City of Wanneroo Town Planning Scheme No. 1 Amendment 837 - Rezone from Rural to Rural Community, Lots 201 and 202 Breakwater Drive, Two Rocks

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City of Wanneroo

Report and recommendations of the Environmental Protection Authority

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Summary and recommendations

The City of Wanneroo proposes to rezone Lots 201 and 202 Breakwater Drive, Two Rocks from the zoning of "Rural" to "Rural Community". This report provides the Environmental Protection Authority's (EPA's) advice and recommendations to the Minister for the Environment on the environmental factors relevant to the proposed scheme amendment.

Section 48D of the *Environmental Protection Act 1986* requires the EPA to report to the Minister for the Environment on the environmental factors relevant to the scheme amendment and on the conditions and procedures to which the scheme amendment should be subject, if implemented. In addition, the EPA may make recommendations as it sees fit.

Relevant environmental factors

Although a number of environmental factors were considered by the EPA in the assessment, it is the EPA's opinion that the following are the environmental factors relevant to the proposed scheme amendment, which require detailed evaluation in the report:

a) vegetation - potential for direct impacts on locally significant vegetation within the amendment area involving habitat loss, and potential indirect impacts on adjacent areas of regionally significant vegetation identified in draft *Perth's Bushplan* (Government of Western Australia, 1998);

b) stygofauna and troglobitic fauna - potential for adverse impacts on habitat areas of species of stygofauna (habitat areas are karst wetlands) and troglobitic fauna including pollution of groundwater and water table drawdowns;

c) karst - potential for adverse impacts on karstic landforms;

d) groundwater quality - potential for adverse impacts on habitat areas of species of stygofauna and troglobitic fauna, regionally significant vegetation, regional water supply and other beneficial uses; and

e) Aboriginal Culture and Heritage - potential for adverse impacts on an ethnographic site of Aboriginal significance.

Conclusion

The EPA has concluded that Amendment 837 to the City of Wanneroo's TPS No. 1 to rezone Lots 201 and 202 Breakwater Drive, Two Rocks from "Rural" to "Rural Community" can be implemented to meet the EPA's objectives provided the conditions recommended in Section 4 and set out in detail in Appendix 3 are imposed and enforced.

Recommendations

The EPA submits the following recommendations to the Minister for the Environment:

1. That the Minister notes that the amendment being assessed is for the rezoning of Lots 201 and 202 Breakwater Drive, Two Rocks from "Rural" to "Rural Community".

2. That the Minister considers the report on the relevant environmental factors of vegetation, stygofauna and troglobitic fauna, karst, groundwater quality and Aboriginal Culture and Heritage as set out in Section 3.

3. That the Minister notes that the EPA has concluded that the EPA's objectives can be met, provided there is satisfactory implementation by the Responsible Authority of the recommended conditions summarised in Section 4 and set out in detail in Appendix 3.

4. That the Minister imposes the conditions and procedures recommended in Appendix 3 of this report.

5. That the Minister notes that where any future development proposal complies with the Plans and raises no additional environmental factors, the development proposal will not normally be subject to further assessment under Part IV of the *Environmental Protection*

Act 1986. However, future development proposals will still be subject to the normal development approvals process, including licensing and pollution control environmental conditions of the *Environmental Protection Act 1986* where applicable.

Conditions

Having considered the information provided in this report, the EPA has developed a set of conditions which the EPA recommends be imposed if the Amendment is approved. These conditions are presented in Appendix 3. Matters addressed in the conditions include the following:

a) a Vegetation Management Plan be prepared and implemented for the Amendment area;

b) a Drainage, Nutrient and Water Management Plan be prepared and implemented for the Amendment area;

c) a Karst Management Strategy be prepared and implemented for the Amendment area;

d) an Aboriginal Heritage Management Plan be prepared for the Amendment area; and

e) a Land Capability Assessment and Site Analysis be prepared for the Amendment area.

Contents

1. Introduction

The City of Wanneroo, the Responsible Authority, proposes to rezone Lots 201 and 202 Breakwater Drive, Two Rocks to "Rural Community" from the existing Town Planning Scheme (TPS) No. 1 zoning of "Rural" (Figure 1).

The proposed amendment was referred by the City of Wanneroo to the EPA under Section 48A of the *Environmental Protection Act 1986* . The EPA subsequently set the level of assessment for the proposed amendment at Environmental Review (ER). This decision was based upon the potentially adverse impacts which the proposal could have upon the karstic terrain within the Amendment area and the significant communities of stygofauna and troglobitic fauna which could possibly be associated with this environment.

Karstic areas are of interest to the EPA as there are limited places in which these environments are found in WA. Karst areas are one of the most sensitive of all geomorphic environments, that is, they have a low capacity to cope with disturbance, and are difficult, if not impossible, to restore once degraded. These unique environments also support stygofauna and troglobitic fauna and specifically in relation to the Amendment area, may support aquatic root mat communities (stygofauna) of caves of the Swan Coastal Plain. These communities have been identified as "Critically Endangered" in the report "Identifying and conserving threatened ecological communities (TEC's) in the South West Botanical Province" (English and Blyth, 1997) and are known to occur just south of the Amendment area in Yanchep National Park. Other issues considered when setting the level of assessment included:

- the entire Amendment area being surrounded by regionally significant vegetation identified in draft *Perth's Bushplan* (Government of Western Australia, 1998); and
- the potential for a Public Water Supply area to be contaminated given that the Amendment area falls within the Perth Coastal Underground Water Pollution Control Area (UWPCA), a Proclaimed Priority 3 water supply area.

In compiling this report, the EPA has considered the relevant environmental factors associated with the scheme amendment, issues raised in public submissions, specialist advice from the Department of Environmental Protection (DEP) and other government agencies, the Responsible Authority's response to submissions and the EPA's own research and expertise.

Further details of the proposed amendment are presented in Section 2 of this Report. Section 3 discusses environmental factors relevant to the scheme amendment. The conditions and procedures to which the scheme amendment should be subject, if the Minister determines that it may be implemented, are set out in Section 4. Section 5 provides Other Advice of the EPA. Section 6 presents the EPA's Conclusions and Section 7, the EPA's Recommendations.

A list of people and organisations that made submissions is included in Appendix 1. References are listed in Appendix 2, and recommended conditions and procedures and Responsible Authority's management measures are provided in Appendix 3.

Appendix 4 contains a summary of the public submissions and the Responsible Authority's response. The summary of public submissions and the Responsible Authority's response is included as a matter of information only and does not form part of the EPA's report and recommendations. The EPA has considered issues raised in public submissions when identifying and assessing relevant environmental factors.

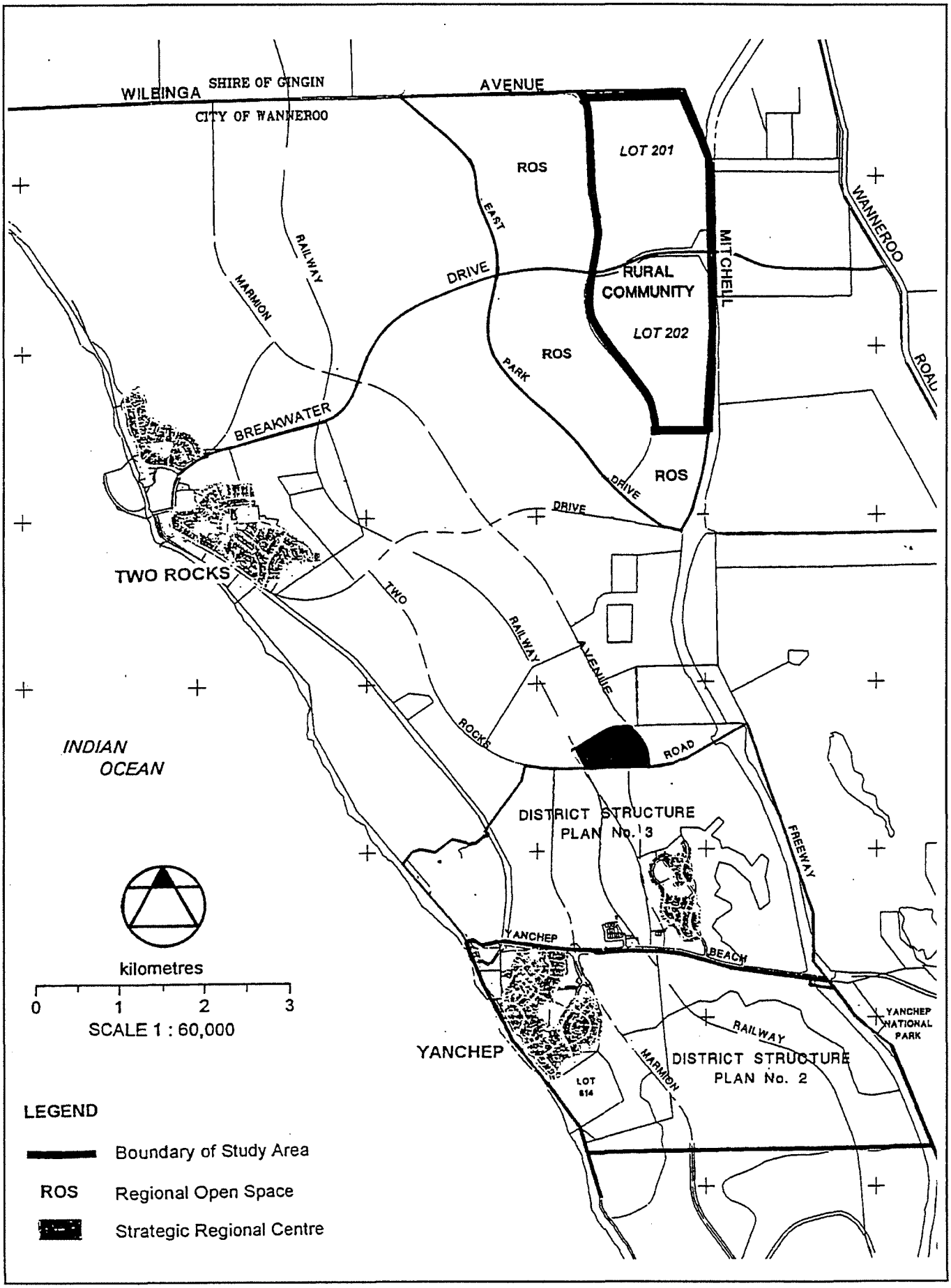

Figure 1. Location of Amendment area for City of Wanneroo Town Planning Scheme No.1, Amendment No.837.

2. The proposed scheme amendment

The Amendment area consists of both Lots 201 (278.45ha) and 202 (232.04ha) Breakwater Drive, Two Rocks (Figure 1). Both lots are zoned "Rural" under the Metropolitan Region Scheme (MRS) and the City of Wanneroo TPS No. 1. The area is bounded by the Mitchell Freeway reservation to the east, Caraban Management Priority area (part of State Forest No. 65) to the north, and Metropolitan Region Scheme (MRS) Parks and Recreation (P&R) reservations to the west and south. The land is divided by Breakwater Drive. The land is part of the extensive Yanchep-Two Rocks area landholding owned by Tokyu Corporation Pty Ltd.

The landowner is seeking a flexible zoning to accommodate either conventional rural-residential subdivision or cluster rural-residential subdivision, whilst including certain special provisions in the Scheme which would apply to the land irrespective of the type of subdivision finally approved. Detailed structure planning, subdivision and development of the site would be undertaken through subsequent steps in the planning process where the fine details of the proposal will be finalised.

Details of Amendment 837 are:

i) Introduce a Rural Community zone and associated new provisions into TPS No. 1;

ii) Rezone Lots 201 and 202 Breakwater Drive, Two Rocks from Rural to Rural Community;

iii) Introduce a new Schedule, Schedule 12 - Rural Community Zones and associated special provisions;

iv) Introduce a new Schedule, Schedule 13 - Environmental Conditions and associated text; and

v) Modifying relevant clauses in TPS No. 1 so that no development, or subdivision, occurs on land in Centre Zone, Urban Development Zone, Industrial Development Zone and the Rural Community Zone until a Structure Plan has been prepared.

A belt of karstic terrain containing numerous cavities and one, possibly two caves, crosses the Amendment area from the southeastern corner through to the northwestern corner. One of these caves has been identified by the Director of the Australian Institute of Aboriginal Studies (Canberra) as being a significant mythological site. Several stands of trees also remain within the amendment area but have not been identified as being regionally significant. However, the adjacent areas all contain regionally significant vegetation as identified by draft *Perth's Bushplan* (Government of Western Australia, 1998). The Amendment area is located within the Perth Coastal (Priority 3) UWPCA.

A summary of the key characteristics of the proposed scheme amendment is presented in Table 1. A detailed description of the scheme amendment is provided in Section 2 of the Environmental Review (ER) (Shire of Wanneroo, 1999).

The potential impacts of the proposed amendment initially predicted by the Responsible Authority in the ER document (Shire of Wanneroo, 1999) and their proposed management are summarised in Table 3.

3. Environmental factors

3.1 Relevant environmental factors

Section 48D of the *Environmental Protection Act 1986* requires the EPA to report to the Minister for the Environment on the environmental factors relevant to the proposed amendment and on the conditions and procedures to which the scheme amendment should be subject, if implemented. In addition, the EPA may make recommendations as it sees fit.

Table 1 - Summary of key proposal characteristics

Element	Description
Total area of land	approximately 510 hectares
Existing land uses	cattle grazing
Karstic terrain	A belt of karstic terrain extends from the southeastern corner of Lot 202 through to the northwestern corner of Lot 201 to the north
Vegetation	The Amendment area is surrounded by regionally significant vegetation identified in draft *Perth's Bushplan* (Site Nos 284, 396 and 406)
Groundwater	The Amendment area falls within the Perth Coastal (Priority 3) UWPCA
Existing zoning/reservation in the MRS and City of Wanneroo's TPS No. 1	"Rural"
Proposed scheme modifications to TPS No. 1	The City of Wanneroo TPS No. 1, Amendment 837 proposes to: • introduce a Rural Community zone and associated new provisions into TPS No. 1; • rezone Lots 201 and 202 Breakwater Drive, Two Rocks from Rural to Rural Community; • introduce a new Schedule, Schedule 12 - Rural Community Zones and associated special provisions; • introduce a new Schedule, Schedule 13 - Environmental Conditions and associated text; and • modifying relevant clauses in TPS No. 1 so that no development, or subdivision, occurs on land in Centre Zone, Urban Development Zone, Industrial Development Zone and the Rural Community Zone until a Structure Plan has been prepared.
Proposed environmental conditions	• Vegetation Management Plan • Drainage, Nutrient and Water Management Plan • Karst Management Strategy • Aboriginal Heritage Management Plan • Land Capability Assessment and Site Analysis

Having considered appropriate references, public and government submissions and the Responsible Authority's response to submissions, it is in the EPA's opinion, that the following are the environmental factors relevant to the proposed amendment:

a) vegetation - potential for direct impacts on locally significant vegetation within the amendment area including habitat loss, and potential indirect impacts on adjacent areas of regionally significant vegetation identified in draft *Perth's Bushplan* (Government of Western Australia, 1998);

b) stygofauna and troglobitic fauna - potential for adverse impacts on habitat areas of species of stygofauna (habitat areas are karst wetlands) and troglobitic fauna including pollution of groundwater and water table drawdowns;

c) karst - potential for adverse impacts on karstic landforms;

d) groundwater quality - potential for adverse impacts on habitat areas of species of stygofauna and troglobitic fauna, regionally significant vegetation, regional water supply and other uses; and

e) Aboriginal Culture and Heritage - potential for adverse impacts on an ethnographic site of Aboriginal significance.

The above relevant factors were identified from the EPA's consideration and review of all environmental factors (preliminary factors) generated from the ER document and the submissions received, in conjunction with the Amendment characteristics and alternative approval processes which ensure that the factors will be appropriately managed. On this basis, the EPA considers other issues raised in the submissions do not require further evaluation by the EPA. The identification process is summarised in Table 2 in Appendix 7.

The land subject to this assessment is within the area affected by the City of Wanneroo Town Planning Scheme No. 1, Amendment No. 837.

The relevant environmental factors are discussed in Sections 3.2 to 3.6 of this report and are summarised in Table 3 in Appendix 7.

3.2 Vegetation

Description

System Six Area M1 occurs in the northern half of the Amendment area. This area was recognised as containing vegetation of significant conservation value, some of it in a fragile state (Department of Conservation and Environment, 1983) (Figure 2). The M1 area has since been reassessed in 1992 by Alan Tingay & Associates as part of planning studies for the Yanchep/Two Rocks area. The assessment concluded that a significant portion of the area supported vegetation in a significantly disturbed condition and that a larger area of higher quality vegetation existed immediately north of the M1 area. Therefore, this portion of land to the north at Wilbinga has been identified as Bushplan Site No. 406 (Government of Western Australia, 1998) given its higher conservation values making it a suitable replacement for M1. This issue is discussed in further detail later.

Existing vegetation within the Amendment area consists of an Open Woodland of Tuart (*Eucalyptus gomphocephala*) with an associated Banksia (*Banksia attenuata*) Low Woodland. There are also small patches of Low Woodlands of Pricklybark and Woodlands of Limestone Marlock. Pockets of Jarrah (*Eucalyptus marginata / Eucalyptus decipiens*) Woodland also occur within the amendment area (Shire of Wanneroo, 1999).

The majority (approximately 95%) of the vegetation within the Amendment area is classified as a degraded area (ie completely, or almost completely, without native species in the structure of the vegetation) (Alan Tingay & Associates, 1992). However, there are two small areas of vegetation classified as "obvious disturbance" in the northwestern and eastern corners of the amendment area, and two centrally located stands of trees classified as "disturbed". These two stands, and one other just south of these, are considered to be locally significant, consisting of Tuart Woodland (two stands) and Jarrah Woodland. These stands provide an occasional habitat for two species of threatened fauna these being the Short-billed Black Cockatoo (*Calyptorhynchus latirostris*) (Schedule 1) and the Peregrine Falcon (*Falco peregrinus*) (Schedule 4). These two species are listed "in need of special protection" under the environmental conditions of the *Wildlife Conservation Act 1950.* Therefore, the protection of these stands is important to avoid habitat loss for these two species.

