nutrients introduced from urban systems can be transported either through surface water flow such as stormwater systems or though groundwater flow. The areas potentially impacted by nutrient enrichment from urban special rural catchment therefore represent all land down groundwater gradient and all land down surface water catchment.

Given the proceeding, development in all but the most westerly section of the study area has the potential to impact on proposed conservation areas. Nutrient enrichment is therefore seen as a key issue to be considered in the proposals for more intensive development within the study area.

Input of nutrients should be minimised, of particular importance is elimination of direct discharges into water bodies, this includes both permanent, seasonal water courses and wetland. Where possible landscaping that does not require high nutrient inputs should be chosen, this is generally achieved via the use of native plants. The development of land should include the requirement for the development of formal management plan to ensure nutrient applications are managed.

Discharge of nutrients to the environment from wastewater treatment systems should be eliminated. This can be achieved by providing a reticulated sewage system to collect wastes. Where this is not economically viable due to low densities on-site treatment units that reduce nutrient loads should be mandatory. The control of stormwater drainage from the perspective of water quality is also an important factor.

Where urban/special rural development are proposed a net reduction in nutrient inputs should be required. This will likely require modification of development such as native only landscaping, nutrient absorbing soil amendments on areas where grassed POS is required, mandatory nutrient absorbing wastewater treatment systems and appropriate treatment of stormwater for water quality.

An urban/special rural development appropriately designed has the potential to reduce nutrient flux within a catchment. Many rural catchments have a large nutrient store in the soil, the fate of this nutrient store under landuse change needs to be considered in any development.

Urban developments will cause a substantial modification to the water balance of a site. The general outcome is an increase in the export of water from a site both in the form of recharge and through surface drainage. The increase in recharge caused by urbanisation commonly causes a rise in groundwater levels, this impact has occurred in the metropolitan area. This rise in water table is particularly significant in respect to urban development as it will impact on the housing potentially causing property damage.

A number of mechanisms can be used to facilitate development in these conditions, typically a number of strategies are combined. One method employed for alleviating problems associated with flooding is the use of imported fill to increase the distance between houses and the water able. Another method is the use of sub-surface drainage to control the rise in water levels.

Another issue specific to the study area is the interplay between the two aquifers that occur in the near surface formations. As seen in the field investigation the piezometric

head in the surface aquifer is substantially greater that the head in the lower Guilford Sand aquifer, this is more pronounced in the south of the site. There is therefore the potential to for water to flow from one aquifer to another if the confining layer between them is substantially breached. This would have a substantial impact on the local hydrology. It is recommended that any substantial earthwork projects including drainage assess the potential to impact on the local water balance.

Due to the lower densities special rural developments are likely to have a similar but smaller impact on the local hydrologic cycle than urban development.

Any proposed development should be guided by the current best practise in stormwater management as dictated by the Department of Environment. The broad principal of stormwater management are as follows:

- Retain and restore natural drainage systems – retain and restore existing valuable elements of the natural drainage system, including waterway, wetland and groundwater features and processes.

- Implement non-structural source controls – minimise pollutant inputs principally via planning, organisational and behavioural techniques, to minimise the amount of pollution entering the drainage system.

- Minimise runoff – infiltrate or reuse rainfall as high in the catchment as possible. Install structural controls at or near the source to minimise pollutant inputs and the volume of stormwater.

- Use of 'in-system' management measures – includes vegetative measures, such as swales and riparian zones, and structural quality improvement devices such as gross pollutant traps.

It may be advantageous to consider modification of water tables through artificial means such as drainage schemes. This may allow development in areas that would previously have been unacceptable for this purpose. Localised modification on water tables has the potential to impact on the local ecosystems. This local impact needs to be traded off against impacts of urban development in other areas such as habitat loss where vegetation is lost to facilitate development. An area where the modification of water tables may be considered is the southern section of the study area.

To aid in future planning decisions it is recommended that a series of detailed hydrological studies be undertaken, these should include investigations to:

- determine the existing hydrological and hydraulic regime for specific areas of development and define the limits of inundation for the 100 year average recurrence interval (ARI) storm and flood hazard category;

- assess the impact of any proposed development on this regime; and

- recommend a strategy for the drainage system identifying fill levels taking into account the need to:

i) maintain the hydrological regime which sustains the wetland systems; and

ii) maintain or improve existing water quality conditions.

6. CONCLUSION

The environmental assessment of the North Boyanup district has been conducted to provide information enabling the compilation of a comprehensive structure plan which aims to achieve a balance between conservation and urban development in addition to ensuring the sustainability of existing rural land uses and the maintenance of access to basic raw materials and strategic mineral resources.

The environmental study has involved a series of detailed field studies of the areas hydrology, vegetation, flora, fauna and wetlands. The main findings of the field assessment were:

- Identification of a thin unconfined surface aquifer over the majority of the area which, in areas where it is exposed, forms the numerous wetlands present.
- Seven vegetation complexes were identified including a total of 28 distinct vegetation units.
- A potential Threatened Ecological Community, FCT3a – *Corymbia calophylla – Kingia australis* woodlands on heavy soil was recorded from a small area on Brookdale Road.
- One Declared Rare Flora, *Caladenia huegelii.*
- Eleven Priority Flora, varying from Priority 1 to Priority 4 were found during the survey, only four of which had been previously reported and recorded on the CALM Rare Flora database for the area.
- Some wetlands previously classified as conservation category were downgraded others considered of lower classification were raised to a higher rank as a result of this survey.
- A comparison of expected vertebrate fauna species against listed Threatened Scheduled and Priority species identified six Scheduled and ten Priority Fauna species as potentially occurring in the study area based on identified habitats present.
- The Schedule 1 rated Western Ringtail Possum was found to be present in low numbers across a wide area of North Boyanup. Signs of the Southern Brown Bandicoot (Priority 4) were also found in a number of locations.

Utilising the EPA's (2002) strategy for identifying regionally significant areas and the detailed flora, vegetation and fauna results obtained from the field assessment, sections of the North Boyanup study area warrant conservation. A key component in determining the conservation significance of an area is its ability to function as a link between differing habitat types. The information gathered during this environmental study has confirmed the importance of an ecological link along the vegetated central section of the North Boyanup Study area (see Figure 30). In addition to some of the factors detailed above the area highlighted for consideration for conservation is characterised by:

- The wetlands present include EPP, conservation, resource enhancement and multiple use wetlands.

- The area is of a relatively large size, much in excess of the minimum 20ha size. This is important, as larger remnants are preferable to smaller ones.

- The area is linked east-west and west-south and includes vegetation units representative of the Karrakatta Central and South, Southern River, Serpentine River, Swan and Bassendean Central and South vegetation complexes.

- Most of the area is recorded as having a vegetation condition of 2-4, which is good to excellent with most being very good to excellent. This indicates that the vegetation structure of the remnant is largely undisturbed.

- The area includes representation of uplands and wetlands. Areas, which contain both ecological community groups, support the highest biodiversity and are a focus for protection.

It can be concluded from an assessment of the land capability mapping that in many cases the conservation land is coincident with the land suitable for urban development. A large percentage of the cleared land has a low capability for residential development due to high water tables and low nutrient retention capacity.

It is suggested that the planning strategy allow developers the opportunity to explore innovative development types which allows urban development in areas otherwise considered unsuitable. The developments may need to consider manipulation of the water table/hydrologic cycle and measures to mitigate nutrients fluxes. The advantage of encouraging more innovative development types is to reduce the pressure to clear areas of recognised conservation value.