The Amendment area is surrounded by areas of regionally significant vegetation identified in the recently released draft *Perth's Bushplan* (Government of Western Australia, 1998) which is an update of *The Darling System - System 6* report (Department of Conservation and Environment, 1983) (Figure 2). On the eastern and western boundaries of the Amendment area

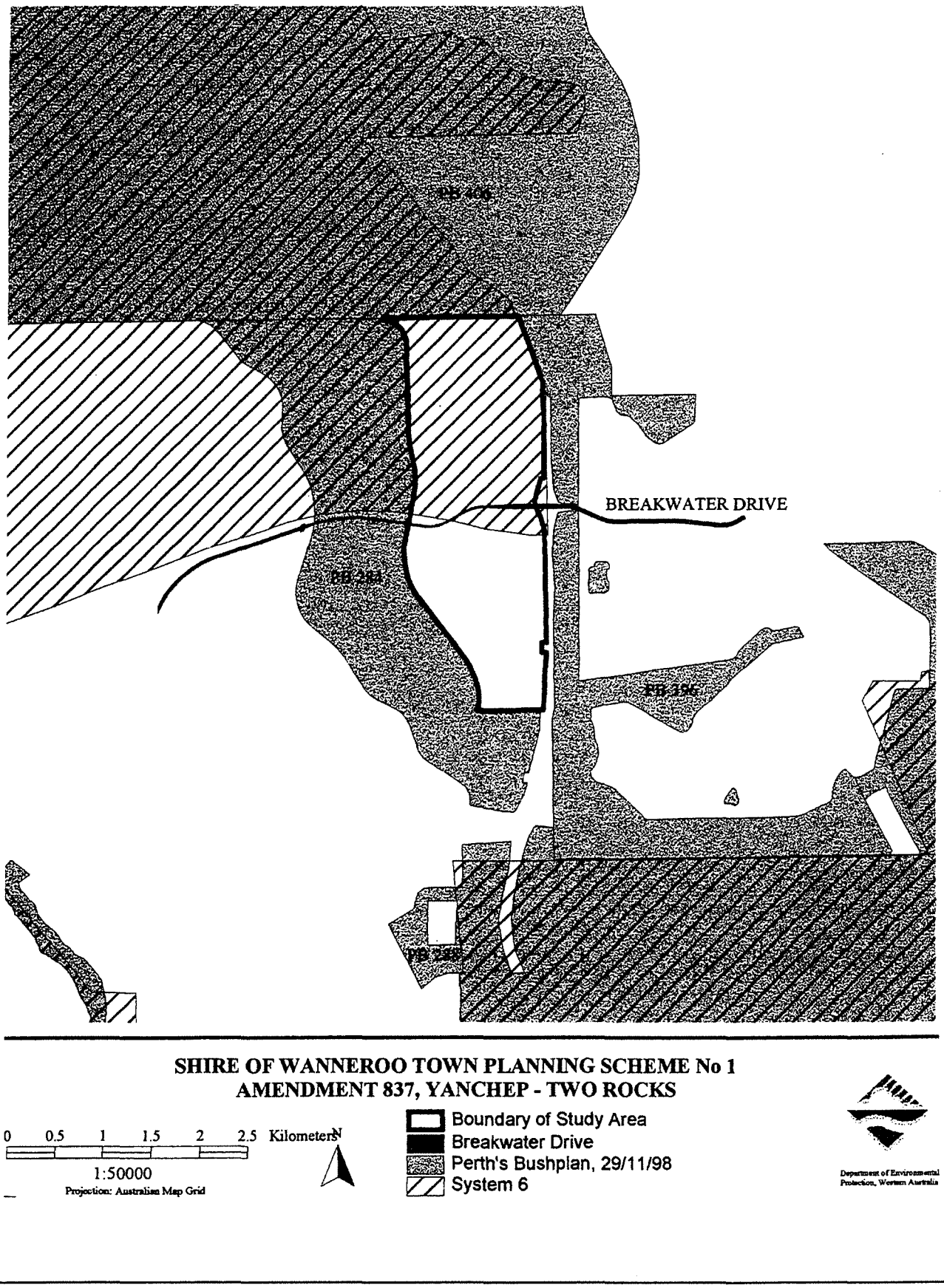

Figure 2. System Six areas and draft Perth's Bushplan areas within and adjacent to the Amendment area.

there are two Bushplan Sites (Nos 284 and 396) which both form part of a regionally significant contiguous bushland/wetland linkage [ie. a link between Wilbinga (to the north of the Amendment area) and Yanchep National Park (to the south)].

More than 75% of the vegetation in Site No. 284 (to the west) is in Very Good to Excellent condition, consisting of woodlands and mallees on limestone, Spearwood *Banksia attenuata - Eucalyptus* woodlands and *Acacia* shrublands on taller dunes. Within the site to the east (No. 396) the majority (greater than 90%) of the vegetation is in Excellent condition, consisting of, the Spearwood *Banksia attenuata - Eucalyptus* woodlands and the Northern Spearwood shrublands and woodlands (Government of Western Australia, 1998). The Wilbinga - Caraban Bushland (Bushplan Site No. 406 to the north) consists of at least nine regional floristic groups (including some of those above), one of which (limestone floristic community type 26a) has been recommended as a "critically threatened community" (Weston and Gibson, 1997).

Bushplan site Nos 406 and 284 also support populations of the Declared Rare Flora (DRF), *Eucalyptus argutifolia*, which is protected under the environmental conditions of the *Wildlife Conservation Act 1950*. The two closest populations occur to the west of the Amendment area with the largest population consisting of 45 mallees up to 4m tall. However, no species of Declared Rare Flora or Priority Flora were identified within the Amendment area. These two sites also support significant mammal species such as the Coastal Dunnart and Honey Possum (Site No. 284 only), and the Western Brush Wallaby (Government of Western Australia, 1998).

Assessment

The area considered for assessment of this factor is the Swan Coastal Plain.

The EPA's environmental objective for this factor is maintain the abundance, species diversity, geographic distribution and productivity of vegetation.

In December 1994 the EPA provided Section 16 advice to the State Planning Commission on the Central Coast Regional Strategy (State Planning Commission, 1994). In this advice the EPA recognised that the Wilbinga land had greater environmental and landscape attributes than the M1 area. Therefore, the Wilbinga area could be set aside for conservation as a replacement for the M1 area without compromising the conservation values sought to be protected by the System 6 recommendation M1 (EPA, 1994). However, the EPA also sought a high level of certainty that the land at Wilbinga would be retained primarily for conservation before it would be prepared to recommend to Government that M1 is not required for conservation (EPA, 1994). Subsequent to this the then Minister for the Environment indicated his intention to proceed with the conservation of Wilbinga and instructed the DEP to "ensure that the relevant portion of the Wilbinga land is included in the System 6 update" (EPA, 1996). Therefore, the relevant portion of the Wilbinga land has been included in draft *"Perth's Bushplan"* (Site No. 406) (Government of Western Australia, 1998). In 1998 Cabinet agreed that the Wilbinga area would form an important coastal component of the proposed "Gnangara Park" (discussed below) and as such would be managed for conservation (CALM, 1999).

Generally, the amendment area does not support vegetation of regional significance, however, it does contain vegetation of local significance (as described above), which provides wildlife habitat but is unlikely to support populations of DRF or Priority flora. The vegetation within the Amendment area is also in surrounding Bushplan Site Nos 284, 396 and 406. Site Nos 406 and 396 are both included within State Forest No. 65 which is managed by the Department of Conservation and Land Management (CALM). However, in 1996 Cabinet approved the concept of the development of "Gnangara Park" which will ultimately result in State Forest No. 65 being managed for conservation purposes by CALM following an amendment to the Metropolitan Region Scheme (MRS) to rezone the areas within the Park to Parks & Recreation (P&R) (CALM, 1999). A concept plan has since been released in May 1999 by CALM which identifies the main issues and discusses proposed directions for the Park.

The protection of groundwater resources and the reduction of the fire risk are key components of the Park concept. The development of the Park will constitute the removal of approximately 23,000 hectares of pine plantation to be replaced with native vegetation over the next 20 years. A further 27,000 hectares of surrounding State-owned Banksia woodlands will create a major park (CALM, 1999). Bushplan Site No. 284 is not proposed for inclusion within Gnangara Park, however, it is already reserved for P&R in the MRS.

The development of a Rural Community will impact directly on some areas of vegetation within the amendment area due to the need for some isolated clearing. This clearing will contribute directly to habitat loss within the amendment area. There is also the potential for indirect impacts on the adjacent Bushplan sites. These may include recreational activities, intrusion by domestic pets, weed invasion, an increase in the frequency of fires, litter, rubbish dumping, removal of firewood and the use of nutrients and pesticides associated with small scale agricultural activities.

To manage these potential impacts the draft scheme amendment has environmental conditions which involve the preparation and implementation of a Vegetation Management Plan by the subdivider at the Local Structure Planning (LSP) stage to the requirements of the Responsible Authority with the concurrence of the DEP and CALM (Shire of Wanneroo, 1999). The specifics of this Plan include:

- description of vegetation and vegetation values, and retention of significant areas of vegetation;
- retention of mature trees and all three significant stands of trees except where areas are suitable for agriculture, or a needed to accommodate utilities;
- use of firebreaks, fencing and paths to isolate Amendment area from adjacent Bushplan sites;
- management arrangements to protect soil and vegetation for areas for keeping of horses;
- weed control; and
- allocation of responsibilities and identification of timing for the implementation of the plan.

The Urban Bushland Council, the Wildflower Society of WA and CALM all raised concerns about the adequacy of the draft environmental conditions to manage the potential impacts on vegetation. CALM has requested that their advice be sought during the development of fire management strategies, and the allocation of landuses [at the Local Structure Planning (LSP) stage] adjacent to State Forest No. 65. CALM also indicated that it should not be presumed that bridle paths within Bushplan Site No. 284 and State Forest No. 65 will be acceptable.

The Urban Bushland Council and the Wildflower Society of WA raised the following concerns:

- the adequacy of the proposed management measures for indirect impacts on adjacent regionally significant vegetation, including the DRF species *Eucalyptus argutifolia;*
- the retention of remnant vegetation with a view to maintaining corridors for the provision of wildlife movement;
- the three remaining significant stands of trees within the amendment area are very important for wildlife habitat and as such should be retained;
- the adequacy of the vegetation condition ratings used in the ER;
- the use of provenance seed for rehabilitation;
- the definition of what is "locally significant"; and
- the ownership of cats within the proposed Rural Community should be discouraged to help protect fauna in the surrounding bushland areas of high conservation value.

To address these concerns the DEP negotiated with the Responsible Authority and the landowner following the public comment period to revise the Responsible Authority's draft environmental conditions. Firstly, these modifications entail the requirement for the subdivider

to also consult with appropriate community groups (ie. Wildflower Society of WA and the Urban Bushland Council) during the preparation of the Vegetation Management Plan. Secondly, the Vegetation Management Plan should address habitat loss more specifically and as such should be referred to as the "Vegetation and Fauna Management Plan". This Plan should recognise that the preservation of vegetation will also assist in maintaining the diversity of the fauna utilising the remnant vegetation as habitat. Therefore, the fauna values of the vegetation should be addressed in the Plan which should be modified to include the following:

- the definition and retention of "locally significant" areas of vegetation within the amendment area (which provides fauna habitat) with consideration to the creation of vegetation corridors to facilitate the movement of fauna and floristic genepools;
- retention of all three significant stands of trees to avoid habitat loss for fauna, particularly threatened fauna including the Peregrine Falcon and the Short-billed Black Cockatoo;
- the selection of landuses adjacent to the Bushplan sites in consultation with CALM;
- fire management;
- control of off-road vehicle use, dumping of rubbish and enhance community awareness of bushland protection;
- the development of bridle paths within the Amendment area only; and
- the use of provenance seed in rehabilitation.

Summary

Having particular regard to:

a) the values inferred in System Six Area M1 being replaced at Wilbinga which has higher conservation value;
b) the adjacent areas supporting regionally significant vegetation either reserved as P&R in the MRS or proposed for inclusion in "Gnangara Park" which will be established and managed by CALM;
c) the identification of three "locally significant" stands of trees within the amendment area which provide wildlife habitat;
d) the identification of a species of DRF occurring to the north and west of the Amendment area;
e) the fact that there will be consultation with the Urban Bushland Council, the Wildflower Society of WA and CALM during the preparation of the Vegetation and Fauna Management Plan; and
f) revised environmental conditions proposed by the Responsible Authority;

it is the EPA's opinion that given the environmental conditions discussed above the amendment can be managed to meet the EPA's objective for vegetation.

3.3 Stygofauna and Troglobitic fauna

Description

Troglobitic fauna are obligatory cave dwellers which show significant eye and pigment reduction as they are obliged to live in the deep zone (Gillieson, 1996). These creatures are terrestrial and may also inhabit interstitial and fissure habitats in the rock (Humphreys, 1993). For aquatic organisms there is a parallel classification. Stygofauna are those highly specialised animals living entirely in the groundwater environment and, therefore, absent in surface waters (Gillieson, 1996). Given the identification of a belt of karst (including one, possibly two caves) within the amendment area it is possible that these areas may be inhabited by troglobitic fauna and/or stygofauna.

The EPA identified stygofauna and troglobitic fauna as a relevant environmental factor principally for two reasons. Firstly, troglobitic fauna are confined to the deep zone in caves where there is no light and for this reason have a limited habitat. Secondly, studies of the stygofauna in Yanchep National Park have found abundant and diverse stygofauna communities

occur in the root mats (of overlying Tuart woodlands) which in turn occur in the epiphreatic streams that intersect karst formations (karst wetlands) in the Yanchep National Park area [Jasinka *et al* (1996), Jasinka and Knott (1991) and Jasinka (1990)]. These aquatic root mat communities of caves in the Swan Coastal Plain have been identified as Critically Endangered in a report by English and Blyth (1997). These communities may occur within the Amendment area as it is just north of Yanchep National Park and although subterranean aquifer water of the Gnangara Mound (immediately east of the amendment area) may be expected to have radial flow (ie. directly towards the Indian Ocean), local inhomogeneities of the geological strata may result in some subterranean connectivity with the groundwaters of Yanchep National Park.

An assessment of the karstic belt within the Amendment area (Figure 3) for troglobitic fauna and stygofauna identified two species of stygofauna (crangonyctoid amphipods and calanoid copepods) from samples of subterranean water taken from bores. These are still to be formally identified but are clearly interstitial by virtue of their small size (~600µm) and lack of pigmentation. These species appear to be not restricted to the critically endangered "Aquatic Root Mat Communities of Caves of the Swan Coastal Plain". The one confirmed cave within the amendment area was also surveyed for stygofauna and troglobitic fauna. The survey identified very few tree roots at the bottom of the cave and there were no streams, therefore, there were no root mat communities.

No species of troglobitic fauna were identified within this cave. No attempt was made to explore what may have been a second cave (a hole leading into a cavern) given the unstable and dangerous nature of the sediments.

Assessment

The area considered for assessment of this factor is the Wanneroo Cave Belt.

The EPA's environmental objective for this factor is:

i) Ensure that stygofauna and troglobitic fauna, and habitat areas are adequately protected, in accordance with the *Wildlife Conservation Act 1950;* and

ii) Maintain the abundance, diversity and geographical distribution of stygofauna and troglobitic fauna.

The EPA recognises that the survey of the Amendment area did not identify any species of stygofauna which are restricted to the aquatic root mats of epiphreatic streams in caves. However, whilst the survey of the Amendment area may have been limited, the EPA recognises that it was due to the great difficulty encountered in undertaking a drilling program (due to the sandy soils within the Amendment area), and the very unstable nature of the sediments in the other possible cave, creating a highly dangerous environment. The EPA also considers that for two reasons it is expected that a limited stygofauna assemblage would occur within the amendment area.

Firstly, five factors have been identified by Jasinka (1997) as controlling the development of tree root mats. These factors are:

1. Presence of trees above caves. Root mats in Australia are related to a number of species of trees, including *Eucalyptus gomphocephala*, *Casuarina* spp., *Corymbia calophylla*, *Agonis flexuosa* and *Ficus* spp.
2. Cavernous rock with fissures or solution channels, ie rock penetrable by roots.
3. Depth to cave waters of <30m, reflecting the limit to which tree roots can penetrate substrates.
4. Arid conditions in the cave atmosphere and soil above the cave for extended periods of the year.
5. Permanent streams or pools in caves.

The assessment of the karstic areas for stygofauna identified that there is no evidence to support the presence of subterranean streams or pools within the Amendment area. Therefore, given that this is a factor controlling root mat formation then its absence significantly reduces the likelihood of stygofauna occurring within the amendment area.

Secondly, connections have been demonstrated between the control that surface waters have on fauna in subterranean waters. Jasinka (1997) recognised six sources of aquatic cavernicoles (animals living in the waters in caves) at Yanchep. These include:

- interstitial groundwater species;
- aquatic surface water dwelling species representing burrow and other commensals;
- benthic and planktonic open water highly mobile forms and aquatic forms that move across land;
- surface water dwelling species with terrestrial adult stages and aquatic larvae;
- subterranean open water forms; and
- moist litter and wet-soil dwellers.

Therefore, it is apparent that surface waters serve as passageways for colonisation of subterranean waters and given that there are no surface waters within the Amendment area then there is a reduced possibility that root mat communities occur within the amendment area. The EPA still recognises, however, that two species of stygofauna have been identified within the Amendment area and may be impacted upon by the development of a Rural Community. The absence of a survey of the other possible cave due to the danger involved, may also mean that there is a potential for troglobitic fauna to occur within the amendment area.

In previous assessments of karstic environments in the Cape Range Karst Province in Exmouth the EPA has considered that the impact on water quality and water table levels of mining (EPA, 1997), water extraction (EPA, 1997a) and residential development (EPA, 1996) could significantly affect the habitat of stygofauna and troglobitic fauna. The EPA considers that these two issues also need to be addressed in this assessment and that cave sedimentation may also adversely impact upon stygofauna and troglobitic fauna (Gillieson, 1996).

The potential drawdown impacts of pumping water from the aquifer to service the Rural Community development have been modelled (using a simple lumped parameter analytical groundwater model) based on two development scenarios. These are:

- Scenario 1: 255 Rural-residential lots evenly distributed over the Amendment area or in numerous clusters with bushland in between; and
- Scenario 2: 300 Rural-residential lots with approximately 200ha under boutique agriculture.

The above two development scenarios are not those presented in the ER but are based on information provided after the public comment period by the Responsible Authority and the landowner. This amended modelling exercise is presented in Appendix 5.

A number of potential borefield configurations could supply these two development scenarios. The two most likely configurations which have been used in the modelling exercise are:

- five bores at 1km spacings supplying 2ML/d each for six months of the year (total of 10ML/d) and 1ML/d each average over the whole year (total of 5ML/d); and
- ten bores pumping at 1ML/d each for six months of the year, with five pumping at 1ML/d each all year.

Drawdowns have been predicted at two lines parallel to and located 200m and 500m from the line of the bores in the wellfield.

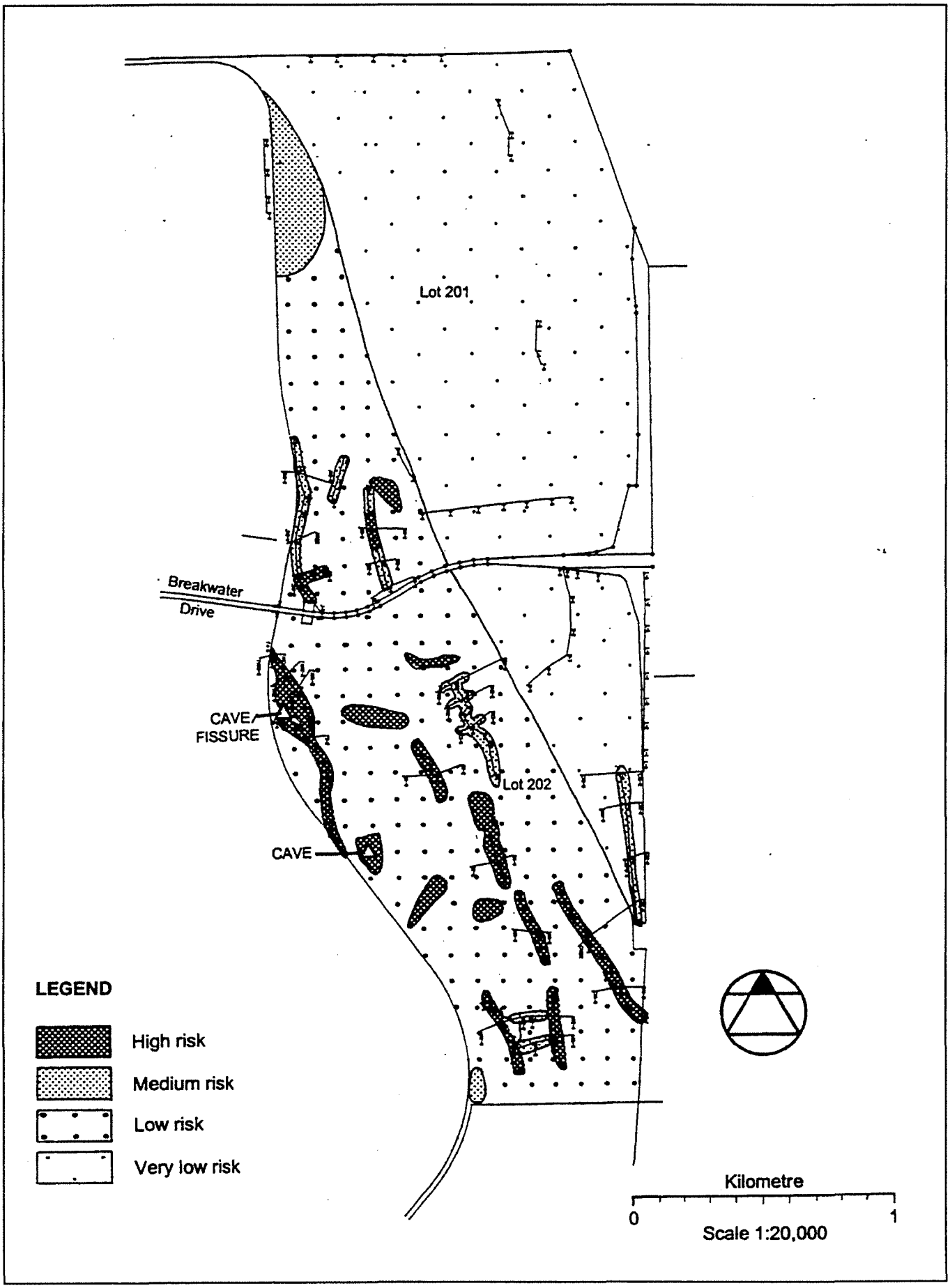

Figure 3. Summary of Karstic Terrain within the Amendment area.

The results of the modelling have indicated that under Scenario 2 (worst case scenario) water table drawdowns in the amendment area could vary between 0.5m (after 12 months average pumping) and 0.9m (after 6 months summer pumping) at a distance of 200m from the line of the wellfield. This figure then drops to 0.4m at 500m from the wellfield after 6 and 12 months of pumping. Dr Brenton Knott (UWA Zoology department) has provided comment that drawdowns of 0.5m would not affect the stygofauna assemblage identified within the Amendment area (B. Knott, *pers. comm.*). Problems associated with minor drawdowns in water table (eg 5cm) are related to the specific situation of root mat habitats in karst wetlands. It should also be noted that seasonal fluctuations in water table across the site are likely to be greater than 0.5m.

In previous assessments the EPA has recognised that there is some uncertainty with regards to the sensitivity of stygofauna and troglobitic fauna to increases in the levels of nutrients or other contaminants in the groundwater (EPA, 1996). However, the EPA considers that given that the depth to groundwater within the amendment area is between 10m and 40m and that the soils within the Amendment area have very high Phosphorus Retention Indices (PRIs) of 10 or greater pollution of the groundwater from phosphorus should be minimised. Also the proposed use of phosphorus attenuating effluent disposal systems such as Alternative Treatment Units (ATUs), modified septic systems or a small package treatment plant (for cluster development) to service the development lessens the risk of pollution from phosphorus. However, pollution from nitrogen may be of concern as these units have not been approved to attenuate nitrogen.

There has been very little research undertaken in WA or other parts of Australia to determine the levels of nitrate (NO_3 - N) which stygofauna and troglobitic fauna can tolerate. Jasinka (1997) has undertaken limited research in this field through a recent study of a number of caves in the Yanchep area. The research included a one-off measurement of nitrate levels in streams in Gilgie Cave and Twilight Cave (both south of the amendment area). The measurement was 37.1 mg/L of nitrate for both caves, and the number of species recorded in each cave stream was 40 and 42 respectively. This is a significant number of species given that the level of nitrate is more than three times the 10mg/L Maximum Contaminant Level set by the World Health Organisation for drinking water (Jasinka, 1997). Therefore, the animals were clearly tolerating the higher levels of nitrate.

The EPA considers, however, that:

- based on the lack of rigorous evidence on this potential impact; and
- given that the minimum requirements for nitrogen input in a Priority 3 Underground Water Pollution Control Area (UWPCA) (within which the Amendment area falls) is 5.7mg/L;

then if the development is managed to meet this level of 5.7mg/L (50% of the NH&MRC limit of 11.3mg/L NO_3 - N) which is substantially lower than 37.1mg/L found in caves populated by troglobitic fauna and stygofauna, the impact on stygofauna within the amendment area can be minimised.

To demonstrate the potential for the development to meet the required level of 5.7mg/L of NO_3 - N in recharge the DEP requested the landowner to undertake additional nutrient modelling (Appendix 6). The modelling was based on similar scenarios to those discussed above. The results for Scenario 1 predict that 2.8mg/L of NO_3 - N will occur in recharge following development, whereas for Scenario 2 the level is 5.4mg/L of NO_3 - N. Both these figures are less than the requirement for a P3 UWPCA. However, the EPA recognises that the results for Scenario Two are based on 100ha of agriculture whereas the ER identified up to 200ha of land as potentially suitable for agriculture. Therefore, if more than 100ha is to be used for agriculture then management measures (eg use of slow release fertilisers and soil improvers) would need to be developed and implemented to limit nitrogen application to half of that stipulated for the 100ha model.

To manage these potential impacts the draft scheme amendment has environmental conditions which involve the preparation of a Drainage, Nutrient and Water Management Plan by the subdivider at the LSP stage to the requirements of the Responsible Authority with concurrence of the DEP and WRC on advice of the Water Corporation and relevant scientific experts.

The specifics of this plan include:

- location of groundwater extraction bores in areas where drawdowns will not impact on areas of karst or potentially significant stygofauna habitats. In all cases however, the borefield will be located at least 200m from high risk karst areas to avoid any potential impacts on stygofauna;
- provision of details on the size and location of groundwater extraction bores and predictions of the area of impact of these bores;
- limitation of agricultural activities to avoid adverse impacts on karstic zones in terms of water quantity and quality;
- protection of the habitat of stygofauna in respect of nutrient and groundwater levels;
- maintenance of the rate, quantity and quality of wastewater infiltrating the Amendment area at levels compliant with the minimum requirements of the protection of a Priority 3 Groundwater Source Protection Area;
- incorporation of best practice Water Sensitive Urban Design principles to maximise on-site water infiltration generally;
- provision of measures to facilitate the removal of pollutants and nutrients;
- incorporation of the use of nutrient attenuating sewage disposal mechanisms; and
- development of monitoring and contingency plans.

The Responsible Authority also proposes a draft environmental condition which stipulates the need for the subdivider to protect the cave in the southwestern corner of the amendment area (which is part of an Aboriginal Site) on a lot of no less than 3ha. The EPA considers that the environmental conditions should be broadened to include a measure to manage the potential impact of sedimentation on this cave following development.

The Australian Speleological Federation and the Western Australian Speleological Group raised the concern that the surveys were largely restricted to stygofauna and, therefore, a more comprehensive search of the Amendment area should be undertaken for troglobitic fauna. The EPA considers, however, that due to the relative low density of the proposed development the potential impact from this development on the habitat of stygofauna and troglobitic fauna is low and that the surveys completed for the ER are adequate for the EPA to make a recommendation to the Minister for the management of this factor. In addition, further investigations of the karst areas will be undertaken as part of the draft environmental conditions proposed by the Responsible Authority for the subdivider at LSP stage to develop a Karst Management Strategy (refer to Section 3.4). This Strategy will specify, in particular, that further assessment of the areas of outcrop not previously investigated be undertaken and that there is to be no development over high risk karst areas unless approved by the DEP on the advice of a geotechnical consultant and an environmental scientist.

These two groups also raised concerns that:

- the management of stygofauna could not also provide for the management of troglobitic fauna; and
- that the hydrological assessment was not adequate, a water balance should be developed for the site and water table fluctuations should be managed to be within seasonal fluctuations.

The EPA considers, in this case that stygofauna are the most sensitive of the two types of fauna to environmental disturbance associated with this development, and therefore the management of stygofauna needs to be the primary focus of management to be applied in the development.

To address the other concerns the DEP negotiated with the Responsible Authority and the landowner following the public comment period to modify the proposed environmental conditions. Firstly these modifications include that the subdivider should also consult with relevant technical experts during the preparation of the Drainage, Nutrient and Water Management Plan. Secondly, this Plan should be modified to address the following:

- if more than 100ha of agriculture is to be developed within the amendment area, more detailed modelling will need to be carried out to determine suitable locations for the bores. This modelling should be based on variable and site-specific data for aquifer parameters and calibrated against longer term modelling records given that the potential drawdown of the water table could go beyond seasonal fluctuations;

- If more than 100ha of agriculture is to be developed within the Amendment area then additional management measures will be required to limit either the quantity of nitrogen applied to the soil or the quantity of nitrogen that leaches through the soil profile into the groundwater system; and

- to protect the cave from sedimentation the entrance should be gated in addition to the protection of the cave in a lot of no less than 3 ha.

Summary

Having particular regard to:

a) the known presence of two species of stygofauna within the amendment area;

b) the fact that these species of stygofauna are not confined to root mat habitats and that there is no evidence of underground streams, hence, root mat habitats within the Amendment area;

c) the two most significant impacts on stygofauna and troglobitic fauna being water table fluctuations (beyond natural levels) and pollution of groundwater;

d) the fact that modelling has indicated that water table drawdowns can be managed to be within seasonal fluctuations if only 100ha of agriculture developed. If more than this area is to be developed further modelling and management is required;

e) the high PRIs of the soils, the depth to groundwater and the use of phosphorus attenuating effluent disposal systems should minimise pollution from phosphorus;

f) the fact that no criterion has been developed for levels of Nitrogen which can be tolerated by stygofauna and troglobitic fauna;

g) limited evidence to indicate that stygofauna may be able to tolerate a level of 37.1mg/L of NO_3- N;

h) the requirement for the development to not exceed a level of 5.7mg/L NO_3- N in recharge with respect to drinking water quality requirements and limited evidence to suggest that this is achievable; and

i) revised environmental conditions proposed by the Responsible Authority;

it is the EPA's opinion that given the environmental conditions discussed above the amendment can be managed to meet the EPA's objectives for troglobitic fauna and stygofauna.

3.4 Karst

Description

Karstic terrain is commonly characterised by closed depressions, subterranean drainage and caves. This terrain is formed principally by the solution of the rock, most commonly limestone (Gillieson, 1996). More specifically, groundwater seeps along fractures and other zones of weakness gradually create sizeable passages. These passages may not have entrances to the

surface as dissolution generally takes place beneath the ground. In temperate climates studies have shown that two thirds or more of the total limestone solution takes place at the soil-rock interface where waters percolate through the soil into the rock mass (Hamilton-Smith *et al*, 1998).

There are limited environments in which karstic areas are found in WA. Karstic areas are also formed by a complex interplay of geologic, pedologic (soil), climatic, topographic, hydrologic, biologic and temporal factors which contributes to the limited capacity of these areas to cope with disturbance. As discussed in Section 3.3, caves in the Swan Coastal Plain also support aquatic root mat communities which have been identified as Critically Endangered in the report "Identifying and conserving threatened ecological communities (TEC's) in the South West Botanical Province" (English and Blyth, 1997).

At Yanchep, the limestone formation is a thin veneer over a permeable sand formation (Bastian, 1996). The limestone/sand interface slopes westwards, to eventually lie below sea level at or near the coastline. Radial drainage off the Gnangara Mound (a series of unconfined aquifers of water in the sand formation) results in a westwards flow towards the Indian Ocean where it intersects the limestone because it goes beneath sea level at the coast. This intersection results in the formation of caves (Bastian, 1996).

The zone along which the groundwater first makes contact with the limestone is referred to as the "Cave Source Zone". This zone fluctuates in accordance with the seasonal water table fluctuations in the sand formation (Bastian, 1996). Therefore, the Cave Source Zone may be defined as the zone between the mean annual high and low contact lines of the water table within the limestone formation, and is the area where cave formation begins (Bastian, 1996).

Generally, the formation of caves at Yanchep begins when surface water enters the limestone principally through active dolines in shallow valleys. This water then flows through the joints and fissures which over time forms caverns and voids. These caverns eventually collapse with the limestone eroding away. At this point a spring occurs and beyond the spring point the stream flows through karstic terrain where the limestone has been removed, and into Loch McNess (Alan Tingay & Associates, 1998).

A karstic terrain appraisal of the amendment area conducted through aerial photo interpretation, ground proofing and using Ground Probing Radar (GPR) identified two types of suspected karstic structures in the area; small scale features and massive collapse features. Small scale features observed on the surface include small cavities, fissures and solution pipes which are considered to be characteristic of the entire Tamala Limestone formation. Massive collapse features, however, include karstic terrain such as caves and dolines. These massive collapse features (high risk areas for karst) (Figure 3) appear to be confined to interdunal depressions within the Tamala Limestone in the Amendment area. However, they are not always, in fact the confirmed cave within the Amendment area occurs on the top of a limestone ridge.

Within this interdunal depression there is one, possibly two caves. The one confirmed cave occurs in the southwestern corner of the amendment area whilst the other possible cave, which is a fissure which has collapsed, occurs just to the north of the first cave (Figure 3). A number of dolines also occur within this interdunal depression. One of these dolines is active and has increased in size over a number of years. Other areas which are within the karstic belt but not directly within the interdunal depressions have been mapped as:

- medium risk of karst - valley sides of interdunal depressions in areas regionally associated with karst;
- low risk of karst - land surrounding areas of high and medium risk of karst; and
- very low risk of karst - landform indicates very low risk of karst, and located outside the zone regionally associated with karstic terrain (Figure 3).

Assessment

The area considered for assessment of this factor is the Wanneroo Cave Belt.

The EPA's environmental objective for this factor is to maintain the environmental, scientific, cultural and recreational values of karst landforms.

As described above the belt of karstic terrain which crosses the Amendment area in a northwest to southeast orientation incorporates small scale features (eg fissures) and massive collapse features (eg caves). Given that small scale features are considered to be characteristic of the entire Tamala Limestone formation and are not indicative of a zone of karstic phenomena the EPA considers that for the purposes of this assessment further evaluation will only be undertaken of the massive collapse features. Of particular concern to the EPA is the environmental, scientific, cultural and recreational values of these features. The EPA also recognises that there is a potential risk associated with development in an unstable environment such as karstic terrain due to this environment's propensity to collapse and subside. It should be recognised that in preserving the aforementioned values attached to these environments the risk associated with development over these areas can also be lessened.

The karstic terrain appraisal identified areas of high, medium, low and very low risk of karst. The high risk areas are generally confined to the valley floor areas in the south-western portion of the amendment area and these areas are localised. The EPA recognises that these karstic areas are a complex interplay of various factors which have been mentioned above and as such, impacts on vegetation, water quality, water table levels and development over karst features will impact upon karstic terrain. A number of these impacts have been discussed in Section 3.3.

With respect to development over karst the draft scheme amendment has environmental conditions which involve the preparation of a Karst Management Strategy by the subdivider at the LSP stage. The Strategy will be to the requirements of the Responsible Authority with concurrence of the DEP on advice of the WRC, a geotechnical consultant and relevant scientific experts to avoid development over high risk karst areas. The object of the Strategy is to avoid development over high risk karst areas. The definition of high risk areas is identified in Figure 3 but will be subject to further assessment by a geotechnical engineer and an environmental scientist. The specifics of the Strategy include:

- detailed investigations of karst areas within the Amendment area to determine the presence of large karst structures within the building envelopes on the property;
- no development in areas close to any location where large karstic structures are known or suspected to be present unless approved by a geotechnical engineer and an environmental scientist; and
- preliminary GPR work and detailed drilling where necessary.

The Responsible Authority has also proposed another draft environmental condition (as discussed in Section 3.3) to protect the cave within the amendment area in a 3 hectare lot. The lot will be fenced and signposted as appropriate.

The Australian Speleological Federation and the Western Australian Speleological Group raised concerns about the adequacy of the survey of the Amendment area for karstic areas, particularly given that the authors of the Karstic Terrain Appraisal (Alan Tingay & Associates, 1998) acknowledged that not all areas of outcrop could be identified and mapped within the limited time constraints. These two groups also expressed concerns about :

- the risk associated with development in karstic areas and suggested that the high risk karst areas be included within the area of P&R to the immediate west of the amendment area to ensure protection of the karst and to reduce the risk; and
- the impact of fire on karstic areas given that fire can adversely affect karstic environments (eg. through the leaching of carbon deposits into caves and the spalling of limestone throughout the karst).

Other submissions raised concerns about the need to specify a minimum lot size of 2 hectares within the karstic zone and the need to involve speleologists experienced in the assessment of karstic areas in Yanchep in the appropriate location of roads within the Amendment area.

The EPA recognises that the Karstic Terrain Appraisal did not adequately address all areas of limestone outcrop. However, the EPA considers that based on the current appraisal it would be possible to develop either a conventional layout or a "cluster" development in the amendment area within the constraints imposed by the presence of karst provided that further geotechnical work is undertaken at the LSP stage. This further work has been incorporated, in part, into the draft environmental conditions proposed by the Responsible Authority as previously discussed. However, the DEP has negotiated with the Responsible Authority and the landowner following the public comment period to modify the proposed environmental conditions to address these concerns.