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APPENDIX B

APPENDIX C

APPENDIX D

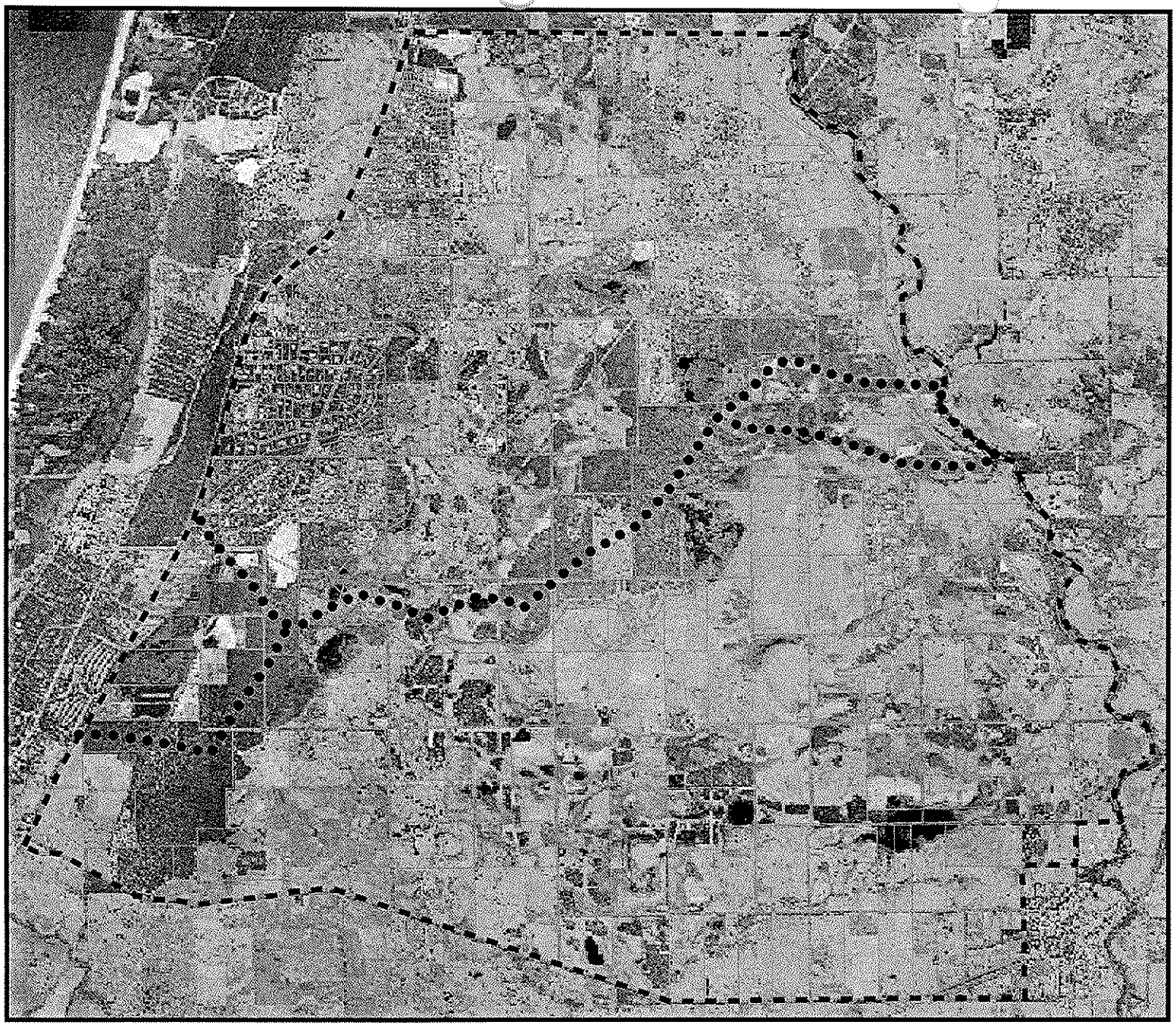
APPENDIX E

APPENDIX F

APPENDIX G

APPENDIX H

APPENDIX I



North Boyanup District Structure Plan
Environmental Study

Kilometers
0 0.25 0.5 1 1.5 2 2.5

emt

Legend

- Study Area Boundary
- Cadastral Boundaries
- Potential Ecological Linkage

Source: Base Data DPI December 2003

Figure 30: Potential Ecological Linkages

FIGURES

APPENDIX A

NORTH BOYANUP DISTRICT STRUCTURE PLAN

DRAFT BACKGROUND WORKING PAPER

FIGURES 1-11

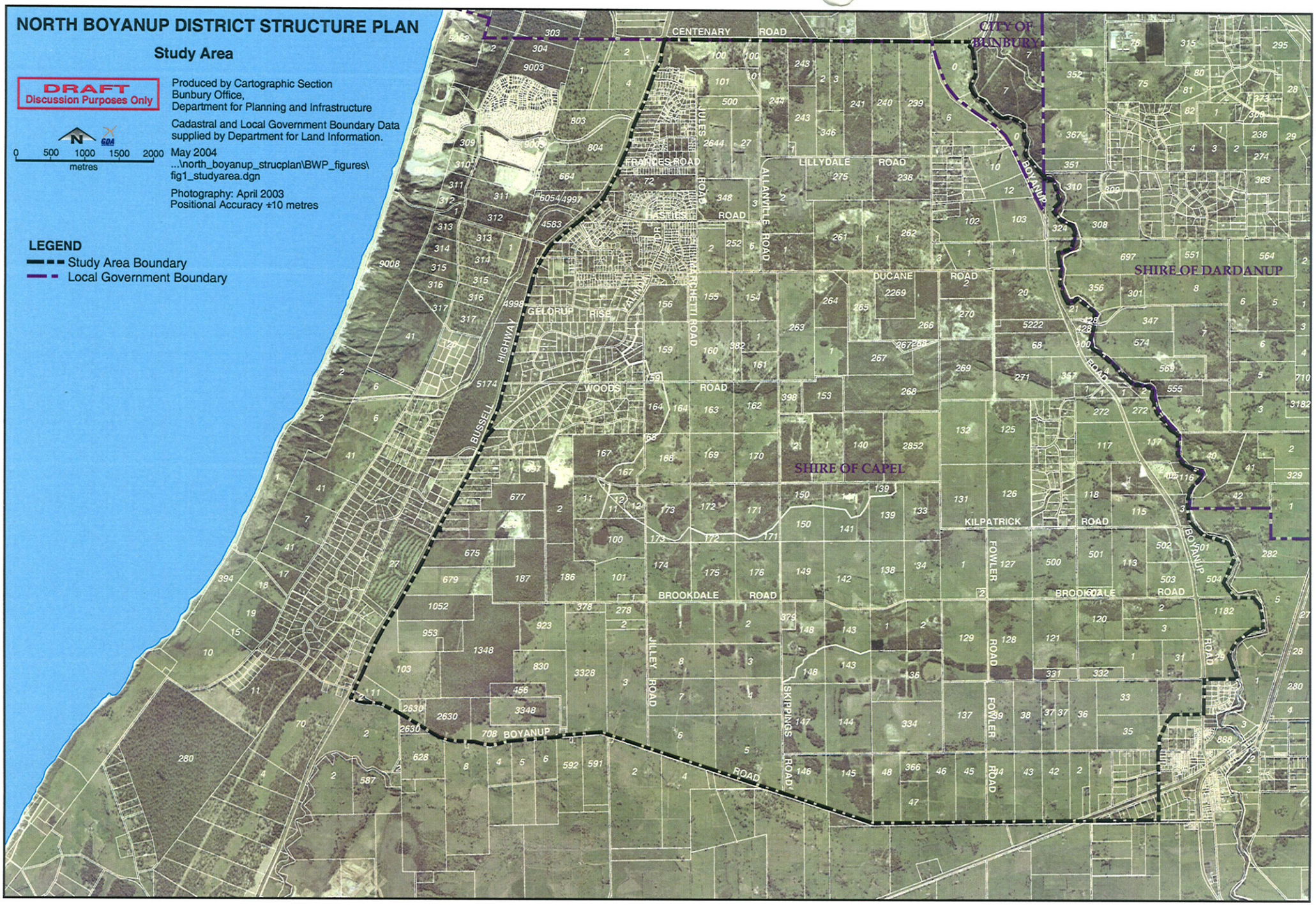

NORTH BOYANUP DISTRICT STRUCTURE PLAN
Study Area
DRAFT
Discussion Purposes Only
Produced by Cartographic Section
Bunbury Office,
Department for Planning and Infrastructure
Cadastral and Local Government Boundary Data supplied by Department for Land Information.
May 2004
...\north_boyanup_strucplan\BWP_figures\fig1_studyarea.dgn
Photography: April 2003
Positional Accuracy ±10 metres
0 500 1000 1500 2000
metres
LEGEND
Study Area Boundary
Local Government Boundary
CENTENARY ROAD
CITY OF BUNBURY
SHIRE OF DARDANUP
SHIRE OF CAPEL
BUSSELL HIGHWAY
GELORUP RISE
WOODS ROAD
FRANCES ROAD
JULES ROAD
ALLANVILLE ROAD
LILLYDALE ROAD
DUCANE ROAD
KILPATRICK ROAD
BROOKDALE ROAD
BOYANUP ROAD
JILLEY ROAD
SKIPPINGS ROAD
FOWLER ROAD
BOYANUP

Figure 1


KIMBERLEY
PILBARA
GASCOYNE
MID WEST
GOLDFIELDS-ESPERANCE
WHEATBELT
PERTH PEEL
SOUTH WEST
GREAT SOUTHERN
Index to Map
Indian
Ocean
Southern
Ocean
Harvey
Bunbury
Collie
North Boyanup District Structure Plan boundary (diagramatic)
Dunsborough
Busselton
Donnybrook
Boyup Brook
Margaret River
Nannup
Bridgetown
Manjimup
Augusta
Pemberton
Northcliffe
Walpole
STATE PLANNING STRATEGY LEGEND
Aboriginal Reserve
Environmental Priority Management Area (including Conservation Estate)
Marine Planning Priority Area
State Forest Area
Agricultural Priority Management Area
Statutory Region Scheme Area
Area Development Strategy Boundary
Productive Agricultural Areas Under High - Extreme Soil Salinity Risk
Existing Strategic Combined Freight and Tourist Road Network / Possible Extension
Existing Strategic Freight Road Network / Possible Extension
Existing Strategic Tourist Road Network / Possible Extension
Strategic Freight / Tourist Route to be Investigated
Existing Government / Private Railways / Possible Extension
Gas pipeline - existing / Potential Extension
Goldfields Water Pipeline
Primary / Secondary Strategic Transport Gateway & Hub
Secondary Airport
All Weather Air Strip
Public Port
Private Port
Strategic Industry Processing Site
Potential Strategic Industry Processing Site
Regional Urban Area
Regional Service Centre
Local Service Centre
Region Boundary
NORTH BOYANUP DISTRICT STRUCTURE PLAN
State Planning Strategy - South-West Region
DRAFT
Discussion Purposes Only
N
0
500
1000
Metres
Produced by Cartographic Section
Bunbury Office,
Department for Planning and Infrastructure
Cadastral and Local Government Boundary Data supplied by Department for Land Information.
May 2004
...\north_boyanup_strucplan\BWP_figures\
fig2_SPStrat.dgn

Figure 2

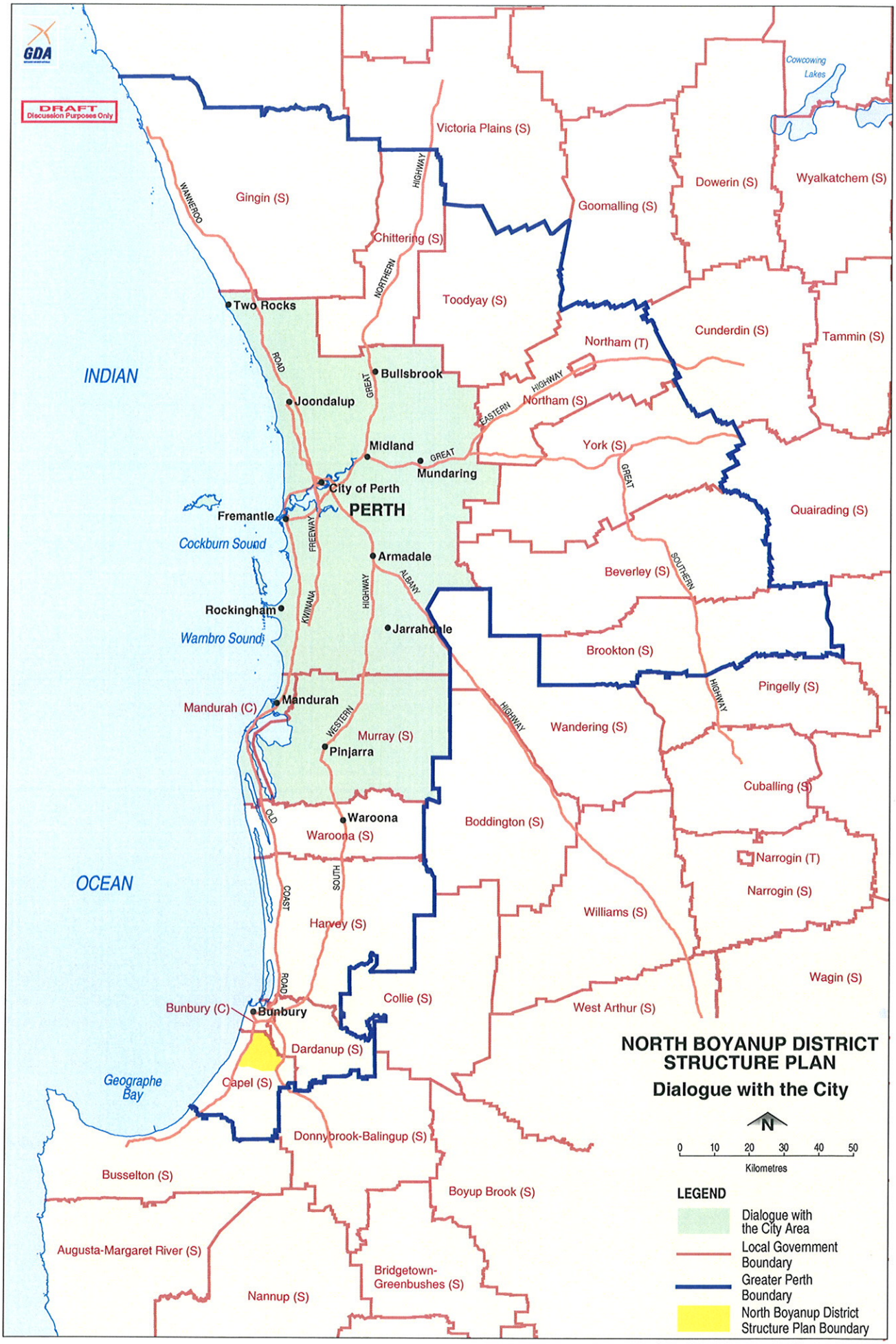

GDA
DRAFT
Discussion Purposes Only
INDIAN
OCEAN
Cockburn Sound
Warnbro Sound
Geographe Bay
Cowcowing Lakes
Victoria Plains (S)
Gingin (S)
Chittering (S)
Toodyay (S)
Goomalling (S)
Dowerin (S)
Wyalkatchem (S)
Cunderdin (S)
Tammin (S)
Northam (T)
Northam (S)
York (S)
Quairading (S)
Beverley (S)
Brookton (S)
Pingelly (S)
Wandering (S)
Cuballing (S)
Boddington (S)
Narrogin (T)
Narrogin (S)
Williams (S)
Wagin (S)
West Arthur (S)
Collie (S)
Harvey (S)
Waroona (S)
Murray (S)
Mandurah (C)
Rockingham
Fremantle
Two Rocks
Joondalup
Bullsbrook
Midland
Mundaring
City of Perth
PERTH
Armadale
Jarrahdale
Pinjarra
Waroona
Mandurah
Bunbury (C)
Bunbury
Dardanup (S)
Capel (S)
Donnybrook-Balingup (S)
Busselton (S)
Boyup Brook (S)
Augusta-Margaret River (S)
Bridgetown-Greenbushes (S)
Nannup (S)
NORTH BOYANUP DISTRICT STRUCTURE PLAN
Dialogue with the City
N
0 10 20 30 40 50
Kilometres
LEGEND
Dialogue with the City Area
Local Government Boundary
Greater Perth Boundary
North Boyanup District Structure Plan Boundary