Firstly, the Karst Management Strategy will also be developed on the advice of relevant scientific experts. Secondly, this Strategy should be modified to specifically address the requirement to undertake further investigations of areas of limestone outcrop. Thirdly, the entrance to the cave will be gated in as sensitive a manner as possible and the Responsible Authority will also ensure that management of the cave is undertaken to ensure public safety and to protect the biodiversity and cultural values of the cave and surrounding 3 hectares.

The EPA considers that the development of the Karst Management Strategy and other management plans proposed for the protection of vegetation, stygofauna and troglobitic fauna will provide protection for the karstic areas, reservation in the MRS is not necessarily required.

The EPA also considers that protection of the karstic areas from fire will be addressed in the Vegetation Management Plan (as discussed in Section 3.2) and that fire control facilities to be incorporated into the proposed development will be in accordance with the requirements of the Bush Fires Board of WA.

Summary

Having particular regard to:

a) the presence of massive collapse features (ie. dolines and one confirmed cave) within the Amendment area;

b) the risk which karst poses to development;

c) the confinement of high risk karst areas to isolated places within the valley floors of the south-western portion of the amendment area;

d) the ability for cluster or conventional development to be designed around these high risk karst areas safely (subject to further geotechnical work); and

e) revised environmental conditions proposed by the Responsible Authority;

it is the EPA's opinion that given the environmental conditions discussed above the amendment can be managed to meet the EPA's objective for karst.

3.5 Groundwater quality

Description

The Amendment area lies within the Perth Coastal (Priority 3) Underground Water Pollution Control Area (UWPCA). Priority 3 areas are defined to minimise the risk of pollution to the water source and are declared over land where water supply sources need to co-exist with other land uses such as residential, commercial and light industrial developments (Water and Rivers Commission, 1998). With respect to the development of a Rural Community within the amendment area, restrictions apply to the siting of effluent disposal systems in areas with poor land capability and a shallow depth to groundwater (Water and Rivers Commission, 1998).

Within the Amendment area the depth to groundwater varies between 10m and 40m depending on topographic elevation, therefore, it is not considered to be shallow. However, groundwater within the amendment area is considered to be vulnerable to contamination due to the unconfined sand aquifer which allows rapid infiltration of surface runoff. Groundwater flow in the region is also moving away from the Gnangara Mound towards the ocean.

The Water Corporation currently draws water from the superficial aquifer for public supply and proposes to continue this practice in the future. Chemical analysis of groundwater from existing production bores indicates the concentration of potential contaminants is within the range recommended by the relevant guidelines for drinking water (Alan Tingay & Associates, 1992).

The proposed development of a Rural Community may potentially impact upon groundwater quality within the Amendment area through activities such as fertiliser application and pesticide use (associated with small scale agricultural pursuits), horse agistment, waste disposal leachate, leakage of fuel and other stored chemicals, and road runoff.

Assessment

The area considered for assessment of this factor is the Perth Coastal (Priority 3) UWPCA.

The EPA's environmental objective for this factor is minimise the risk of pollution to the water source.

A desktop review of the land capability of the amendment area for small scale agricultural activities undertaken as part of the ER concluded that:

- the Phosphorus Retention Indices (PRIs) of the Karrakatta soils and Cottesloe soils which occur within the Amendment area are high with average PRI profiles of 10 or greater, hence, they are well suited to perennial horticultural pursuits (eg. orchards) which are compatible landuses in a P3 UWPCA;
- based on the soil types and the constraints of a P3 UWPCA, the amendment area would most likely be assigned a 'B' vulnerability classification (maximum of 180kgN/ha/yr and 20kgP/ha/yr) based on WRCs recommended maximum nutrient loadings for the protection of public water resources; and
- it is likely that nutrient loadings of a perennial horticultural enterprise within the Amendment area would be less than the criteria specified.

Also, as discussed in Section 3.3, additional modelling of potential levels of NO_3 - N in recharge following development under two possible scenarios was undertaken by the Responsible Authority. The results indicated that the development could meet the required level of NO_3 - N (5.7mg/L) in recharge for a P3 UWPCA. However, as also discussed previously, the EPA recognises that the results for Scenario 2 are based on 100ha of agriculture whereas the ER identified up to 200ha of land as potentially suitable for agriculture. Therefore, if more than 100ha is to be used for agriculture then management measures would need to be developed and implemented to limit nitrogen application to half of that stipulated for the 100ha model.

An assessment of the potential phosphorus and nitrogen contributions from horse agistment within the Amendment area has concluded that the expected annual output would be 62kg of nitrogen and 6kg of phosphorus. Therefore, given the high PRIs of the soils within the amendment area and a maximum number of 255 horses within the 510 hectare area the EPA considers that the potential impact of horse agistment on groundwater quality would be minimal. In reaching this conclusion, the EPA recognises that no account has been made for the uptake of nutrients by vegetation (approximately 20%) or volatilisation of urine-nitrogen as ammonia [eg. Watson & Lapins (1969) recorded more than 50% of nitrogen was lost from urine deposited on sandy soils].

The management of effluent disposal within the Amendment area is recognised by the EPA as particularly important given the number of proposed lots, either 255 conventional or 300 "cluster" which require servicing, and the high cost of providing reticulated sewerage to the proposed development which does not make its use economical. Therefore, to meet the requirements for a P3 UWPCA waste could either be removed to Alternative Treatment Units (ATUs), modified septics or a small package treatment plant. The EPA considers that a conventional subdivision design could be serviced by individual ATUs or a modified septic system to meet the requirements of P3 UWPCA. However, the higher density associated with a "cluster" development would be more sustainably serviced by a small package treatment plant.

To manage these potential impacts the draft scheme amendment has environmental conditions which involve the preparation of a Drainage, Nutrient and Water Management Plan by the subdivider at the LSP stage to the requirements of the Responsible Authority with concurrence of the DEP and WRC on advice of the Water Corporation and relevant scientific experts. The specifics of this plan in relation to the protection of water quality include:

- the rate, quantity and quality of wastewater infiltrating the amendment area is maintained at levels compliant with the minimum requirements of the protection of a Priority 3 Groundwater Source Protection Area;
- best practice Water Sensitive Urban Design principles are incorporated to maximise on-site water infiltration generally;
- provide measures to facilitate the removal of pollutants and nutrients;
- development will need to incorporate the use of nutrient attenuating wastewater disposal mechanism; and
- development of monitoring and contingency plans.

The Responsible Authority has also proposed another draft environmental condition which involves the undertaking of a Land Capability Assessment and Site Analysis at the LSP stage to verify the suitability of the area for agriculture and identify areas of high risk karst which are unsuitable for the development of building envelopes.

The Water Corporation has raised concerns about the concept of "cluster" development which may produce "hot spots" of contamination where natural remediating effects and dilution may not assist in protecting groundwater quality, and therefore, the minimum requirements for a P3 UWPCA cannot be met. The WRC has also advised that the layout of cluster subdivision should be suitably located downstream of any proposed production bores for drinking water supply and that management of the development should "demonstrate the nitrate concentration in groundwater recharge over the Amendment area will not exceed 50% of the National Health and Medical Research Council limit", which is the minimum requirement for a P3 UWPCA. The Health Department of WA has also advised the EPA that none of the Aerobic Treatment Unit systems or soil amendment systems which are available in WA have been approved for the purpose of removing or retaining nitrates.

To address these concerns the DEP negotiated with the Responsible Authority and the landowner following the public comment period to modify the proposed environmental conditions. Firstly, the subdivider will also need to seek the advice of relevant scientific experts during the preparation of the Drainage, Nutrient and Water Management Plan at the LSP stage. Secondly, this Plan should be modified to address the following:

- the concentration of contaminants and stormwater through cluster development will be appropriately investigated and managed; and
- the layout of cluster subdivision should be suitably located downstream of any proposed production bores for drinking water supply.

The EPA also recognises that the Responsible Authority has proposed to reserve at least 3 hectares of the Amendment area in Public Open Space. With respect to the concern raised by the Health Department, the EPA is also aware of an evaluation of alternative wastewater treatment systems undertaken by BRW (1999) for the WRC which concluded that biological nitrogen removal can be achieved in package treatment systems using a nitrification-denitrification process and can achieve 75% to 95% denitrification.

Summary

Having particular regard to:

a) the high PRIs of the soils within the amendment area;

b) these soils being well suited to perennial horticulture;

c) the use of phosphorus attenuating Alternative Treatment Units, modified septic systems or a small package treatment plant (for cluster development) for effluent disposal;

d) the requirement for the development to not exceed a level of 5.7mg/L NO_3 - N in recharge and limited evidence to suggest that this is achievable;

e) the management of stormwater as per WSUD guidelines;

f) the advice of the WC, Health Department of WA and the WRC; and

g) revised environmental conditions proposed by the Responsible Authority;

it is the EPA's opinion that given the environmental conditions discussed above the amendment can be managed to meet the EPA's objective for groundwater quality.

3.6 Aboriginal Culture and Heritage

Description

An ethnographic survey of the Amendment area identified a mythological site in the southwestern corner (Figure 3). According to Mr K Colbung, Director of the Australian Institute of Aboriginal Studies (Canberra), the site includes a cave within which the crocodile slept overnight and was transformed into an emu.

The knoll of the hill lies in a north-south direction and forms the contours of the emu's body. The northern section represents the head, the southerly section the tail and the cave symbolises the heart. The limestone capping and ridges represent the bones of the crocodile and the grass tress covering the knoll symbolise the emu's feathers.

The site is considered a mythological site within the meaning of the *Aboriginal Heritage Act 1972*. No other Aboriginal sites were identified within the amendment area.

Assessment

The area considered for assessment of this factor is the Amendment area.

The EPA's environmental objective for this factor is:

i) Ensure that the proposal complies with the requirements of the *Aboriginal Heritage Act 1972*; and

ii) Ensure that changes to the biological and physical environment resulting from the project do not adversely affect cultural associations with the area.

The EPA recognises that the proposed Rural Community development could directly impact upon the Aboriginal mythological site identified in the southwestern corner of the amendment area.

To manage these potential impacts the draft scheme amendment has environmental conditions which involve the preparation of an Aboriginal Heritage Management Plan which specifically includes:

- the subdivider to protect on a lot not less than 3ha, the identified heritage site; and
- the area immediately surrounding the site to be fenced and sign posted as appropriate.

The Aboriginal Affairs Department (AAD) raised concerns about further sites of Aboriginal significance, particularly subsurface cultural material and burials, being identified during the development of the Amendment area. To protect these potential sites the AAD has requested that construction activities be carefully monitored to ensure that no potential sites are damaged.

To address these concerns the DEP negotiated with the Responsible Authority and the landowner following the public comment period to modify the proposed environmental conditions. This involves modification to the Plan to address the following:

- contractors to undergo a briefing on Aboriginal Heritage issues prior to the commencement of site works to enable them to recognise material which may constitute an Aboriginal Site; and
- adequate supervision of contractors will be required in this regard and in the event of a possible identification, specialist advice will be sought to confirm the identification of the site.

The AAD also stipulated the requirements under Section 18 of the Aboriginal Heritage Act 1972 for developers to apply for a permit from the Minister if development is to impact upon an identified Aboriginal site. These particular requirements can be managed through the provisions of the *Aboriginal Heritage Act 1972*.

Summary

Having particular regard to:

a) the Aboriginal site in the southwestern corner of the amendment area;

b) the Aboriginal Affairs Department's advice; and

c) revised environmental conditions proposed by the Responsible Authority;

it is the EPA's opinion that given the environmental conditions discussed above the amendment can be managed to meet the EPA's objective for Aboriginal Culture and Heritage

4. Conditions

Section 48D of the *Environmental Protection Act 1986* requires the EPA to report to the Minister for the Environment on the environmental factors relevant to the Amendment and on the conditions to which the Amendment should be subject, if implemented. In addition, the EPA may make recommendations as it sees fit.

In developing recommended conditions, the EPA's preferred course of action is to have the Responsible Authority provide an array of management measures and/or environmental conditions to ameliorate the impacts of the amendment on the environment. The management measures are considered by the EPA as part of its assessment of the amendment and, following discussion with the Responsible Authority the EPA may seek additional management measures or environmental conditions.

4.1 Recommended conditions

Having considered the Responsible Authority's proposed environmental conditions and the information provided in this report, the EPA has developed a set of conditions which are consistent with the environmental conditions as originally proposed in the Amendment documentation and as modified during the assessment process, if the proposed amendment is approved for implementation. These conditions are presented in Appendix 3. Matters addressed in the conditions include:

a) preparation and implementation of a Vegetation Management Plan;

b) preparation and implementation of a Drainage, Nutrient and Water Management Plan;

c) preparation and implementation of a Karst Management Strategy;

d) preparation and implementation of an Aboriginal Heritage Management Plan; and

e) preparation and implementation of a Land Capability Assessment and Site Analysis.

5. Other Advice

The EPA notes that with respect to the scheme amendment, provision can be made to annotate the relevant City of Wanneroo TPS No. 1 map/s so that the environmental conditions inserted in the TPS No. 1 text are identified. In the case of this assessment, an environmental condition to that effect has been applied.

6. Conclusions

The EPA has concluded that Amendment No. 837 to the City of Wanneroo TPS No.1 to rezone Lots 201 and 202 Breakwater Drive, Two Rocks to "Rural Community" from "Rural" can be implemented to meet the EPA's objectives provided the conditions recommended in Section 4 and set out in Appendix 3 are imposed and enforced.

7. Recommendations

The EPA submits the following recommendations to the Minister for the Environment:

1. That the Minister notes that the project being assessed is for the rezoning of Lots 201 and 202 Breakwater Drive, Two Rocks from "Rural" to "Rural Community" (Figure 1).
2. That the Minister considers the report on the relevant environmental factors of vegetation, stygofauna and troglobitic fauna, karst, groundwater quality and Aboriginal Culture and Heritage as set out in Section 3.
3. That the Minister notes that the EPA has concluded that the EPA's objectives can be met, provided the recommended conditions summarised in Section 4 and set out in detail in Appendix 3 are incorporated by the Responsible Authority into the scheme and implemented at the appropriate level of planning.
4. That the Minister in consultation with the Minister for Planning imposes the conditions recommended in Appendix 3 of this report.
5. That the Minister notes that where any future development proposal complies with the Plans and raises no additional environmental factors, the development proposal will not normally be subject to further assessment under Part IV of the *Environmental Protection Act 1986*. However, future development proposals will still be subject to the normal development approvals process, including licensing and pollution control environmental conditions of the *Environmental Protection Act 1986* where applicable.

Appendix 1

List of submitters

Organisations:

Water and Rivers Commission
Department of Conservation and Land Management
Water Corporation
Health Department of Western Australia
Department of Minerals and Energy
Aboriginal Affairs Department
Fire and Emergency Services Authority of Western Australia
Masterplan Consultants
Wildflower Society of Western Australia
Urban Bushland Council of Western Australia
Australian Speleological Federation
Western Australian Speleological Group
Heal the World Inc.

Individual:

Mr R. Foulds
Mr L. Bastian

Appendix 2

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Appendix 3

Recommended Environmental Conditions

Recommended Environmental Conditions

STATEMENT THAT A SCHEME MAY BE IMPLEMENTED (PURSUANT TO THE PROVISIONS OF DIVISION 3 OF PART IV OF THE ENVIRONMENTAL PROTECTION ACT 1986)

CITY OF WANNEROO TOWN PLANNING SCHEME NO. 1, AMENDMENT NO. 837

Scheme Purpose:

a) Introduce a Rural Community zone and associated new provisions into TPS No. 1;

(ii) Rezone Lots 201 and 202 Breakwater Drive, Two Rocks from Rural zone to Rural Community zone;

(iii) Introduce a new Schedule, Schedule 12 - Rural Community Zones and associated special provisions;

(iv) Introduce a new Schedule, Schedule 13 - Environmental Conditions and associated text; and

(v) Modifying relevant clauses in TPS No. 1 so that no development, or subdivision, occurs on land in Centre Zone, Urban Development Zone, Industrial Development Zone and the Rural Community Zone until a Structure Plan has been prepared.

Responsible Authority: City of Wanneroo

Responsible Authority Address: 11 Moolanda Boulevard
KINGSLEY WA 6026

Assessment Number: 1254

Report of the Environmental Protection Authority: Bulletin 956

Subject to the following conditions, there is no known environmental reason why the planning scheme amendment to which the above report of the Environmental Protection Authority relates should not be implemented:

1. The following clauses shall be inserted into the City of Wanneroo Town Planning Scheme No.1 Scheme Text:

"5.13 Environmental Conditions

5.13.1 In accordance with Section 7A4 of the Town Planning and Development Act, environmental conditions imposed by the Minister for the Environment on the Scheme or amendments to the Scheme and contained in Statements under Section 48F of the Environmental Protection Act, are incorporated into the Scheme by Schedule 13 of the Scheme.

5.13.2 Where appropriate, the environmental conditions are indicated on the Scheme Map by the Symbol EC to indicate that environmental conditions apply to the land.

5.13.3 Local Government shall maintain a register of all the Statements published under Section 48F referred to in sub-clause 5.13.1 which shall be made available for public inspection at the offices of the local government."

2. The following schedule shall be inserted into the City of Wanneroo Town Planning Scheme No. 1 Scheme Text:

Schedule 13 Environmental Conditions

Amendment No. (Gazettal Date)	Location of Land	Environmental Conditions Associated with the Area Identified in "Location of Land"
837 - (X/X/199X)	Lots 201 and 202 Breakwater Drive, Two Rocks	**1. Vegetation and Fauna Management Plan** The subdivider shall prepare a Vegetation and Fauna Management Plan at the Local Structure Planning stage, to ensure the long-term viability of remnant vegetation that may be affected directly or indirectly by development of the subject lots, to the requirements of the local government, with the concurrence of the Department of Environmental Protection and the Department of Conservation and Land Management, and in consultation with relevant community groups including the WA Wildflower Society and the Urban Bushland Council. The preservation of vegetation will also assist in maintaining the diversity of the fauna utilising the remnant vegetation as habitat. The fauna values of the vegetation should, therefore, be considered in any assessment. This Plan shall include: 1.1 Description of vegetation and vegetation values. 1.2 The definition and retention of "locally significant" areas of vegetation within the Amendment area (which provides fauna habitat) with consideration to the creation of vegetation corridors to facilitate the movement of fauna and floristic genepools. 1.3 Retention of all three significant stands of trees to avoid habitat loss for fauna, particularly Threatened fauna including the Peregrine Falcon and the Short-billed Black Cockatoo. Retention of mature trees except where utilities such as roads or construction of buildings are necessary or in those areas identified as prospective for small scale agricultural activities. 1.4 Management of indirect impacts on the adjacent Parks and Recreation areas to the requirements of relevant State Agencies through the implementation of firebreaks, bridle paths (within the amendment area only) and fencing as required. 1.5 Management arrangements for the keeping of horses which will address soil and vegetation protection. Restrictions on the keeping of horses to a rate of one horse per lot on conventional lots. In cluster subdivision, horses may only be kept on common land and not on individual lots. 1.6 Clear delineation of significant tree stands (see 1.3) through use of dual use paths, roads and the like.