Figure 3

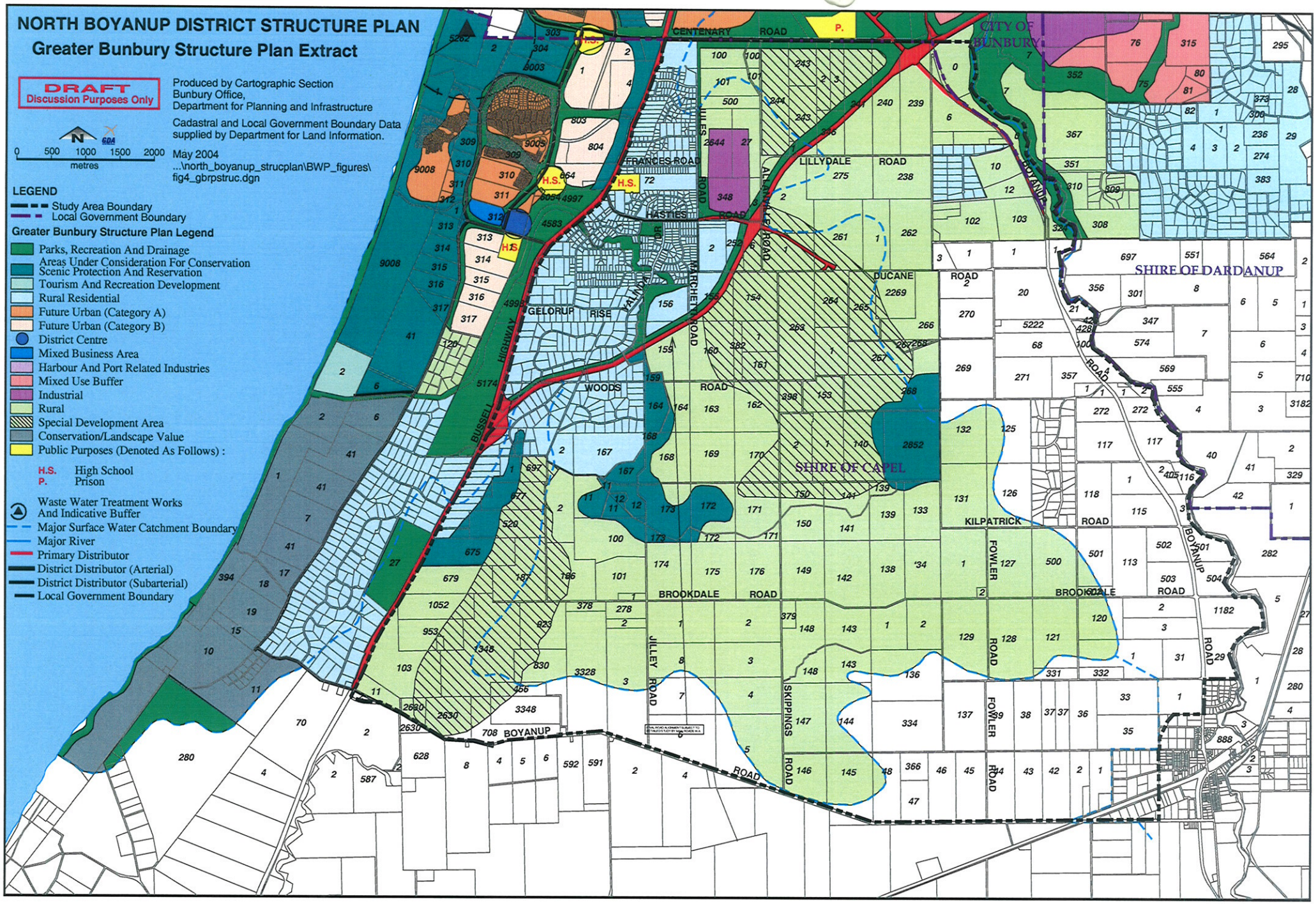

NORTH BOYANUP DISTRICT STRUCTURE PLAN
Greater Bunbury Structure Plan Extract
DRAFT
Discussion Purposes Only
Produced by Cartographic Section
Bunbury Office,
Department for Planning and Infrastructure
Cadastral and Local Government Boundary Data
supplied by Department for Land Information.
N
GDA
0 500 1000 1500 2000
metres
May 2004
...\north_boyanup_strucplan\BWP_figures\
fig4_gbrpstruc.dgn
LEGEND
Study Area Boundary
Local Government Boundary
Greater Bunbury Structure Plan Legend
Parks, Recreation And Drainage
Areas Under Consideration For Conservation
Scenic Protection And Reservation
Tourism And Recreation Development
Rural Residential
Future Urban (Category A)
Future Urban (Category B)
District Centre
Mixed Business Area
Harbour And Port Related Industries
Mixed Use Buffer
Industrial
Rural
Special Development Area
Conservation/Landscape Value
Public Purposes (Denoted As Follows) :
H.S. High School
P. Prison
Waste Water Treatment Works
And Indicative Buffer
Major Surface Water Catchment Boundary
Major River
Primary Distributor
District Distributor (Arterial)
District Distributor (Subarterial)
Local Government Boundary
CENTENARY ROAD
CITY OF BUNBURY
SHIRE OF DARDANUP
SHIRE OF CAPEL
FRANCES ROAD
LILLYDALE ROAD
HASTIES ROAD
ALLANSVILLE ROAD
JULES ROAD
MARCHETTI ROAD
VALMAR ROAD
GELORUP RISE
DUCANE ROAD
WOODS ROAD
BUSSELL HIGHWAY
KILPATRICK ROAD
FOWLER ROAD
BROOKDALE ROAD
BOYANUP ROAD
JILLEY ROAD
SKIPPINGS ROAD
BOYANUP

Figure 4

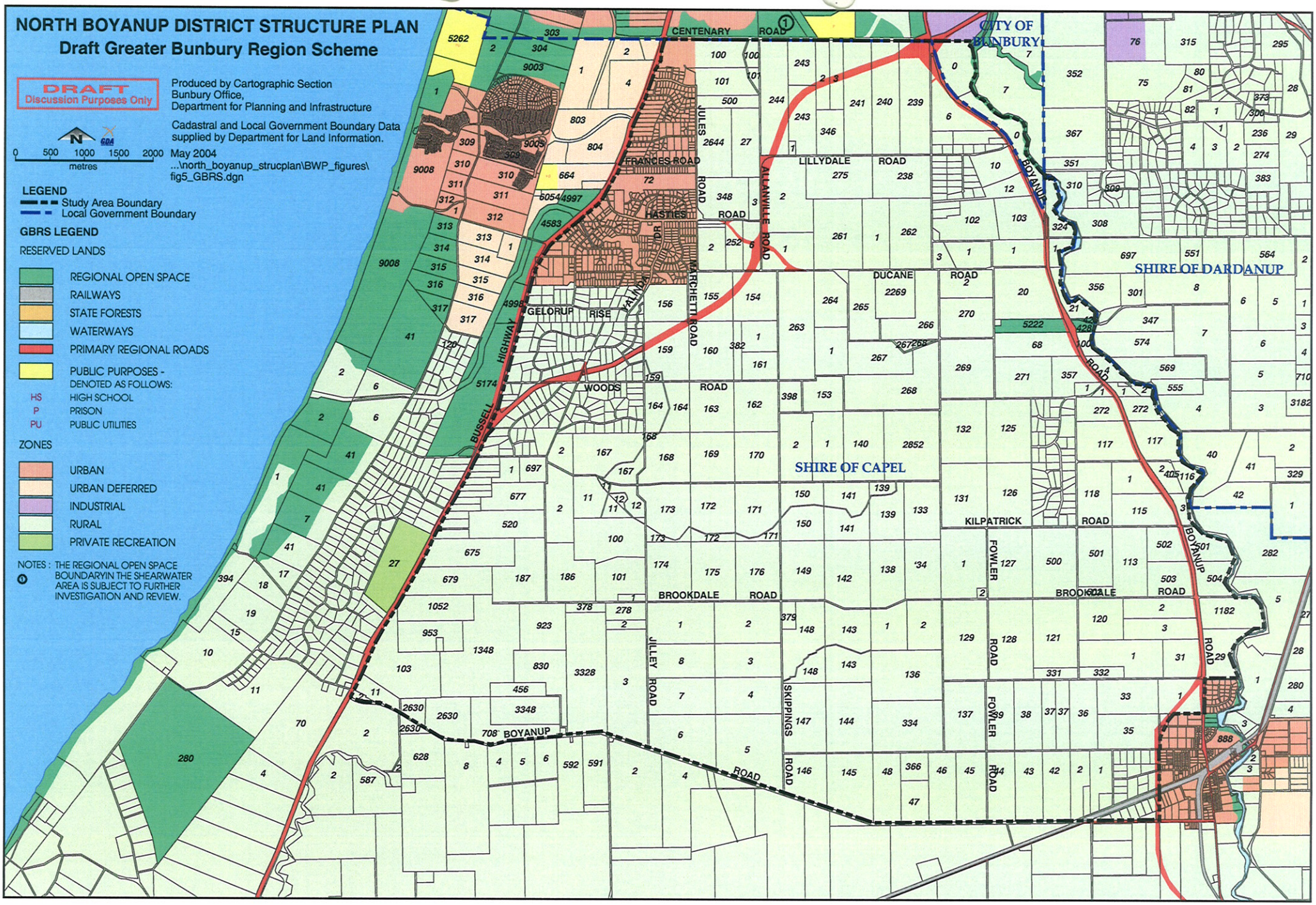

NORTH BOYANUP DISTRICT STRUCTURE PLAN
Draft Greater Bunbury Region Scheme
DRAFT
Discussion Purposes Only
Produced by Cartographic Section
Bunbury Office,
Department for Planning and Infrastructure
Cadastral and Local Government Boundary Data
supplied by Department for Land Information.
May 2004
...\north_boyanup_strucplan\BWP_figures\
fig5_GBRS.dgn
0 500 1000 1500 2000
metres
LEGEND
Study Area Boundary
Local Government Boundary
GBRS LEGEND
RESERVED LANDS
REGIONAL OPEN SPACE
RAILWAYS
STATE FORESTS
WATERWAYS
PRIMARY REGIONAL ROADS
PUBLIC PURPOSES -
DENOTED AS FOLLOWS:
HS HIGH SCHOOL
P PRISON
PU PUBLIC UTILITIES
ZONES
URBAN
URBAN DEFERRED
INDUSTRIAL
RURAL
PRIVATE RECREATION
NOTES : THE REGIONAL OPEN SPACE BOUNDARYIN THE SHEARWATER AREA IS SUBJECT TO FURTHER INVESTIGATION AND REVIEW.
CENTENARY ROAD
CITY OF BUNBURY
SHIRE OF DARDANUP
SHIRE OF CAPEL
LILLYDALE ROAD
DUCANE ROAD
KILPATRICK ROAD
BROOKDALE ROAD
BOYANUP ROAD
FRANCES ROAD
HASTIES ROAD
ALLANVILLE ROAD
MARCHETTI ROAD
JULES ROAD
JULLEY ROAD
SKIPPINGS ROAD
FOWLER ROAD
BUSSELL HIGHWAY
GELORUP
RISE
WOODS

Figure 5

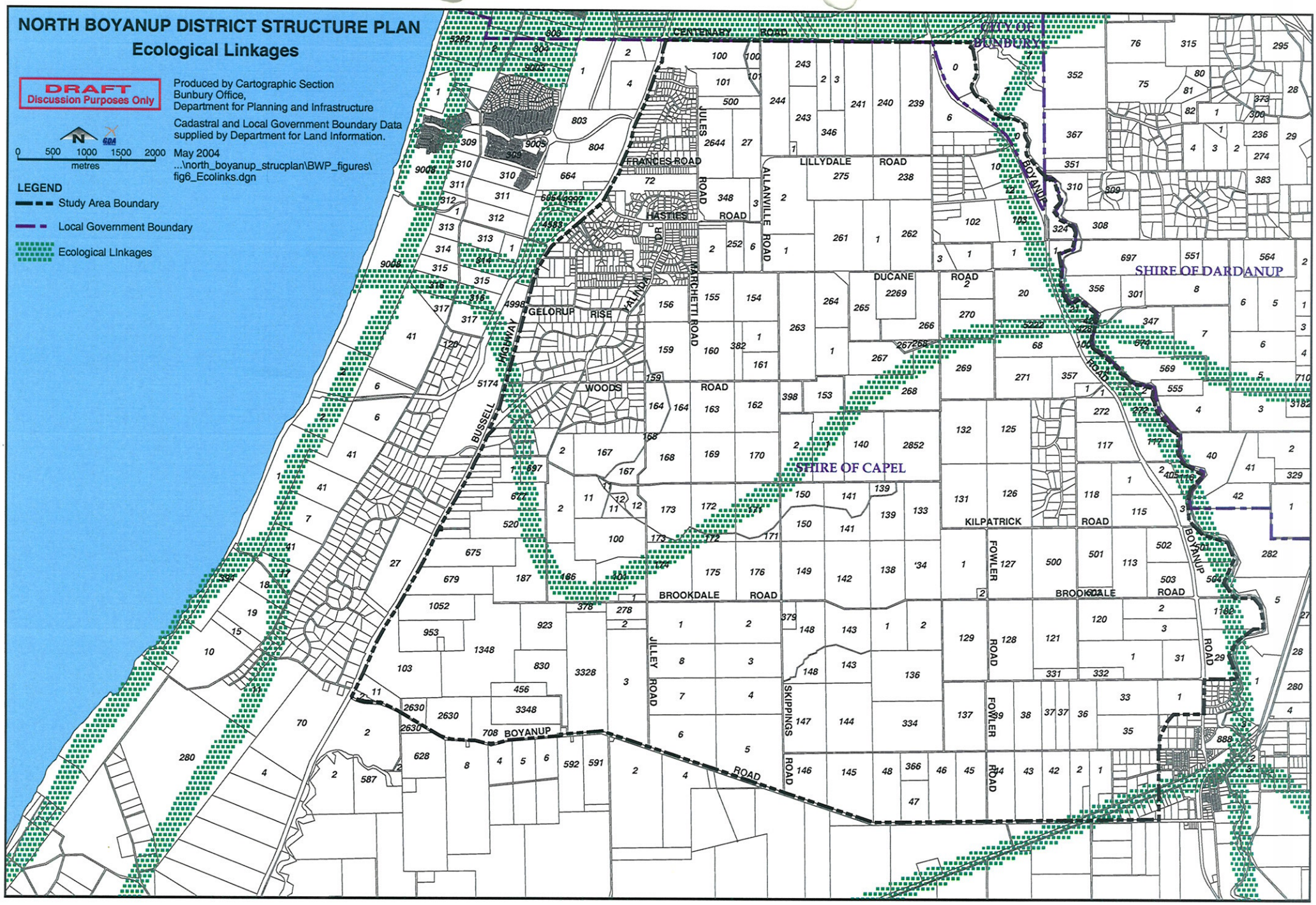

NORTH BOYANUP DISTRICT STRUCTURE PLAN
Ecological Linkages
DRAFT
Discussion Purposes Only
Produced by Cartographic Section
Bunbury Office,
Department for Planning and Infrastructure
Cadastral and Local Government Boundary Data
supplied by Department for Land Information.
0 500 1000 1500 2000
metres
May 2004
...\north_boyanup_strucplan\BWP_figures\
fig6_Ecolinks.dgn
LEGEND
Study Area Boundary
Local Government Boundary
Ecological LInkages
CENTENARY ROAD
CITY OF BUNBURY
SHIRE OF DARDANUP
SHIRE OF CAPEL
LILLYDALE ROAD
FRANCES ROAD
HASTIES ROAD
JULES ROAD
ALLANVILLE ROAD
DUCANE ROAD
BOYANUP ROAD
GELORUP RISE
MARCHETTI ROAD
WOODS ROAD
BUSSELL HIGHWAY
KILPATRICK ROAD
BROOKDALE ROAD
FOWLER ROAD
JILLEY ROAD
SKIPPINGS ROAD
BOYANUP ROAD