		1.7 Details on site maintenance arrangements - including weed control and consideration of the use of provenance seed for rehabilitation. 1.8 Allocation of responsibilities and identification of timing for implementation. 1.9 Fire Management. 1.10 Control of off-road vehicle use and dumping of rubbish. 1.11 Enhancement of community awareness of bushland protection. 1.12 The selection of landuses adjacent to the Bushplan sites in consultation with the Department of Conservation and Land Management.
		2. Drainage, Nutrient and Water Management Plan (Including protection of stygofauna and troglobitic Fauna) The subdivider shall prepare a Drainage, Nutrient and Water Management Plan, at the Local Structure Planning stage, to the requirements of the local government with concurrence of the Department of Environmental Protection and the Water and Rivers Commission on advice of the Water Corporation and relevant scientific experts to ensure that: 2.1 Groundwater extraction bores are located in areas where drawdowns will not impact on areas of karst or potentially significant stygofauna habitats. In all cases, however, the borefield shall be located at least 200 metres from high risk karst areas to avoid any potential impacts on stygofauna. 2.2 The rate, quantity and quality of wastewater infiltrating the Amendment area is maintained at levels compliant with the minimum requirements of the protection of a Priority 3 Groundwater Source Protection Area. 2.3 If more than 100hectares of agriculture is to be developed within the Amendment area, more detailed modelling is carried out to determine suitable locations for the bores. This modelling shall be based on variable and site-specific data for aquifer parameters and calibrated against longer term modelling records, given that the potential drawdown of the water table could go beyond seasonal fluctuations. 2.4 Groundwater extraction does not impact adversely upon vegetation through contributing to tree mortality. 2.5 Agricultural activities do not adversely impact on karstic zones in terms of water quality and quantity. 2.6 Best practice Water Sensitive Urban Design principles are incorporated to maximise on-site water infiltration generally. 2.7 Measures to facilitate the removal of pollutants and nutrients are provided. 2.8 The habitat of stygofauna is protected in respect of nutrient and groundwater levels. 2.9 Nutrient attenuating sewage disposal mechanisms are provided to service the development.

		2.10 Effluent disposal areas are not sited over areas rated as high risk for karst phenomena. 2.11 A monitoring and reporting program is included which measures and reports on the performance of the implemented Plan against performance criteria. 2.12 Contingency plans in the event that the criteria are temporarily not achieved are included. 2.13 The concentration of contaminants and stormwater as a result of Cluster Development will be appropriately investigated and managed. 2.14 If more than 100hectares of agriculture is to be developed within the Amendment area, additional management measures to limit either the quantity of nitrogen applied to the soil or the quantity of nitrogen that leaches through the soil profile into the groundwater system are required. 2.15 The layout of cluster subdivision is suitably located downstream of any proposed production bores for drinking water supply.
		3. Karst Landform Management Strategy The subdivider shall prepare a Karst Management Strategy, at the Local Structure Planning stage, to the requirements of the local government with concurrence of the Department of Environmental Protection on advice of the Water and Rivers Commission, a geotechnical consultant and relevant scientific experts to avoid development over high risk karst areas. The definition of high risk areas is subject to further assessment by a geotechnical engineer and environmental scientist. Areas of outcrop shall also be further investigated. The subdivider shall undertake detailed investigations in accordance with Table 1 to determine the presence of large karst structures within the building envelopes on the property. Development shall not be approved in areas or close to any location where large karstic structures are known or suspected to be present unless deemed acceptable by a qualified geotechnical engineer and environmental scientist. Development shall also only be permitted where investigations indicate that structures can be safely erected. The subdivider shall undertake appropriate geotechnical investigations in the areas which have been identified as within the zone where karstic features may potentially occur. It is recognised that the completion of the geotechnical investigations, staged as necessary, will be required prior to subdivision approval being granted. Preliminary Ground Penetrating Radar Work shall be undertaken at the Local Structure Plan stage. Detailed investigations, including drilling, shall take place where necessary prior to subdivision.
		4. Aboriginal Heritage Management Plan 4.1 In order to manage the potential impact associated with the Aboriginal Heritage Site, the subdivider shall protect on a lot not less than 3ha, the identified heritage site and the area immediately surrounding the site shall be fenced and sign posted, as appropriate. The entrance to the cave (which is part of the Aboriginal site) shall be gated in as sensitive a manner as possible. The Responsible Authority shall also ensure that management of the cave is undertaken to ensure public safety and to protect the biodiversity and cultural values of the cave and surrounding 3hectares.

		4.2 Prior to the commencement of site works, contractors shall undergo a briefing on Aboriginal Heritage issues to enable them to recognise materials that may constitute an Aboriginal Site. During earthworks all contractors shall be supervised by a Site Manager, who if a suspected site is discovered, shall seek advice from the Aboriginal Affairs Department to confirm the identification of the site.
		5. Land Capability Assessment and Site Analysis The subdivider shall under take to the requirements of the local government, appropriate land capability analysis at the Local Structure Planning stage. This analysis will determine: 5.1 lot sizes; 5.2 suitability for agriculture; and 5.3 identification of high risk karst areas unsuitable for the development of building envelopes.

TABLE 1

WORK SCHEDULE REQUIRED FOR SUBDIVISION OF LOTS 201 AND 202 BREAKWATER DRIVE WITH RESPECT TO KARST TERRAIN APPRAISAL

	Structure Plan Assessment Prior to Subdivision	**Placement of Building Envelopes/Drainage Design for Proposed Subdivision**			**Building Envelope Assessment Prior to Building**				
	A further geotechnical appraisal of the high and medium risk karst areas with respect to the draft LSP design **	**Detailed interpretation of existing GPR data**	**Detailed geotechnical inspection target location, drilling and possible remediation**	**Geotechnical inspection and recommendations for additional geotechnical site assessment prior to building [1]**	**Geotechnical Investigations for Foundation Assessment**				
					Further GPR as recommended from the geotechnical evaluation	**Drilling >1 borehole to total depth of 15m**	**Drilling at least 1 borehole to a total depth of no more than 15m**	**Testing Pitting to 3m depth[2]**	**Perth Sand Penetrometer Testing to 750mm[3]**
					Further work on high risk only if specifically required/remediation work				
High	✔	✔	✔						
Medium	✔	✔		✔	✔*	✔		✔	✔
Low		✔		✔	✔*		✔	✔	✔
Very Low		✔		✔	✔*			✔	✔

* On the basis of advice from the geotechnical assessment.
** Geotechnical works likely to involve mapping and Ground Probing Radar. Program to be developed in consultation with the City of Wanneroo and a geotechnical engineer.

1. Following the geotechnical assessment, a reappraisal of the work program for building envelope assessment with respect to the risk rating may be required.
2. Test Pitting is generally carried out by a backhoe and refilled after logging and sampling.
3. The Perth Sand Penetrometer is a hand held portable device used for measuring the compaction of soils.

Appendix 4

Summary of Submissions

and Proponent's Response to Submissions

Summary of Submissions and Responsible Authority's Response to Submissions

BIOPHYSICAL

Vegetation

1.1 How will fire management procedures for the Amendment area be integrated with those for the surrounding areas? It is recommended that the Department of Conservation and Land Management (CALM) be consulted with at the Local Structure Plan stage in regards to the development of fire management and control procedures for the Amendment area. This will ensure the coordination of fire management strategies to protect the vegetation on the surrounding CALM estate (Yanchep National Park and Wilbinga) and within the amendment area.

R1.1 Although not clearly specified in the ER document, it was intended that the Vegetation Management Plan, to be prepared by the subdivider at the LSP stage, would address fire management. The scope of the Vegetation Management Plan has been modified to specifically include fire management. Necessarily CALM will be consulted over the Vegetation Management Plan and as the Plan requires the Department's concurrence, it will be able to ensure that its requirements are satisfied as per the Environmental Condition 1 (attached).

1.2 What about the consideration of appropriate landuses in the interface between the Amendment area and the CALM estate? This should be addressed at the Local Structure Plan stage and should also include strategies to minimise the potential for unregulated access to crown land. CALM should be consulted with in regards to this issue.

R1.2 As detailed in Section 4 of the report the process of preparing the Vegetation Management Plan (at the LSP stage) will include consultation with CALM and the NPNCA to achieve "Isolation from the adjacent Parks and Recreation areas to the satisfaction of the NPNCA and CALM and will include opportunities for firebreaks, bridle paths and fencing as required". As the Vegetation Management Plan requires CALM concurrence, the Department will be able to ensure that its requirements are satisfied. Refer to Environmental Condition 1 (attached).

1.3 What is the intent of bullet point 4 on page 16 of the Environmental Review (ER) with regards to bridle paths? There should be no presumption that bridle paths within the Regional Open Space (ROS) and CALM estate will be acceptable.

R1.3 The intention is for Bridle Paths to be within the amendment area.

1.4 The rezoning of the site to Rural Community represents the ideal use for this attractive site which is surrounded by Parks and Recreation land and State Forest. The ability to create

cluster and/or conventional subdivision is highly appropriate for this site. The amendment is also consistent with requests from both the Chairman of the Western Australian Planning Commission and the Office of the Minister for Planning to pursue the rezoning of the land for rural community purposes.

R1.4 Noted.

1.5 Why is it that all of the remnant vegetation within the three significant stands of trees cannot be retained? Why are there exceptions to this to allow for the construction of utilities such as roads or the construction of buildings, or the development of small scale agricultural activities? There should be no exceptions as these utilities and activities can be planned to retain these trees and incorporate them as a distinctive local feature.

R1.5 All of the three significant stands of trees will be retained. The wording of the Condition 1.3 has been modified to clarify this intention (refer to attachment). Condition 1.4 indicates the protection for vegetation beyond these stands, because of the degraded nature of the majority of the vegetation on the site, it is not realistic to stipulate that all vegetation will be retained.

1.6 The Wildflower Society of WA would like to be involved in the development of the Vegetation Management Plan at the Local Structure Plan stage. Could this please be arranged?

R1.6 Environmental Condition 1 as included in the Environmental Review report committed the City to consultation with DEP, CALM and NPNCA in the preparation of the Vegetation Management Plan. This Condition 1 has now been modified to include relevant community groups including the WA Wildflower Society and the Urban Bushland Council in this consultation process (see attachment).

1.7 Development of the Rural Community must be sensitive to the conservation values of the adjacent areas which support vegetation of regional significance. Management measures must be considered to control off road vehicle use, domestic pets, the increased risk of fire and introduction of disease, dumping of rubbish, weed invasion and contamination by pesticides and nutrients.

R1.7 Agreed. Preparation of the Vegetation Management Plan in consultation with DEP, CALM and relevant community groups provides the opportunity to address these issues. Refer to Environmental Condition 1 (attached).

1.8 The occurrence of Tuart and its associated plant communities has been greatly diminished since European settlement of Western Australia. These communities and the Tuarts in particular are not regenerating. Therefore, the presence of

scattered Tuarts on Lots 201 and 202 is of particular interest to the Wildflower Society of WA.

R1.8 Agreed. Hence the intention to retain the two remaining Tuart stands (and one Jarrah stand) and majority of healthy trees and undergrowth. Refer to Environmental Condition 1 (attached).

1.9 Why is it that all bushland areas within the Amendment area which still retain their basic structure and which can regenerate (ie. are not in a 'degraded' condition) cannot be protected? This includes the "corridor of slightly disturbed vegetation which runs along the western boundary of Lot 201, adjacent to the Regional Open Space", the "two small areas of vegetation classified as 'obvious disturbance' in the northwestern and eastern corners of the amendment area and two centrally located stands of trees classified as disturbed".

R1.9 See response 1.5

2.0 Why were the Vegetation Condition Scales used in "Perth's Bushplan Directory" (Volume 2 Part A, Table 2) not used to assess the condition of the vegetation within the Amendment area? Given that Bushplan was prepared by the Western Australian Planning Commission, the Environmental Protection Authority, the National Parks and Nature Conservation Authority and the Water and Rivers Commission, it is preferable that these condition rating terminologies be employed in planning documents of this nature.

R2.0 As detailed in the report, the Vegetation Management condition mapping was carried out in 1992, which is prior to the publication of the Bushplan Report (1999). The system historically used by Alan Tingay & Associates is an objective, descriptive system and has six categories, like the Bushplan scale. The only difference between the scales is the terminology adopted to describe the vegetation condition (refer to the following comparison table).

Condition Rating Used by Keighery (1994) and adopted by Bushplan (1999)	Condition Rating Used by (Trudgen (1993)	Condition Rating Used by Alan Tingay & Associates
Pristine Pristine or nearly so, no obvious signs of disturbance	**Excellent** Pristine or nearly so, no obvious signs of damage caused by the activities of European man.	**Undisturbed** No obvious sign of impact caused by human activities
Excellent Vegetation structure intact, disturbance affecting individual species and weeds are non aggressive	**Very Good** Some relatively slight signs of damage caused by the activities of European man. For example, some signs of damage to tree trunks caused by repeated fires and the presence of relatively non aggressive weeds or occasional vehicle tracks.	**Slightly Disturbed** Some slight signs of impact caused by human activities such as the presence of non-aggressive weeds and vehicle tracks.
Very Good Vegetation structure altered, obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.	**Good** More obvious signs of damage caused by the activities of European man, including some obvious impact on the vegetation structure such as caused by low levels of grazing or by selective logging. Weeds as above, possibly plus some more aggressive ones.	**Disturbed** Signs of impact caused by human activities including some impact on the vegetation structure such as caused by grazing, fire and logging. Mainly non-aggressive weeds with some more aggressive ones also possibly present.
Good Vegetation structure significantly altered by very obvious signs of multiple disturbance. Retains basic vegetation structure or ability to regenerate. Fore example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.	**Poor** Still retains basic vegetation structure or ability to regenerate to it after very obvious impacts of activities of European man such as grazing or partial clearing (chaining) or very frequent fires. Weeds as above, probably plus some more aggressive ones such as *Ehrharta* spp.	**Obviously Disturbed** Obvious human impacts such as grazing, partial clearing, and frequent fires. Vegetation structure slightly altered but still able to regenerate. More aggressive weeds such as Veldt Grass probably present.
Degraded Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.	**Very Poor** Severely impacted by grazing, fire, clearing, or a combination of these activities. Scope for some regeneration but not to a state approaching good condition without intensive management. Usually with a number of weed species including aggressive species.	**Severely Disturbed** Severely impacted by grazing, fire or clearing with little scope of regeneration to normal structure. Usually with a number of weed species including aggressive species.

Completely Degraded The structure of the vegetation is no longer intact and the areas is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora composing weed or crop species with isolated native trees or shrubs.	**Completely Degraded** Areas that are completely or almost completely without native species in the structure of their vegetation, i.e. areas that are cleared or 'parkland cleared' with their flora comprising weed or crop species with isolated native trees or shrubs.	**Degraded** Areas that are completely or almost completely without native species in the structure of the vegetation. Includes areas that are parkland cleared with their flora comprising weed or crop species with isolated native trees or shrubs.

2.1 Why does the ER not address conservation commitments directly? Why are these commitments pushed along to subsequent stages of the planning process? For example, the ER states that "It is proposed that the building envelopes be identified to protect existing remnant vegetation. Any agricultural activities will be restricted to "degraded" areas where the minimum clearing of vegetation is required". It also further states that "It is also proposed that environmental management provisions be included within the scheme to specifically identify locally significant areas of vegetation on the property and demonstrate that subdivision plans comply with a general policy of vegetation management and retention". The text merely states that it is proposed that the processes and actions will be carried out. The Urban Bushland Council (UBC) fears that planners and developers will be trying to minimise the amount of bushland they need to protect by disputing what is considered to be "locally significant".

R2.1 The specific intention of the rezoning amendment in this instance is to establish the framework for detailed structure planning through which environmental commitments will be addressed. Consistent with this intention, the amendment includes a provision establishing a requirement for preparation of a Vegetation Management Plan (refer to Environmental Condition 1). This condition has been modified to include consultation with UBC to ensure conservation commitments are appropriately addressed at the LSP Stage 1 (refer to attachment).

2.2 The UBC does support the Proposed scheme provisions to implement the Management Strategy (p16) in the ER but is uncertain as to how effective they will be in terms of conserving remnant vegetation. The UBC generally does not support the clearing of any bushland as those areas even in poor condition can sometimes provide important habitat areas for fauna or provide corridors for fauna movement. Therefore, the UBC requests that the City of Wanneroo act to conserve as much as is possible of the remnant vegetation through the subdivision process. What measures are to be used, if any, to protect remnant vegetation at the subdivision stage?

R2.2 It is the intention to retain as much native vegetation as possible. The development of the Vegetation Management Plan at the LSP stage will interlia address the specific measures to protect vegetation at subdivision

stage. Condition 1 has been modified to include consultation with UBC at the LSP Stage to ensure vegetation conservation measures are appropriate (refer to attachment).

2.3 Figure 8 of the ER suggest that a great many trees are threatened by the proposed Rural Community development. The UBC strongly supports the retention of indigenous trees and if some replacement trees are to be planted they should be indigenous trees as opposed merely to native trees. They should also be grown from provenance seed.

R2.3 Figure 8 relates primarily to the cluster development option and includes areas which are *prospective* only for this land use. It does not establish that the entire area will be used for low intensity agriculture. Further, if the traditional subdivision occurs, possible agricultural use of common areas is no longer relevant. It is also noteworthy that substantial areas of *tagasaste* (*Chamaecytisus palmensis*) occur within Lot 202 and there is no reason why these areas should not be cleared.

The UBC's recommendation to use provenance seed is noted. The issues of species to be used in revegetation will be addressed in the Vegetation Management Plan. UBC's involvement with the preparation of the plan, and the possible use of Provenance correct seed, has now been included in Condition 1.7 (refer to attachment).

2.4 Why were the pockets of sedges and mosses which occur in a corridor between the pines and the System Six area M1 not inspected during the flora survey? This area could be an important micro-habitat and should be inspected before decisions are made on the M1 flora.

R2.4 To the east, the Amendment Area is bordered by the future extension of the Mitchell Freeway. Areas of vegetation outside the Amendment area are not the subject of the ER with exception of peripheral effects from development.

3.0 Declared Rare and Priority Flora

3.1 The Declared Rare species, *Eucalyptus argutifolia*, occurs just to the west of the amendment area. Every effort must be made to ensure that the increased population pressure associated with the Rural Community development does not endanger this significant species.

R3.1 Noted. This will be incorporated into the Vegetation Management Plan as detailed in the report. (Refer to Condition 1.4, attached).

4.0 Terrestrial Fauna

4.1 The three remaining significant stands of trees within the Amendment area are very important for wildlife habitat and will retain wildlife within the Rural Community, as well as providing important islands of refuge for animals moving between the conservation areas surrounding the Rural Community.

R4.1 Agreed.

4.2 Provision should be made for corridors of remnant vegetation to allow for the movement of fauna.

R4.2 Refer to response 2.2.

4.3 It would be preferable that the ownership of cats within the Rural Community be discouraged to help protect fauna in the surrounding bushland areas of high conservation value.

R4.3 Although discouraging cat ownership would be desirable, experience has shown such is not yet practical in this State.

5.0 Troglobitic fauna and stygofauna

5.1 It appears that the survey for subterranean fauna has been largely restricted to stygofauna. Why is this so when Table S1 in the ER clearly also makes mention of troglobitic fauna?

The recording of terrestrial invertebrates remains a gross omission from the environmental description of Lots 201 and 202 with the lack of any proposal by the developer for reducing negative impacts on troglobitic terrestrials should they be found and described. There is no inventory of the terrestrial invertebrates on the site and whether any are troglobitic or are important Gondwana relict species.

The report also assumes that much the same cave fauna will be located within the amendment area as that found in the nearby Yanchep National Park. However, many existing and unknown species could exist within short distances of one another. Stygofauna and troglobites may also exist in many caves that are presently not open to the surface.

Therefore, it is recommended that a more exhaustive search and survey of the Amendment area is undertaken by experienced biospeleologists to enable a more comprehensive inventory of the invertebrates, particularly terrestrial invertebrates in caves and solution pipes. The survey should be undertaken using methods employed by the Western Australian Speleological Group and the Speleological Research Group which are widely accepted in Europe, North America, China and many other tropical and temperate karst areas.

R5.1 As detailed in Section 3.2.3, "Troglobitic fauna is fauna that is restricted to living in caves. Stygofauna is a sub-set of troglobitic fauna and refers to aquatic troglobytes. It is considered that stygofauna, as a subset of troglobitic fauna, are likely to be the most sensitive to environmental disturbance (Brenton Knott, pers. comm.). Hence for the balance of this report the issues relating to stygofauna and troglobitic fauna will be analysed with respect to stygofauna. However, clearly management for stygofauna can be taken to include for the management of troglobitic fauna."

There are only two caves on the site, one which is of a significant size and has been partly explored by Dr Brenton Knott (UWA, Zoology) and Mr Neil Beckingham (Alan Tingay & Associates). The other is an inaccessible fissure which appears limited in size. The cave of significant size contained no underground stream or root mat habitat. No troglobites were observed by Dr Knott who is an invertebrate expert. It is possible that another cave connects to the first. In relation to this possible cave, Dr Knott's report regarding possible occurrence of subterranean fauna indicated the following:

"In the other possible cave, a hole leading into a cavern, no attempt was made to explore this site given the unstable and dangerous nature of sediments. Given these conditions I would predict the presence of, at most, a limited subterranean fauna".

It is incorrect to assume that the same cave fauna as found in Yanchep National Park will occur within the Amendment Area. The field work undertaken indicated a very limited presence of stygofauna, and the stygofauna assessment was undertaken by an internationally recognised independent scientist (Dr Knott). As indicated in the ER, the importance of surface waters at Yanchep, for example Loch McNess and Yunderup Lake serving as conduits for possible colonisation of caves in the area is readily apparent. The absence of surface water in the Amendment area is therefore likely to be a causal factor in limiting stygofauna/troglobitic fauna occurrence.

Finally, it is considered by the City that rezoning of the site to Rural Community represents an ideal, relatively low impact use of this site. The relatively low impact of the development and management controls (refer to the attachment, Conditions 2 and 3) mitigate potential impacts on stygofauna and troglobitic fauna. Hence, an exhaustive search and survey of the Amendment Area for invertebrates is not considered necessary.

6.0 Karst Wetlands

6.1 The ER does not accurately describe the hydrological controls of the cave systems in the region. The caves are created by groundwater from the Gnangara Mound intersecting the base of the Tamala Limestone. There is a clearly defined zone at which the groundwater makes contact with the limestone, this is referred to as the Cave Source Zone. This zone is identifiable throughout the region.

The maps in the ER suggest that the Cave Source Zone passes diagonally from NNW to SSE through these blocks, corresponding more or less with the line shown in Figure 9

as the demarcation between Low Risk and Very Low Risk terrain.

R6.1 The hydrological controls which would affect caves in the area are stated in Sections 3.2.6 "Groundwater Quantity" and 3.3.1 "Groundwater Quality" of the report. The management controls discussed in these sections provide for the protection of groundwater and therefore karst wetlands. In addition the specific management proposals relating to karst landforms/wetlands detailed in Section 3.2.5 ("Karst Wetlands") establish protective measures for the "Cave Source Areas" (refer to Conditions 1, 2 and 3, attached). It should also be noted that Conditions 2 and 3 have been modified to provide for relevant scientific expert advice in development of the Drainage, Nutrient and Water Management Plan, and the Karst Management Strategy.

6.2 Some of the International Union for the Conservation of Nature (IUCN) guidelines which have been developed to assist karst managers with specialised knowledge relating to karst systems clearly indicate that the hydrology of karst regions is vital to their integrity. With regards to these guidelines, the hydrology of the Amendment area has not been sufficiently documented particularly considering that there is a line of dolines indicating the presence of an underground stream.

The path of this stream and associated feeder streams should be adequately mapped by an experienced karst geomorphologist before any development proceeds. The total catchment area of the karst should also be identified. Development over the active streamways would be dangerous both to the cave environment and to the structures built on the surface above.

R6.2 The management framework set out in the Drainage, Nutrient and Water Management Plan commitment will ensure that "Groundwater extraction bores are located in areas where drawdowns will not impact on areas of karst or potentially significant stygofauna habitats. In all cases, however, the borefield will be located at least 200m from high risk karst areas to avoid any potential impacts on stygofauna" (refer to Condition 2.1). Implicit in this commitment is that more detail of the borefield layout and impacts will be assessed at the stage of borefield design. This work will be undertaken by a hydrogeologist. The karst mapping was undertaken by a geologist with environmental qualifications and a geotechnical engineer. Mapping of "karst feeder streams" by a "karst geomorphologist" is not considered necessary or feasible on the site.

In addition, the risk of contamination of the groundwater beneath the subject land will be minimised by adopting water sensitive urban design guidelines, appropriate effluent disposal and developing a Comprehensive Drainage, Nutrient and Water Management Plan (refer to Section 3.3. of the ER). Additionally, Conditions 2 and 3 (attached) have been modified to allow for additional advice from scientific experts.

7.0 Groundwater quantity

7.1 How will a localised drawdown of the water table impact on vegetation and contribute to tree mortality? This issue should be reviewed in consultation with the Water and Rivers Commission.

R7.1 The modelling of peak demand indicated that at no point did drawdowns exceed 0.6m (eg. well within seasonal fluctuations). It is therefore anticipated there will be no tree mortality associated with the borefield. However, clearly this issue will need to be addressed further in the Drainage, Nutrient and Water Management Plan as indicated in Section 3.2.6 of the ER (refer to Condition 2, attached).

7.2 The amendment area falls within the operating licence area for the Water Corporation for both water and sewer services. Therefore, consultation with the Corporation as to the provision of services is recommended at the earliest stages of development.

R7.2 The residential densities associated with a "Rural Community" do not justify the infrastructure required to deep sewer the site. The Government Sewerage Policy stipulates that lots greater than 2000m^2 in size do not require connection to a sewerage service. Furthermore, the impacts of the development are manageable with nutrient attenuating on-site sewerage disposal systems. A licence for groundwater extraction will of course be sought from the Water Corporation. Development of the Drainage, Nutrient and Water Management Plan will be undertaken in consultation with the DEP, Water Corporation, WRC and relevant scientific experts (refer to Condition 2, attached).

7.3 The Amendment area is located within the Gnangara Groundwater Area where there is a requirement to obtain a groundwater well licence for irrigation projects greater than 0.2ha in size. This includes areas reserved for recreation and areas of public open space. Licences issued will contain a number of conditions including the quantity of water that can be pumped each year.

R7.3 Noted.

7.4 The information provided in the Aquaterra report on the hydrology of the site is inadequate to predict impacts on the groundwater table and the resultant impacts on the karst environment. Further modelling should be undertaken using more site specific data. This would enable more reliable predictions of water table drawdowns.

R7.4 The Aquaterra study is intentionally conservative and is considered to adequately demonstrate that the project water supply can be provided on-site. Impacts on karst environment will be minimised by careful borefield placement which will be determined by detailed site investigation and numerical groundwater modelling at the LSP stage (refer to Section 3.2.6 of the ER and Condition 2 as attached).

7.5 Why was a 'water balance' not developed for the site? This should be done and the 'urban development model' would provide the information necessary to make a valid assessment. Information could be sourced from the Baragoon wellfield as well as any local data available. There may also be a need to generate site-specific data.

R7.5 An approximate water balance was developed for the site as discussed in Appendix 6 of the ER document. Further detail on water extraction and wastewater production will be prepared as a part of Condition 2 (refer to attachment).

7.6 If the proposal is approved a condition of approval should be that water extraction is managed to maintain the water table within natural fluctuations. A water monitoring program should also be developed to determine changes to the water table.

R7.6 As indicated in Section 3.2.6 and Appendix 6 of the Environmental Review document, worst case scenario drawdowns are 0.6m. It is appropriate that drawdown effects are minimised at the karst areas. Further detail on the size and location of groundwater extraction bores, impacts and management will be provided at the LSP stage (refer to Condition 2, attached). Further, it is anticipated that any monitoring requirements will be established through the Water & Rivers Commission groundwater well licensing process.

8.0 Karst landforms

8.1 Cavernous limestone in the amendment area may present difficulties for house construction.

R8.1 As indicated in Section 3.2.7 of the ER document, appraisal of the karst terrain within the Amendment area occurred in consultation with the DEP and MFP. One objective of this appraisal was to assess the likelihood (i.e. risk) of karst occurrence within the Amendment Area. The risk assessment study was partly aimed at defining the levels of geotechnical investigation required for house construction. Further geotechnical investigations form part of Condition 3 (attached).

8.2 It is recommended that Yanchep experienced speleologists be asked to assist in making sure that roads are sited with a view to public safety and to preserve natural scenery.

R8.2 It is considered that geotechnical engineers and environmental geologists are suitably qualified. The construction of Breakwater Drive was undertaken by these personnel and successfully traverses the karstic zone. However, Condition 3 has been modified to allow for provision of advice from relevant scientific experts with respect to karst (refer to attachment).

8.3 The clearing of the understorey in the interdunal swale between the Spearwood dunes will encourage runoff to

collect in the depressions, many of which would also collect vegetation resulting in dense root growth supporting shrub growth and binding soil. This dense growth can conceal blocked solution pipes which may fall in after heavy rainfall following a fire. The development of a Rural Community will probably increase the fire risk. Therefore, how will the susceptibility of the depressions to collapse be managed so as to not compromise safety?

R8.3 The interdunal swales are not narrow enough for the scenario outlined to occur. Fire management will be dealt with in consultation with CALM (refer to Condition 1, attached).

8.4 According to the consultants own Karst report the limestone ridges have not been exhaustively searched for cavernous features. Therefore, it is recommended that speleologists experienced in the location of the many different types of karst features in this area be allowed to undertake a survey which supplements the methods used by the consultants.

R8.4 At the LSP stage the areas of outcrop will be further assessed by a geologist experienced in karst scenery assessment. Although this would necessarily have formed part of the further karst assessment, Condition 3 has been modified to clarify this accordingly (refer to attachment).

8.5 Why does the ER not specify a minimum block size? This is essential in this terrain. The criteria for a subdivision in karstic terrain should be that:

i) every lot in the subdivision is viable, in the sense that the purchaser would not find that caves he has identified beneath his property are restricting him to have to build in unacceptable edges or corners; and

ii) that public road access must not go over caves. While the property owner may use his discretion to put his internal access drive over a cave, this must not be condoned in the public areas.

Experience on Lot 50 in Carabooda (which has a similar karstic portion to Lots 201 and 202, Two Rocks) has shown that Lot sizes somewhat smaller than 2ha, eg. 1ha, at least some of the lots would prove to be unsafe to build on in spots where the purchaser would find it acceptable. Therefore, it is recommended that a minimum lot size of 2ha for the karstic portion of the Amendment area be specified.

R8.5 The zoning of "Rural Community" allows for either conventional special rural lots, cluster development or a combination of both. The smallest lot size would occur in the event of cluster development and would be in the order of 2000m^2 to 4000m^2. A minimum lot size for a conventional special rural subdivision is 1ha (refer to Sections 1.2 and 2.1 of the ER).

One objective of the karst appraisal study was to establish that it would be possible to identify geotechnically viable building envelopes on all lots through the structure planning process.

There is only one known cave and a cave/fissure within the Amendment Area, neither of which will be affected by infrastructure. For example, the cave of aboriginal significance will be protected by a 3ha buffer and areas of high risk for karst will be avoided unless further investigations indicate such to be geotechnically and environmentally unnecessary. It should also be noted that Breakwater Drive which traverses the karstic zone, was subject to prior geotechnical evaluation similar to that intended in this instance and thoroughly geotechnically evaluated. Conditions 2, 3 and 4 (attached) establish requirements to safeguard karst features within the Amendment area.

8.6 The ER describes a cave located on Lot 202 as "a cave of significant size", "at least 30m deep" and "the cave is extensive". If this is the case then a cave of 30m depth would be the deepest known cave in the Yanchep karst making it a very important feature, with the possibility of extensive underground drainage to allow dolines to form in 30m thickness of limestone. If a cave of this size exists then why was there not a more detailed survey done of its true boundaries, as well as for tight solution pipes which can lead to extensive caves? Further survey work by experienced speleologists is recommended prior to any decision by the City of Wanneroo to allow Rural Community development.

R8.6 The cave is to be protected by a 3ha buffer which will more than adequately protect the site from indirect effects of the Rural Community development. Further speleological work can therefore be carried out at the City's discretion. The cave has been partially explored by Dr Brenton Knott (UWA Zoology) who commented, "We were able to get to the bottom of the cave of the one undisputed cave despite the unstable rock forms. There were very few roots and none extended to near the bottom of the cave. There was some cave decoration. Although the sediments at the bottom of the cave were moist and there was some evidence of limited surface flow, presumably from the rainfall of the preceding weekend, there was no stream or root mats. In the other possible cave, a hole leading into a cavern, no attempt was made to explore the site given the unstable and dangerous nature of the sediments. Given these conditions, I would predict the presence of, at most, a limited subterranean fauna."

Anecdotal evidence suggests that a second highly unstable cave is connected to the abovementioned cave. However, it is likely to be no deeper than the cave to which it is connected which is approximately 10m deep (Alan Nottley, pers. comm). The 30m "depth" referred to in the ER corresponds to the total length of underground chambers.

Given the relatively low impact of the proposed development (Rural Community) and the management controls to be installed to protect karst, exhaustive exploration of the existing cave was considered unnecessary.

8.7 Why did the consultants who prepared the ER not reference any of the works by Bastian (1991, 1964, 1996) and Williamson, K & Lance, K (1979)? Lex Bastian has been conducting speleological studies at Yanchep for over forty years. Why was he not consulted over the eight year period of this research? Clearly the use of his expertise would have

provided a more thorough understanding of the karstic terrain within the amendment area.

R8.7 The following consultants were engaged to undertake the karst assessment:

- Coffey Partners International (Geotechnical Engineers);
- Alan Tingay & Associates (Environmental Scientists, Geologists and Engineers); and
- Zoology Department of Western Australia (Stygofauna and Troglobitic Fauna Experts).

All concerned are conversant with the geomorphology of the Yanchep area and accordingly, the karst appraisal undertaken is considered to be thorough. Further, as the cave within the Amendment area is to be comprehensively protected by a 3ha buffer, a thorough speleological study was not considered critical.

8.8 Why was the impact of fire on karst features not considered? A detailed Fire Management Plan should be drafted to ensure that bush areas containing karst features are adequately protected. Fire can impact on karst features through:

- **the leaching of carbon deposits in caves;**
- **the impacts of smoke and ash on secondary cave deposits and cave fauna;**
- **the degradation of cave entrances through denudation followed by rainfall;**
- **the spalling of limestone throughout the karst; and**
- **fracture and collapse due to heating.**

R8.8 Of the known caves within the Amendment Area, only one has an entrance that could be affected by fire. This cave is also a site of known Aboriginal significance and is situated in an isolated patch of vegetation surrounded by cleared land. This cave will be protected by a 3ha buffer which will encompass the surrounding vegetation and, combined with other precautions, will help to reduce any risk of fire damage as suggested.

Condition 1 (attached) has been modified to stipulate that fire management issues need to be addressed as part of the Vegetation Management Plan, and it also establishes that the Plan (and therefore fire management proposals) requires CALM's concurrence. It is considered that development within the Amendment area will, in fact, enhance fire management capability within the area, thereby diminishing any risk to karst features from fire.

8.9 Why is the cave which has been identified as an Aboriginal site only being protected for its cultural and spiritual values? Why is it not also being protected for its biodiversity value as well? The surrounding development could potentially impact upon the cave from a hydrological and a biodiversity perspective. Human visitation will increase to the cave after the Rural Community is developed. If the cave is

accidentally discovered, what precautions exist to prevent that person entering and damaging the cave? A fence and appropriate sign posting is not suitable as signs will merely draw attention to the cave and fences are easily breached.

A possible solution would be to gate the entrance to the cave specifically. However, this should not occur until extensive studies have been carried out both in the cave meteorology and the fauna of the cave.

R8.9 By protecting the cave site for its cultural value its fauna will also be protected. From a safety perspective the entrance to the cave will need to be secured as is the practice for other caves in the south-west. The cave was partially explored by Dr Brenton Knott (UWA Zoology), who considered that its fauna is probably limited due to the absence of underground streams and root mats. Nevertheless, the exclusion of access to the cave will ensure protection of any fauna present.

9.0 Karst systems can be highly intrusive and housing nearby to active karst systems, whilst appearing to be in a safe location initially can become the victim of subsidence at short notice.

Therefore, it is recommended that the high risk karst area within the amendment area, as well as the Aboriginal site, be included in the proposed reserve, Site No. 284 of Perth's Bushplan. This will involve moving the eastern boundary of Site 284 further east to encompass the area of high risk karst identified in the ER.

R9.0 Areas assessed as "high risk" of karst occurrence are likely to become POS or be incorporated within the "common areas" of the development. Refer to Condition 3 (attached).

9.1 The ER refers to "large karst structures". What is the definition of a large karst structure? In comparison with most other karst areas in Australia, the Yanchep area contains caves which are small in size. It is suggested that the term of reference should be "significant cave feature for the area of karst". This allows for the cave to be compared to other karst features within the area.