Figure 6

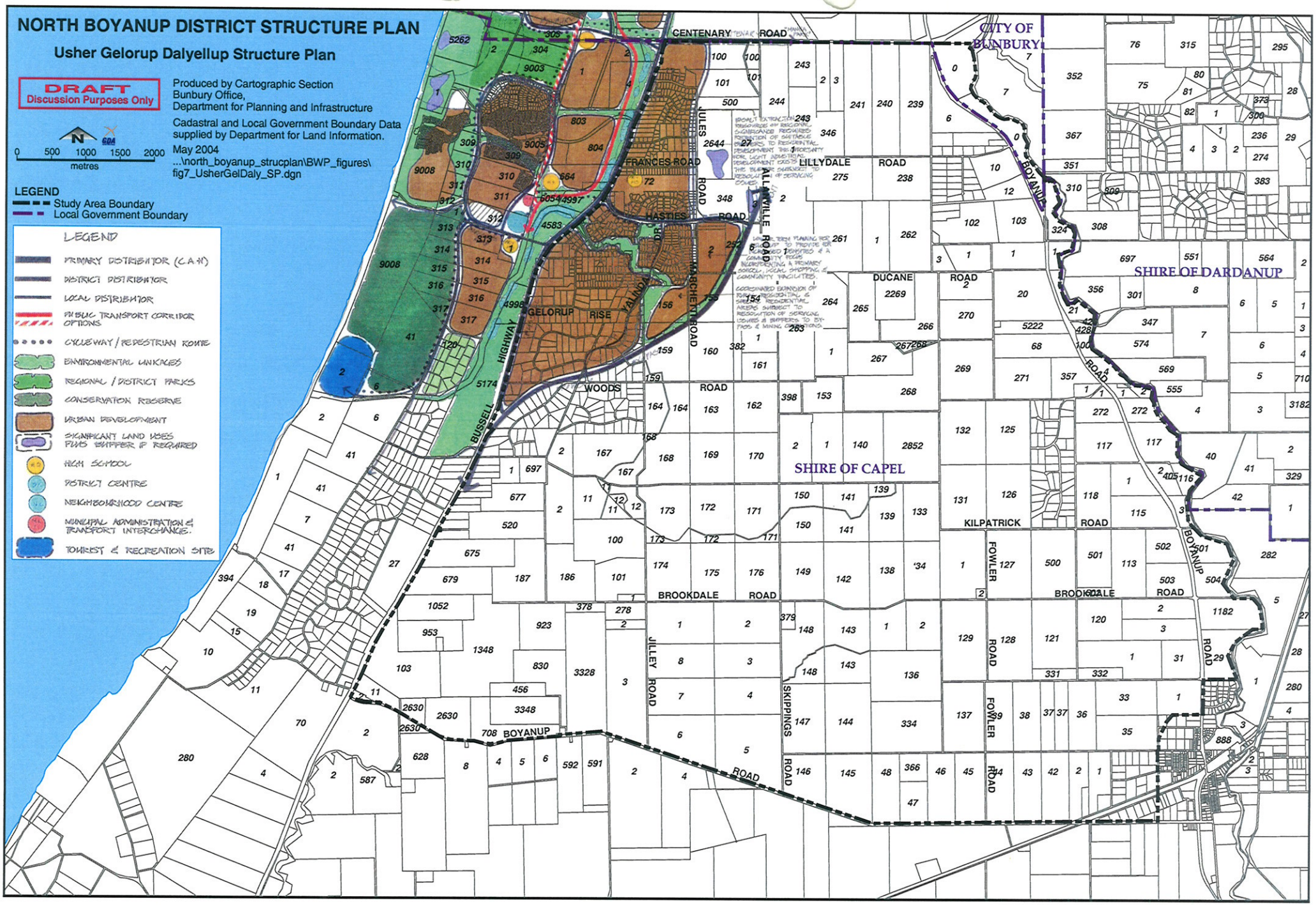

NORTH BOYANUP DISTRICT STRUCTURE PLAN
Usher Gelorup Dalyellup Structure Plan
DRAFT
Discussion Purposes Only
Produced by Cartographic Section
Bunbury Office,
Department for Planning and Infrastructure
Cadastral and Local Government Boundary Data
supplied by Department for Land Information.
May 2004
...\north_boyanup_strucplan\BWP_figures\
fig7_UsherGelDaly_SP.dgn
0 500 1000 1500 2000
metres
LEGEND
Study Area Boundary
Local Government Boundary
LEGEND
PRIMARY DISTRIBUTOR (C.A.H)
DISTRICT DISTRIBUTOR
LOCAL DISTRIBUTOR
PUBLIC TRANSPORT CORRIDOR OPTIONS
CYCLEWAY / PEDESTRIAN ROUTE
ENVIRONMENTAL LINKAGES
REGIONAL / DISTRICT PARKS
CONSERVATION RESERVE
URBAN DEVELOPMENT
SIGNIFICANT LAND USES PLUS BUFFER IF REQUIRED
HIGH SCHOOL
DISTRICT CENTRE
NEIGHBOURHOOD CENTRE
MUNICIPAL ADMINISTRATION & TRANSPORT INTERCHANGE.
TOURIST & RECREATION SITE
CENTENARY ROAD
CITY OF BUNBURY
SHIRE OF DARDANUP
SHIRE OF CAPEL
FRANCES ROAD
HASTIES ROAD
LILLYDALE ROAD
ALLANVILLE ROAD
JULES ROAD
MACHELL ROAD
DUCANE ROAD
GELORUP RISE
VALLEY DR
HIGHWAY
BUSSELL
WOODS ROAD
BROOKDALE ROAD
JILLEY ROAD
SKIPPINGS ROAD
KILPATRICK ROAD
FOWLER ROAD
BOYANUP ROAD
BOYANUP

Figure 7

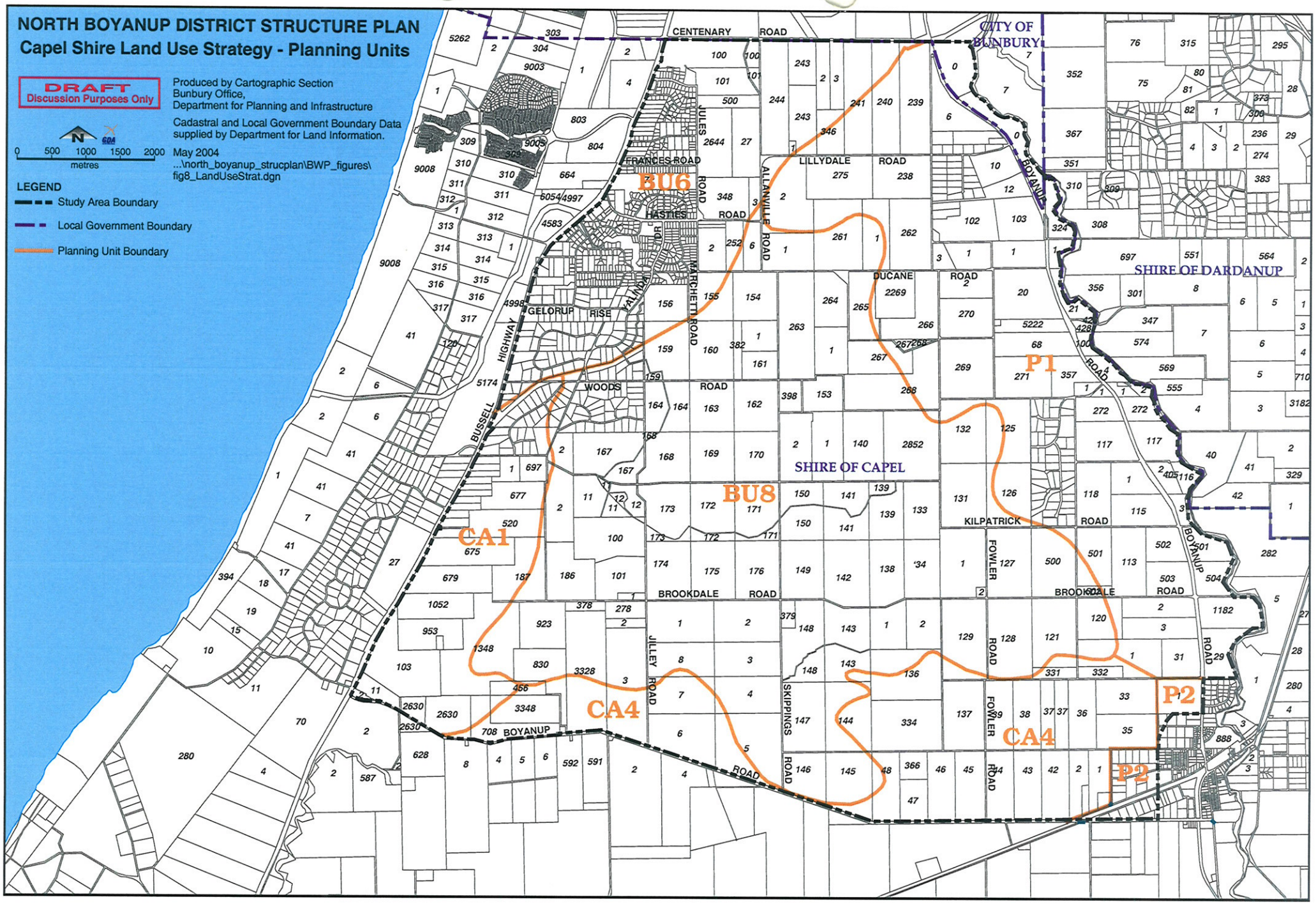

NORTH BOYANUP DISTRICT STRUCTURE PLAN
Capel Shire Land Use Strategy - Planning Units
DRAFT
Discussion Purposes Only
Produced by Cartographic Section
Bunbury Office,
Department for Planning and Infrastructure
Cadastral and Local Government Boundary Data supplied by Department for Land Information.
0 500 1000 1500 2000
metres
May 2004
...\north_boyanup_strucplan\BWP_figures\fig8_LandUseStrat.dgn
LEGEND
Study Area Boundary
Local Government Boundary
Planning Unit Boundary
CENTENARY ROAD
CITY OF BUNBURY
SHIRE OF DARDANUP
SHIRE OF CAPEL
BU6
BU8
CA1
CA4
P1
P2
FRANCES ROAD
HASTIES ROAD
LILLYDALE ROAD
DUCANE ROAD
GELORUP RISE
WOODS ROAD
KILPATRICK ROAD
BROOKDALE ROAD
BOYANUP ROAD
JULES ROAD
ALLANVILLE ROAD
MARCHETTI ROAD
HIGHWAY
BUSSELL
JILLEY ROAD
SKIPPINGS ROAD
FOWLER ROAD