R9.1 Large karst structures in the ER document are referring to interdunal dolines, which are sand filled collapse features generally greater than 5m in diameter.

POLLUTION MANAGEMENT

10.0 Groundwater quality

10.1 The Amendment area falls within the Perth Coastal Underground Water Pollution Control Area (UWPCA) and not the Yanchep UWPCA as stated in the ER.

R10.1 Groundwater quality will be protected through nutrient attenuating on-site sewage, the use of alternative waste disposal systems or package sewage

treatment plan and preparation of a drainage nutrient and management plan. The management of nutrients will be assessed and carefully planned with Water and Rivers Commission to meet Priority 3 UWPCA requirements. Refer to Condition 2 (attached).

10.2 The Water and Rivers Commission compatibility table for landuse in Public Drinking Water Source Areas allows for unsewered development with a minimum lot size of 1ha. Under these guidelines the proposed Rural Community development conforms to these requirements. However, the proposal is centred around the concept of cluster development with 300 lots ranging in size from between 2000m^2 and 4000m^2 using an averaging methodology to maintain a notional 1ha average lot size.

Part of the rationale of the minimum 1ha lot size in Priority 3 UWPCA's was that there would be a spreading of contaminants over an area where natural remediating effects and dilution would assist in protecting groundwater quality. The effect of cluster development, however, has the propensity to produce "hot spots" of contamination, which may not be attenuated by the process mentioned above. Therefore, how will the proposed approach meet the intent of the Water and Rivers Commission's policy?

The Water Corporation recommends that this new concept of "averaged cluster development" needs considerable research and resolution before it becomes an accepted approach to "Rural Living Land Development" within P3 UWPCA's.

R10.2 It is agreed that sewage disposal needs to be managed very carefully to avoid potential "hot spots" of contamination. Clearly, should the cluster option proceed, the method of sewage disposal will need to ensure WRC objectives for Priority 3 UWPCA are met. Similar issues will also need to be addressed in relation to the management of stormwater disposal.

The Drainage, Nutrient and Water Management Plan, which will be developed during the LSP stage, and on advice from the DEP, WRC, Water Corporation and other relevant experts, is the mechanism by which these issues will be addressed (refer to Condition 2, but more particularly 2.12 which has been added to specifically ensure that these issues are adequately addressed).

10.3 How will the land which is proposed for common ownership under a "cluster" development be managed so as to not be compromised in the future by the possibility of further development that may bring it outside of the guidelines for the Water and Rivers Commission's policy for drinking water source areas?

It is recommended that a suitable size portion of the remnant land be set aside for Parks and Recreation to ensure that the average lot density remains consistent with the policy and exceeds a 1ha average. If this is not to be implemented then it is recommended that the cluster development be required to

be provided with a suitable sewerage system to cater for the overall development area.

R10.3 The development of a comprehensive Drainage, Nutrient & Water Management Plan at the LSP stage will detail a management framework for common areas. This framework will have to set limits on development and contaminants (eg. fertilisers and pesticides). During preparation of the Drainage, Nutrient & Water Management Plan the type of effluent disposal system will be stipulated (refer to Condition 2, attached).

Future use of common areas within the Amendment Area will be appropriately determined by City of Wanneroo.

10.4 The Health Department of Western Australia gives support to the recommendations of the Water and Rivers Commission on the proposed amendment given the location of the Amendment area within the P3 UWPCA.

R10.4 Noted.

10.5 On-site wastewater systems should not exceed a density of an average of one system per one hectare of land in accordance with the Water and Rivers Commission's guidelines on development in a P3 UWPCA.

R10.5 Agreed. This average will be maintained across the entire site. Also refer to response 10.2.

10.6 Site conditions will need to be demonstrated as suitable for on-site wastewater disposal at the Local Structure Planning stage.

R10.6 Agreed.

10.7 Package sewage treatment plant and wastewater disposal development will need to be:

- **licensed by the Office of Water Regulations;**
- **referred to the Water and Rivers Commission and the Department of Environmental Protection; and**
- **approved by the Health Department of Western Australia.**

R10.7 Noted.

10.8 None of the Aerobic Treatment Unit systems, or soil amendment system, as described or available has been approved for the purpose of removing or retaining nitrates.

R10.8 It is recognised that Alternative Waste Treatment Systems (AWTS) have not, in most cases, received formal recognition for nitrate removal. However, an evaluation of AWTS by BRW for Water and Rivers

Commission concluded that biological nitrogen removal can be achieved in package treatment systems using a nitrification-denitrification process and can achieve 75% to 95% denitrification (BRW, 1999). Hence, if denitrification is considered necessary, the means for achieving such does exist.

10.9 Potable water should be of the standard as specified in the National Health and Medical Research Council's document "Guidelines for Drinking Water Quality in Australia", given the absence of a reticulated water supply.

R10.9 Agreed. If treatment is necessary to achieve this standard, such will occur.

11.0 Priority 3 UWPCA's are defined to minimise the risk of pollution to the water source. P3 areas are declared over land where water supply sources need to co-exist with other landuses such as residential, commercial and light industrial developments. Protection of P3 areas is achieved through management guidelines rather than restrictions on land use. If the water source does become contaminated, then water may need to be treated or an alternative water source found.

R11.0 Noted.

11.1 The specific objective for allowable contamination by nitrogen of the recharge water in P3 areas is:

demonstrate the nitrate concentration in groundwater recharge over the lot will not exceed 50% of the National Health and Medical Research Council (NH&MRC) limit (Australian Drinking Water Guidelines, 1996).

The allowable contamination is estimated or measured at the point of entry to a watercourse or at the watertable and averaged for the property of a calendar year.

R11.1 The Drainage, Nutrient and Water Management Plan to be prepared, will ensure this objective is met (refer to Condition 2 as attached).

11.2 The Water Quality Protection Branch of the Water and Rivers Commission should be consulted with during the development of the Drainage, Nutrient and Water Management Plan, particularly with respect to the protection of the quality of drinking water.

R11.2 Condition 2 ensures that the Commission will be consulted in preparation of the plan.

11.3 The layout of cluster subdivision should be suitably located downstream of any proposed production bores for drinking water supply.

R11.3 Noted.

11.4 Provisions should be included in the City of Wanneroo's Town Planning Scheme No. 1 which recognise that the Amendment Area is located within a Priority 3 UWPCA and that development applications which may impact on the water quality should be referred to the Commission. Advice will be based on the Commission's Land Use Acceptability Table and groundwater recharge criteria for P3 UWPCA's.

R11.4 The City already takes cognisance of the Commission's land Use Capability Tables in dealing with development proposals throughout its district, and this information was in fact used in preparing the ER document (refer to Appendix 7). Specific amendment of the City's Town Planning Scheme as suggested is not, therefore, considered necessary.

12.0 Noise

12.1 What about the buffer distance between the lots and the proposed Mitchell Freeway? This should be determined in consultation with the Department of Environmental Protection.

R12.1 Necessarily, the proposal for the Amendment area will need to accommodate prevailing policies and regulations relating to management of noise.

SOCIAL SURROUNDINGS

13.0 Aboriginal Culture and Heritage

13.1 In Table S1 "Summary of Environmental Factors" in the ER it is indicated that the Aboriginal Site will be protected within a 3ha buffer. However, which site is being referred to here? The archaeological site or the ethnographic site? Mr Quartermaine did not mention a management plan for the archaeological site, so it is most likely referring to the site within the McIntyre and Dobson report. However, will both sites be protected during the development of the Amendment area?

R13.1 The 3ha buffer is in conformance with requests by Mr Colbung and Quartermaine (1991) to protect the cave site which has ethnographic significance. There are no archaeological sites within the study area.

13.2 The one archaeological site found is important as it is one of only a few sites found on the Quindalup Dunes. However, only 33% of the Amendment area was surveyed for Aboriginal archaeological sites. Therefore, the Aboriginal Affairs Department (AAD) endorses Mr Quartermaine's recommendation that the amendment area be monitored for subsurface cultural materials and also burials when the surface is excavated for development.

R13.2 The archaeological site is not in the Amendment area. It is located approximately 1km north of the current Yanchep townsite. The response is inaccurate in specifying only 33% of the Amendment Area was

surveyed. The Amendment area was covered by the Archaeological study by Quartermaine, (1991). The archaeological survey covered approximately 7000 hectares of land situated on the coast at Yanchep and Two Rocks, and comprised:

- Assembly of data from previous work in the region, including information from WA Museum Aboriginal site files, previous survey reports, maps and environmental data.
- A sample survey of the total project area.
- The location and recording of archaeological sites within the designated survey area.

Prior to the commencement of site works, staff shall undergo a briefing on Aboriginal Heritage, to enable staff to recognise materials that may constitute an Aboriginal Site. During earthworks all contractors will be supervised by a Site Manager, who if a suspected site is discovered, will seek specialist advice to confirm the identification of the site. Condition 4 has been modified to specifically incorporate these requirements (refer to Condition 4.2).

13.3 The AAD has only one of the two Aboriginal heritage reports that are mentioned in the ER, the "Report on an Archaeological Survey for Aboriginal Sites" by Gary Quartermaine. Would you please ensure that Alan Tingay and Associates provides the AAD with a copy of the ethnographic report, in order for staff to assess it. This report is almost eight years old and depending on who was consulted in the anthropological report, you may need to consult others with interests in the area in regard to the proposed amendment.

R13.3 The report will be forwarded to AAD. The ethnographic study specifically used Aboriginal people who "have a knowledge of, or retain cultural links with, the Yanchep area", including:

- Mr C Bodney, a highly respected Aboriginal consultant who is custodian of traditional knowledge of the area was used;
- Mr K Colbung was used as a consultant and advisor. Mr K Colbung who, in 1991, was Director of the Institute of Aboriginal Studies in Canberra, has been involved as a consultant and advisor on a number of proposed developments in the Wanneroo-Yanchep area; and
- Mr Edward Nippy is a well respected Aboriginal spokesperson for the Yuart people in the Moora/Gingin area.

13.4 If areas are to be developed then archaeological surveys and ethnographic consultations need to be conducted with local Aboriginal communities prior to work commencing. Accordingly, any proposed development which may impact upon a site with Aboriginal significance must be granted a section 18 permit from the Aboriginal Cultural Material Committee.

R13.4 There will be no impact on the ethnographic site. Archaeological and ethnographic surveys with local aboriginal communities have already been carried out by Quartermaine (1991) and MacIntyre and Dobson (1991). The management of potential undiscovered sites is addressed in Condition 4 (attached).

14.0 Public Safety - Unexploded Ordnance

14.1 The Unexploded Ordnance (UXO) Unit of the Fire and Emergency Services Authority of Western Australia has completed a Field Validation Study (FVS) of the amendment area. The results of this study indicate that no further action by the UXO unit is required for this area. Therefore, this Unit has no objections to the proposed amendment. However, areas to the north, west, south and to a lesser extent to the east will be required to be subjected to further FSV searches as required.

R14.1 Noted.

15.0 Social Surrounds

15.1 Why not consider 'sustainable development', the establishment of fourth wave eco-villages or fourth wave cluster housing and other matters related to alternative lifestyles?

R15.1 The City considers that the overall philosophy of the rural community is consistent with producing sustainable outcomes.

Appendix 5

Additional modelling of potential impacts of pumping on water table levels

Water Demand

Based on the generic demand figures used in the previous assessment (source: Water Corporation/WAWA and AGWA) and the modified development scenarios:

- Scenario 1: 255 Rural Residential Lots;
- Scenario 2: 300 Rural Residential Lots with 200ha under 'boutique' agriculture;

the estimated water demands are as shown in the table below.

	Scenario 1	**Scenario 2**
Peak summer daily demand	1.5ML/d	9.8ML/d
Average summer demand	1.1ML/d	9.3ML/d
Average annual demand	0.5ML/d	4.5ML/d

Impact of Pumping on Regional Groundwater

The average annual demand for Scenario 2 of 4.5ML/d (or 1640ML/yr) is some 82% of the estimated annual groundwater throughflow of 2,000ML/yr. This exceeds the proportion of throughflow (70%) beneath the study area that WAWA (1990) envisaged as being acceptable. However, the estimated throughflow is believed to be conservative (WAWA, 1990). Also, when taking into account the potential enhanced recharge over the study area (some 960ML/d), the proportion of total estimated groundwater flows abstracted by pumping to meet the demand (of 4.5ML/d) falls to 55%.

Impact of Pumping on Study Area

There are a number of potential borefield configurations that could supply the above demands. We have assessed the likely drawdown impacts of two such configurations to supply Scenario 2:

- Case 1: Five bores at 1km spacings supplying 2ML/d each for six months of the year (total of 10ML/d) and 1ML/d each average over the whole year (total of 5ML/d); and

- Case 2: Ten bores pumping at 1ML/d each for six months of the year, with five pumping at 1ML/d each all year.

As with the previous work, drawdowns were estimated (using a simple lumped parameter model) at several 'lines' some 200m and 500m from and parallel to the alignment of an elongated north-south borefield. Again, an aquifer transmissivity of 1,000m^2/d and a storativity of 0.2 were adopted. The resulting predictions are as follows:

Case	Pumping	Drawdown at the 200m line	Drawdown at the 500m line
Case 1	After 6 months summer pumping	0.7 to 0.9m	0.3 to 0.4m
	After 12 months average pumping	0.5 to 0.6m	0.3 to 0.4m
Case 2	After 6 months average pumping	0.5 to 0.8m	0.3 to 0.5m
	After 12 months average pumping	0.5 to 0.6m	0.3 to 0.4m

If, say, the aquifer transmissivity was 2,000m^2/d, the predicted drawdowns would be less. However predicted drawdowns are still around 0.5 to 0.6m (Case 1) and 0.4 to 0.5m (Case 2)

at the 200m line after six months summer pumping and around 0.3 to 0.4m at the 200m line after one years average pumping for both cases.

Conclusions

Revised water demands for both Scenario 1 and 2 are higher than estimated previously. However, the main increase is for Scenario 2 and is as a result of the doubling of the area for boutique agriculture. This has increased demand by 4ML/d (peak and summer demand) or 2ML/d (average annual demand). The increase in Special Rural Residential Lots in Scenario 2 from 200 to 300 has only increased demand by around 0.6ML/d (peak), 0.4ML/d (average summer) or 0.2ML/d (annual average).

It is estimated that the increased demand could be sustained by the aquifer system. Pumping would represent some 82% of the groundwater throughflow from the east and some 55% of the potential throughflow to the west when taking account of enhanced recharge (due to urbanisation and clearing).

Predicted drawdowns at distances of 200m and 500m from two alternative elongated borefield configurations is also higher than previously predicted and exceeds 0.5m (at the 200m line) in all cases.

However, the above estimates and predictions are based on conservative estimates and a simple lumped parameter analytical model. If Scenario 2 is to be considered further, it is recommended that more detailed modelling be carried out based on variable and site specific data for aquifer parameters and calibrated against longer term monitoring records.

Appendix 6

Additional modelling of potential levels of nitrogen in recharge following development

MODELLING OF NITROGEN IMPACTS ASSOCIATED WITH AMENDMENT 837.

As a result of your written request (3/9/99), nitrogen impacts associated with the proposed land uses on the Lots 201 and 202 Breakwater Drive, which are the subject of Amendment 837 to the City of Wanneroo Town Planning Scheme No. 1, have been modelled. This report, which has been prepared in conjunction with Bob Jeffery (Soil Management Consultant), presents the results of that modelling.

It is understood that the requirement for this work arises from concerns that nitrogen applied to the land surface may result in elevated levels in the groundwater that may in turn impact on the limited stygofauna assemblage identified on the site.

Based on discussions with DEP officers and Brenton Knott (UWA, Zoology), it has been determined that there are no well defined water quality criteria for the protection of stygofauna. Brenton Knott has suggested that as stygofauna rely largely on organic matter in the form of detritus as a food source, it may be the case that a moderate elevation of nutrients through agricultural practices and effluent disposal may be beneficial by possibly providing a food source. In view of the uncertainty it was considered that the Water & Rivers Commission (WRC) Criteria used for assessing the acceptability of nitrogen in recharge for Priority 3 Ground Water Protection Areas would form a conservative basis for a preliminary analysis of nitrogen impacts

Modelling was performed for two different scenarios representing either a cluster development with some agricultural land use or conventional special rural development. The assumptions used for the two scenarios are summarised below:

Scenario 1. 255 special rural lots with a minimum lot size of 1ha and an average lot size of 2ha with no more than 1 horse permitted on each lot; and

Scenario 2. 300 'cluster' lots of between 2000m^2 and 4000m^2 with 100 ha of land (20% of the site) allocated for perennial horticulture with no horses on the cluster lots but suitable agistment provided in the common rural area.

The nitrogen loadings were assessed using the methodology and assumptions WRC uses for the Mirrabooka Underground Pollution Control Areas (UWPCA) for determining nutrient load calculations and based on the most likely application scenario. The results were compared to the standards set out in the WRC UWPCA internal methodology for assessing proposals in Priority 3 Groundwater Protection Zones. Priority 3 Source Protection Areas are defined to minimise the risk of pollution to the water source. The allowable concentration of nitrogen in recharge is set at 50% of the NH&MRC limit of 11.3mg/L NO_3 –N, to minimise the risk of pollution. This equates to 5.7mg/L for a Priority 3 area.

Comparison was also made with the WRC Vulnerability Categories. The WRC has developed recommended maximum nutrient loadings for the protection of public water resources, based on soil type upstream of the water resource, and the vulnerability of the receiving environment. As detailed in Tingay (1999), the Amendment area is most likely to be assigned a "B" vulnerability category classification. Category B classification describes coarse sandy soils/ gravels draining to waters with a low risk of eutrophication and have a maximum nitrogen loading of 180 kg/yr.

SCENARIO 1

Nitrogen Sources

Horses: N output of 62kg N/head/yr, most of the N in urine.

Sewage Disposal: Using advanced treatment units with outputs of 2kg N/house/year. This is a 90% reduction on N output from septic tanks (eg. 18kg N/yr).

Small Farms (1-2ha): Total output from all sources is 34kg N/farm/yr. Assumes sewerage treatment by ATU (Kinhill, 1995).

Modelling Assumptions

Recharge Rate: $2000m^3/yr$ (based on annual rainfall of 800mm/year)

Leaching Factors: Used 'likely case' leaching factors for Spearwood Soils given by WRC. These leaching factors are used by the Water Protection Branch of the WRC for internal assessment of proposals (Coleman & O'Neill).

Volatilization of N: Forms part of the leaching factors used.

Calculated Nitrogen Application Rate for Scenario 1

Horses 255 horses x 62kgN/horse/yr = 15810kg N/yr

Farms 255 ATUs x 34kgN/ATU/yr = 8670kg N/yr

Total = 24480kg N/yr over xha

= 48kg N/ha/yr

This application rate is well under the maximum WRC nutrient loadings for a category B vulnerability classification of 180 kgN/ha/yr (refer to Alan Tingay & Associates, 1999).