Figure 8

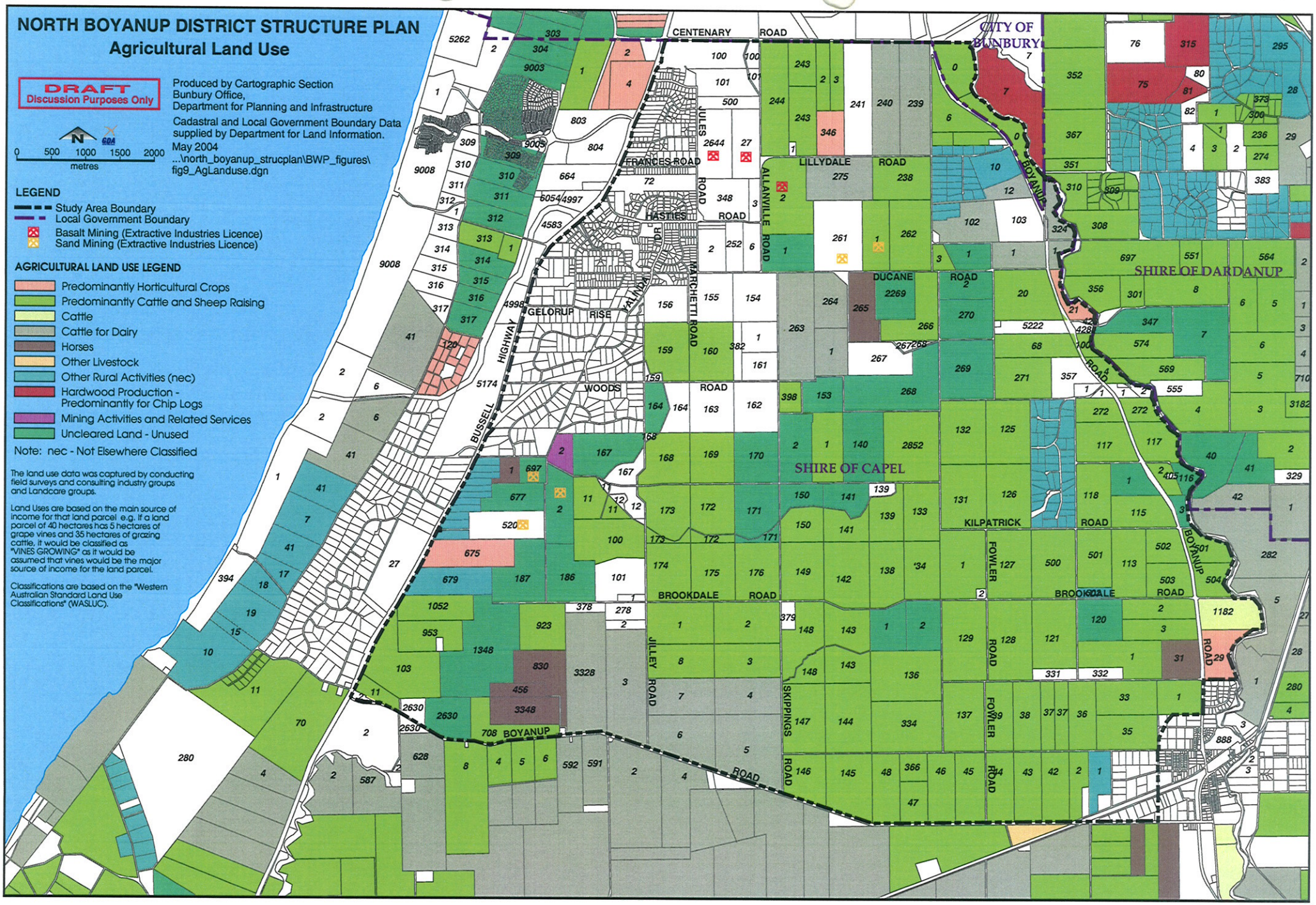

NORTH BOYANUP DISTRICT STRUCTURE PLAN
Agricultural Land Use
DRAFT
Discussion Purposes Only
Produced by Cartographic Section
Bunbury Office,
Department for Planning and Infrastructure
Cadastral and Local Government Boundary Data supplied by Department for Land Information.
May 2004
...\north_boyanup_strucplan\BWP_figures\fig9_AgLanduse.dgn
0 500 1000 1500 2000
metres
LEGEND
Study Area Boundary
Local Government Boundary
Basalt Mining (Extractive Industries Licence)
Sand Mining (Extractive Industries Licence)
AGRICULTURAL LAND USE LEGEND
Predominantly Horticultural Crops
Predominantly Cattle and Sheep Raising
Cattle
Cattle for Dairy
Horses
Other Livestock
Other Rural Activities (nec)
Hardwood Production - Predominantly for Chip Logs
Mining Activities and Related Services
Uncleared Land - Unused
Note: nec - Not Elsewhere Classified
The land use data was captured by conducting field surveys and consulting industry groups and Landcare groups.
Land Uses are based on the main source of income for that land parcel e.g. If a land parcel of 40 hectares has 5 hectares of grape vines and 35 hectares of grazing cattle, it would be classified as "VINES GROWING" as it would be assumed that vines would be the major source of income for the land parcel.
Classifications are based on the "Western Australian Standard Land Use Classifications" (WASLUC).
CENTENARY ROAD
CITY OF BUNBURY
SHIRE OF DARDANUP
SHIRE OF CAPEL
LILLYDALE ROAD
FRANCES ROAD
HASTIES ROAD
ALLANVILLE ROAD
JULES ROAD
MARCHETTI ROAD
DUCANE ROAD
GELORUP RISE
WOODS ROAD
HIGHWAY
BUSSELL
KILPATRICK ROAD
BROOKDALE ROAD
FOWLER ROAD
BOYANUP ROAD
JILLEY ROAD
SKIPPINGS ROAD
BOYANUP

Figure 9

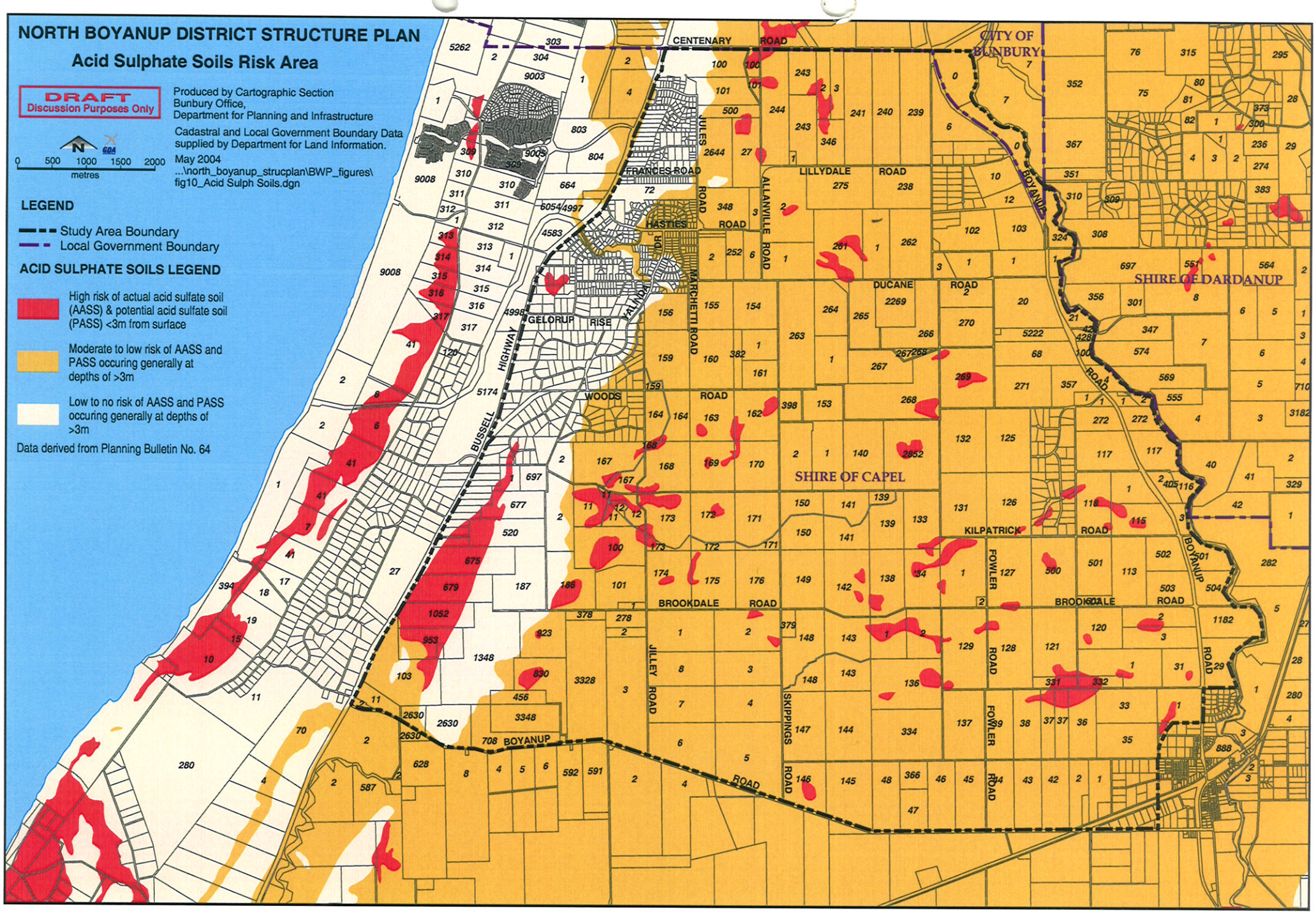

NORTH BOYANUP DISTRICT STRUCTURE PLAN
Acid Sulphate Soils Risk Area
DRAFT
Discussion Purposes Only
Produced by Cartographic Section
Bunbury Office,
Department for Planning and Infrastructure
Cadastral and Local Government Boundary Data supplied by Department for Land Information.
May 2004
...\north_boyanup_strucplan\BWP_figures\
fig10_Acid Sulph Soils.dgn
0 500 1000 1500 2000
metres
LEGEND
Study Area Boundary
Local Government Boundary
ACID SULPHATE SOILS LEGEND
High risk of actual acid sulfate soil (AASS) & potential acid sulfate soil (PASS) <3m from surface
Moderate to low risk of AASS and PASS occuring generally at depths of >3m
Low to no risk of AASS and PASS occuring generally at depths of >3m
Data derived from Planning Bulletin No. 64
CENTENARY ROAD
CITY OF BUNBURY
SHIRE OF DARDANUP
SHIRE OF CAPEL
FRANCES ROAD
LILLYDALE ROAD
HASTIES ROAD
DUCANE ROAD
GELORUP RISE
WOODS ROAD
KILPATRICK ROAD
BROOKDALE ROAD
BOYANUP ROAD
HIGHWAY
BUSSELL
JULES
ALLANVILLE ROAD
MARCHETTI ROAD
YALINDA
FOWLER
JILLEY ROAD
SKIPPINGS ROAD

Figure 10

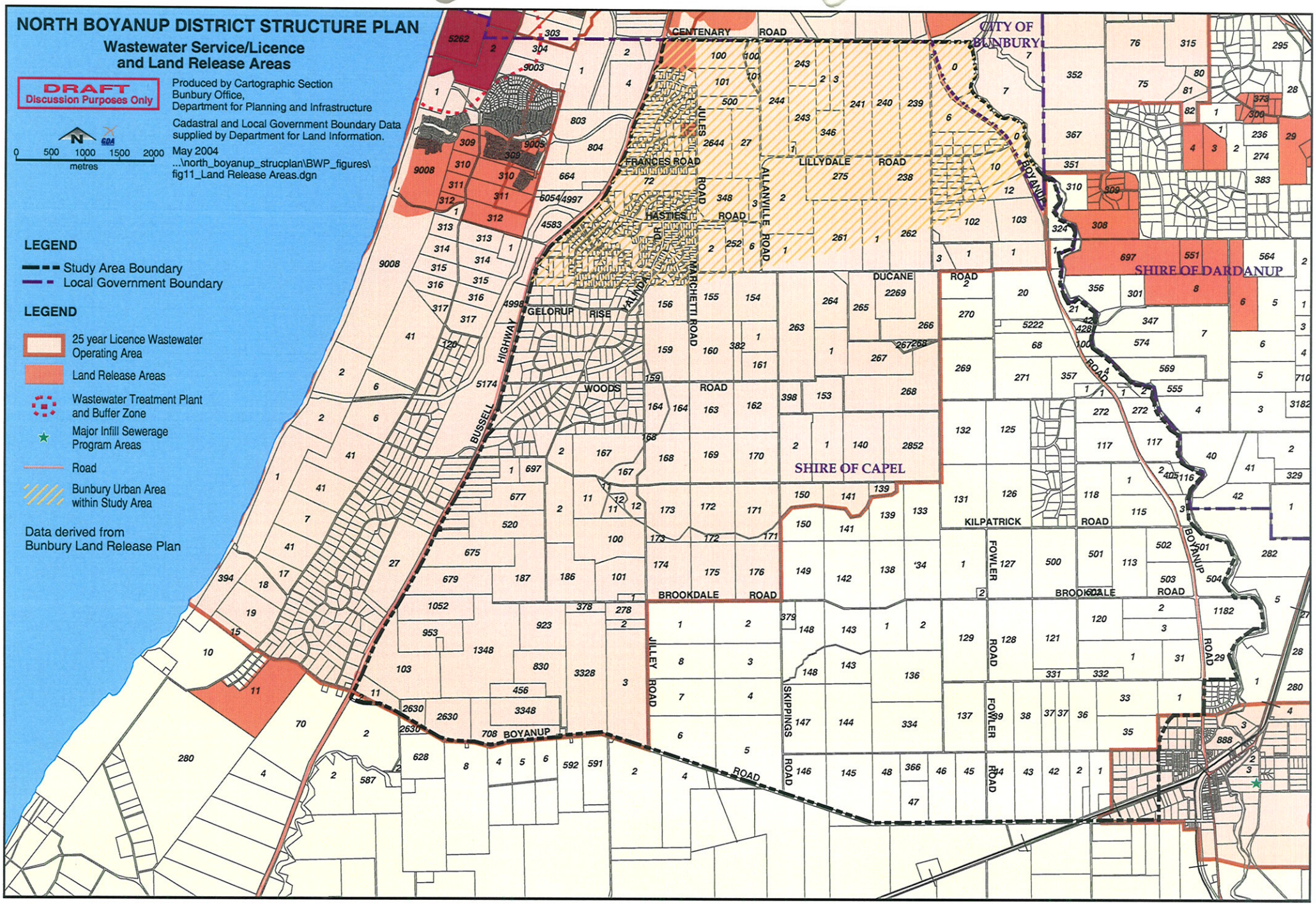

NORTH BOYANUP DISTRICT STRUCTURE PLAN
Wastewater Service/Licence
and Land Release Areas
DRAFT
Discussion Purposes Only
Produced by Cartographic Section
Bunbury Office,
Department for Planning and Infrastructure
Cadastral and Local Government Boundary Data
supplied by Department for Land Information.
May 2004
...\north_boyanup_strucplan\BWP_figures\
fig11_Land Release Areas.dgn
0 500 1000 1500 2000
metres
LEGEND
Study Area Boundary
Local Government Boundary
LEGEND
25 year Licence Wastewater
Operating Area
Land Release Areas
Wastewater Treatment Plant
and Buffer Zone
Major Infill Sewerage
Program Areas
Road
Bunbury Urban Area
within Study Area
Data derived from
Bunbury Land Release Plan
CENTENARY ROAD
CITY OF BUNBURY
SHIRE OF DARDANUP
SHIRE OF CAPEL
FRANCES ROAD
HASTIES ROAD
LILLYDALE ROAD
JULES ROAD
ALLANVILLE ROAD
BOYANUP ROAD
DUCANE ROAD
MARCHETTI ROAD
GELORUP RISE
YALINDA HOLT
HIGHWAY
BUSSELL
WOODS ROAD
KILPATRICK ROAD
FOWLER ROAD
BROOKDALE ROAD
JILLEY ROAD
SKIPPINGS ROAD
BOYANUP ROAD

Figure 11