Calculated Nitrogen in Recharge to Groundwater

To work out the [NO_3 – N] in recharge, the WRC leaching factors are applied. These are 0.1 for horses and 0.15 for farmland.

Horses 15810kgN/yr x 0.1 = 1581kgN/yr

Farms 8670kgN/yr x 0.15 = 1300kgN/yr

TOTAL = 2881kgN/yr

$$[No_3 - N] \text{ in recharge} = \frac{2881 kgN/yr \times 1000}{510ha \times 2000}$$

$$= 2.8 mg/L$$

For a Priority 3 Groundwater Protection Area, the WRC assesses the acceptability of nutrient impacts by examining the concentration of nitrogen in recharge water on the basis of an annual average. The allowable concentration of nitrogen in recharge is set at 50% of the NH&MRC limit of 11.3mg/L $N0_3$ –N, to minimise the risk of pollution. This equates to 5.7mg/L for a Priority 3 area. Scenario 1 is well within this criterion.

SCENARIO 2

Nitrogen Sources

Horses and pasture:	As above but assuming one horse for each of 300 lots.
Houses:	On 0.2ha, total N output is 6kg N/year. Assumes sewage treatment by ATU.
Perennial Horticulture:	Application rates of N fertilisers range from 100-200kg N/ha/yr, with an average for orchards and vineyards of 150kg N/ha/yr. Crop removal rates vary from approximately 40% for grapes to approximately 60% for citrus. An average of 50% is assumed for crop removal from perennial horticulture.

Model Assumptions

As per Scenario 1.

Calculations Nitrogen Application Rates for Scenario 2

Horses: 300 x 62 = 18600 kg N/yr
Houses with ATU: 300 x 6 = 1800 kg N/yr
Horticulture: 100 x 75 = 7500 kg N/yr
TOTAL 35400 kg N/yr

= 69kg N/ha/yr

This application rate is well under the maximum WRC nutrient loadings for a Category B vulnerability classification of 180N/kg/ha/yr (Alan Tingay & Associates, 1999).

To work out the [NO_3 – N] in recharge the WRC leaching factors are applied. These are 0.1 for horses, 0.15 for houses with ATU and 0.45 for horticulture.

Horses: 18600 x 0.1 = 1860 kg N/yr
Houses with ATU: 1800 x 0.15 = 270 kg N/yr
Horticulture: 7500 x 0.45 = 3375 kg N/yr
TOTAL 5505kg N/yr

$$[NO_3 - N] \text{ in recharge} = \frac{5505 \times 1000}{510 \times 2000}$$

= 5.40mg/L

This is below the WRC criteria for minimising risk of pollution in a Priority 3 area (5.7mg/L).

Note: The modeling was based on likely N-application rates for 100ha. The Environmental Review identified up to 200ha of land as being potentially suitable for perennial agriculture. In order for more than 100ha of the site to be used for perennial horticulture, management measures would need to be developed and implemented to limit N application to approximately half that stipulated for the 100ha model eg. 75kg N/ha/yr.

Possible management measures include:

- Use of slow release fertilisers;
- Careful design of irrigation and fertiliser systems to achieve higher utilisation of applied nitrogen;

- Limiting the number of horses kept on the site; and

- Use of soil improvers such as compost or mulch to retain nitrogen and water in the root zones of the crop plants.

If such measures are proposed to allow more than 100 ha of land to be used for agricultural use then the method of use would need to be described in the nutrient and drainage management plan, which will be required to be developed to the satisfaction of DEP, WRC and other agencies.

Conclusion

The modelling performed uses most likely case scenarios as nominated by WRC for Spearwood Sands. Based on these assumptions the following conclusions were reached:

1. Nitrogen levels in recharge to the groundwater system for a conventional development will comply with the WRC criteria for a Priority 3 Groundwater Protection Area.

2. Nitrogen levels in recharge to the groundwater system for a Cluster development with 100ha of perennial agriculture will comply with the WRC criteria for a Priority 3 Groundwater Protection Area.

3. If developers wish to proceed with a cluster development at the highest density allowable while also allowing more than 100 ha of perennial horticultural development, additional management measures will be required to limit either the quantity of nitrogen applied to the soil or the quantity of nitrogen that leaches through the soil profile into the groundwater system. Such management measures would need to be described and justified in the Drainage and Nutrient Management Plan required under the Scheme Provisions.

The Scheme provision which details the requirements for the Drainage and Nutrient Management Plan to requires confirmation that contaminant levels (which would include nitrogen) in groundwater do not exceed the WRC Criteria detailed above (Condition 2.2, 2.6, 2.7, 2.10 and 2.11). Please refer to the attached Scheme Provisions. Other contaminants, which will require management, include pesticides and herbicides.

REFERENCES

Agriculture WA: Neil Lantzke, person communications.

Alan Tingay & Associates, 1999: Shire of Wanneroo. Town Planning Scheme No. 1 Amendment 837. Yanchep-Two Rocks Environmental Review. Report No. 99/12.

Coleman, J & O'Neill WRC Water Protection Branch. Internal Methodology for Nutrient Calculations in UWPCA's.

Gerritse et al, 1992: National impacts from various landuses on the Darling Plateau of WA - Results of a survey. CSIRO Division of Water Resources. Report 92/3

Kinhill Engineers/Water Authority, 1995: Nitrogen application limits for various landuses.

Appendix 7

Identification of Relevant Environmental Factors and Summary of Assessment of Relevant Environmental Factors

Table 2: Identification of Relevant Environmental Factors

FACTOR	AMENDMENT COMPONENT WITH POSSIBLE IMPACT	GOVERNMENT AGENCY AND PUBLIC COMMENTS	IDENTIFICATION OF RELEVANT ENVIRONMENTAL FACTORS
BIOPHYSICAL			
Vegetation	The Amendment area includes the M1 System Six Area. It is also surrounded by regionally significant vegetation identified in draft *Perth's Bushplan* (Western Australian Government, 1998) as site Nos 284, 406 and 396. The development of a rural community will involve some isolated clearing. The potential indirect impacts on regionally significant vegetation in the adjacent areas include intrusion by domestic pets, changes to hydrology, weed invasion, the use of fertilisers and pesticides, and increase in fires and litter.	• CALM as manager of the State Forest to the north and east, and the Yanchep National Park to the south, has recommended that during preparation of the Local Structure Plan, the subdivider liaise with them in regards to: ⇒ the development of fire management strategies for the Amendment area; and ⇒ the allocation of landuses in the interface between the Amendment area and the CALM estate. • There should be no presumption that bridle paths within the Regional Open Space and CALM estate will be acceptable. • All of the remnant vegetation within the three significant stands of trees within the Amendment area should be retained, there should be no exception for the construction of utilities or the development of small scale agricultural activities. • Management measures to control indirect impacts on adjacent areas of regionally significant vegetation should be implemented including the control of domestic pets, fire, rubbish dumping, weed invasion, off road vehicle use and contamination by pesticides and nutrients. • As much as is possible of the remnant vegetation on the site should be conserved through the subdivision process.	Requires further evaluation. Considered to be a relevant factor.

FACTOR	AMENDMENT COMPONENT WITH POSSIBLE IMPACT	GOVERNMENT AGENCY AND PUBLIC COMMENTS	IDENTIFICATION OF RELEVANT ENVIRONMENTAL FACTORS
Declared Rare and Priority Flora	No Declared Rare Flora (DRF) or Priority flora species have been recorded within the Amendment area. However, populations of the Declared Rare Flora species *Eucalyptus argutifolia* occur in the adjacent draft *Perth's Bushplan* sites No's 284 and 406. Development of the Amendment area as a Rural Community may indirectly impact on this species of DRF through intrusion by domestic pets, changes to hydrology, weed invasion, the use of fertilisers and pesticides, and increase in fires and litter.	• The Declared Rare species, *Eucalyptus argutifolia,* occurs just to the west of the Amendment area. Every effort must be made to ensure that the increased population pressure associated with the Rural Community development does not endanger this significant species.	Considered to be a relevant factor but addressed under the factor of Vegetation.
Stygofauna and troglobitic fauna	Localised areas of karstic landforms (including two caves) have been identified within a northwest - southeast running belt across the Amendment area. Troglobitic fauna and stygofauna are restricted to living within caves. The potential impacts which may result from development on stygofauna and troglobitic fauna species within the Amendment area (and in the nearby Yanchep National Park) include a lowering of the water table, pollution of groundwater through fertiliser application, pesticide use, waste disposal leachate, leakage of fuel and other stored chemicals and stormwater runoff.	• The survey of the Amendment area for stygofauna and troglobitic fauna was largely restricted to stygofauna. Therefore, a more exhaustive search of the Amendment area should be undertaken to enable a more comprehensive inventory of the troglobitic fauna to be made. • Management of stygofauna cannot also provide for the management of troglobitic fauna.	Requires further evaluation. Considered to be a relevant factor.

FACTOR	AMENDMENT COMPONENT WITH POSSIBLE IMPACT	GOVERNMENT AGENCY AND PUBLIC COMMENTS	IDENTIFICATION OF RELEVANT ENVIRONMENTAL FACTORS
Specially Protected (Threatened) Fauna	Remnant vegetation within the Amendment area could provide an occasional habitat for two species of threatened fauna. These being the Short-billed Black Cockatoo (*Calyptorhynchus latirostris*) (Schedule 1) and the Peregrine Falcon (*Falco peregrinus*) (Schedule 4). These two species are listed "in need of special protection" under the environmental conditions of the *Wildlife Conservation Act 1950.* The clearing of vegetation for development could potentially remove some habitats for these species.	• The three remaining significant stands of trees within the Amendment area are very important for wildlife habitat and as such should be retained. • Provision should be made for corridors of remnant vegetation to allow for the movement of fauna. • The ownership of cats within the proposed Rural Community should be discouraged to help protect fauna in the surrounding bushland areas of high conservation value.	Considered to be a relevant factor but habitat loss addressed under the factor of Vegetation.
Karst wetlands	The Amendment area is underlain by the Tamala Limestone aquifer within which karst wetlands (areas where groundwater intersects karst) could potentially occur. Any changes to groundwater quality, the destruction of remnant Tuart woodlands, or a lowering in the water table as a result of development could impact upon stygofauna and any karst wetlands which may occur within the area.	• The description provided within the Environmental Review of the hydrological controls of the cave systems in the Yanchep/Two Rocks region is incorrect. The caves are created by groundwater from the Gnangara Mound intersecting the base of the Tamala Limestone. There is a clearly defined zone at which the groundwater makes contact with the limestone and this is referred to as the Cave Source Zone. • The hydrology of the Amendment area has not been sufficiently documented particularly considering that there is a line of dolines indicating the presence of an underground stream. This stream and associated feeder streams should be mapped.	Considered to be a relevant but addressed under the factor of stygofauna and troglobitic fauna.
Groundwater quantity	The Tamala Limestone, Leederville Formation and the Yarragadee Formation aquifers all underlie the Amendment area. The Tamala Limestone is the shallowest and most productive aquifer in the Amendment	• The Amendment area is located within the Gnangara Groundwater Area where there is a requirement to obtain a groundwater well licence for irrigation projects greater than 0.2ha in size. • If the proposal is approved a condition of approval should be that water	Considered to be a relevant factor but addressed under the factor stygofauna and troglobitic fauna.

FACTOR	AMENDMENT COMPONENT WITH POSSIBLE IMPACT	GOVERNMENT AGENCY AND PUBLIC COMMENTS	IDENTIFICATION OF RELEVANT ENVIRONMENTAL FACTORS
	area. To support development of the Rural Community it will be necessary to pump water from this aquifer to meet supply needs. Groundwater extraction from this aquifer to support the Rural Community development could potentially result in an excessive drawdown of the water table which may adversely impact upon stygofauna species and habitats.	extraction is managed to maintain the water table within natural fluctuations. A water monitoring program should be developed. • Consultation with the Water Corporation should be undertaken prior to development given that the area falls within the operating licence area for the Corporation for water and sewerage services. • The potential impact of a water table drawdown on vegetation within and immediately surrounding the Amendment area should be reviewed in consultation with the Water and Rivers Commission. • Further modelling of the hydrological environment within the Amendment area should be undertaken using more site-specific data. A water balance for the Amendment area should also be developed.	
Karst	Localised areas of karstic landforms have been identified within a northwest - southeast running belt across the Amendment area. Within this belt two existing caves have been identified. There is a potential for collapse or subsidence of karstic structures if development occurs over (or near to) these features. Stormwater runoff could also potentially impact on karstic structures, if infiltration is concentrated over subsurface collapse structures and washing sand down into cavities.	• A detailed Fire Management Plan which ensures that karst features are adequately protected should be prepared for the Amendment area. • The cave on the southwestern edge of Lot 202 should be protected not only for its cultural values (having Aboriginal significance) but its biodiversity values as well. The entrance to the cave specifically should be gated. • Housing adjacent to the active karst systems can become the victim of subsidence at short notice. Therefore, the high risk karst area within the Amendment area should be included in the Parks and Recreation (P&R) reserved land immediately to the west of the site. This will involve extending the eastern boundary of this P&R area further east to encompass the high risk karst area. • It is recommended that Yanchep experienced speleologists be asked to assist in making sure that roads are sited with a view to public safety and to preserve natural scenery.	Requires further evaluation. Considered to be a relevant factor.

FACTOR	AMENDMENT COMPONENT WITH POSSIBLE IMPACT	GOVERNMENT AGENCY AND PUBLIC COMMENTS	IDENTIFICATION OF RELEVANT ENVIRONMENTAL FACTORS
		• The limestone ridges within the Amendment area should be more thoroughly searched for cavernous features. • It is recommended that a minimum lot size of 2ha for the karstic portion of the Amendment area be specified. • The cave on Lot 202 in the southwestern corner is of high significance if it is 30m deep. This cave should be further surveyed with a view to determining exact boundaries and identifying tight solution pipes which can lead to extensive caves.	
POLLUTION			
Groundwater quality	The Amendment area is within the Perth Coastal (Priority 3) Underground Water Pollution Control Area (UWPCA). Groundwater within the area could potentially be contaminated as a result of the activities associated with the Rural Community development. These include fertiliser application, pesticide use, waste disposal leachate, leakage of fuel and other stored chemicals, stormwater runoff and nutrient loading from the keeping of horses.	• The Health Department of Western Australia gives support to the recommendations of the Water and Rivers Commission on the proposed amendment given the location of the Amendment area within the Priority 3 Underground Water Pollution Control Area (UWPCA). In this regard on-site wastewater systems should not exceed a density of an average of one system per one hectare of land and package sewage treatment plant and wastewater disposal development will need to be: ⇒ licensed by the Office of Water Regulations; ⇒ referred to the Water and Rivers Commission and the Department of Environmental Protection; and ⇒ approved by the Health Department of Western Australia. • The proposed Rural Community is centred around the concept of cluster development with 300 lots ranging in size from between 2000m^2 and 4000m^2 using an averaging methodology to maintain a notional 1ha average lot size (which is the minimum size for lots in P3 UWPCA's). However, cluster development has the propensity to produce "hot spots" of contamination where natural remediating effects and dilution may not assist in protecting groundwater quality as the contaminants are not spread around.	Requires further evaluation. Considered to be a relevant factor.

FACTOR	AMENDMENT COMPONENT WITH POSSIBLE IMPACT	GOVERNMENT AGENCY AND PUBLIC COMMENTS	IDENTIFICATION OF RELEVANT ENVIRONMENTAL FACTORS
		The Water Corporation, therefore, recommends that this concept of "averaged cluster development" needs considerable research and resolution before it can be an acceptable form of development in P3 UWPCA's. • It is recommended that a suitable size portion of the remnant vegetation within the Amendment area be set aside for Parks and Recreation to ensure that the average lot density remains consistent with the Water and Rivers Commission's policy for drinking water source areas as it pertains to P3 UWPCA's. • None of the Aerobic Treatment Unit systems, or soil amendment system, as described or available has been approved for the purpose of removing or retaining nitrates. • The Water Quality Protection Branch of the Water and Rivers Commission should be consulted with during the development of the Drainage, Nutrient and Water Management Plan. • The layout of cluster subdivision should be suitably located downstream of any proposed production bores for drinking water supply. • Environmental conditions should be included in the City of Wanneroo's Town Planning Scheme No. 1 which recognise that the Amendment area is located within a P3 UWPCA and that development applications which may impact on the water quality should be referred to the Commission. Advice will be based on the Commission's Land Use Acceptability Table and groundwater recharge criteria for P3 UWPCA's.	

FACTOR	AMENDMENT COMPONENT WITH POSSIBLE IMPACT	GOVERNMENT AGENCY AND PUBLIC COMMENTS	IDENTIFICATION OF RELEVANT ENVIRONMENTAL FACTORS
SOCIAL SURROUNDINGS			
Aboriginal Culture and Heritage	A cave located within the amendment area has been identified by the Aboriginal Community as a site of mythological significance. The cave could potentially be damaged or destroyed as a result of construction activities, acts of vandalism or the introduction of horses and domestic pets into the area as part of the Rural Community development.	• The Aboriginal Affairs Department (AAD) recommends that the Amendment area be monitored for subsurface cultural materials and also burials when the surface is excavated for development. • If areas are to be developed then the AAD recommends that archaeological surveys and ethnographic consultations be conducted with local Aboriginal communities prior to work commencing. Any proposed development which may impact upon a site with Aboriginal significance must be granted a section 18 permit from the Minister on the advice of the Aboriginal Cultural Material Committee.	Requires further evaluation. Considered to be a relevant factor.

Table 3: Summary of Assessment of Relevant Environmental Factors

RELEVANT FACTOR	RELEVANT AREA	EPA OBJECTIVES	EPA ASSESSMENT	EPA ADVICE
Vegetation	Swan Coastal Plain	Maintain the abundance, species diversity, geographic distribution and productivity of vegetation.	The EPA considers that the Responsible Authority (RA) has provided sufficient information to confirm that the potential direct and indirect impacts upon vegetation can be managed under the draft environmental conditions to go into the scheme (as revised) to meet the EPA's objective. The EPA notes that: • Wilbinga (Bushplan Site No. 406) which has greater environmental and landscape attributes than the System Six M1 Area has been set aside for conservation as a replacement for M1. • The amendment area supports vegetation of "local significance" which provides wildlife habitat but is not considered to be regionally significant. • Bushplan Site No.'s 396 and 284 are also adjacent to the Amendment area, with 284 reserved for P&R, and 396 and 406 proposed for inclusion in Gnangara Park (to be managed by CALM). • The draft scheme amendment has environmental conditions to manage the potential direct and indirect impacts on vegetation which include the preparation and implementation of a Vegetation Management Plan by the subdivider at the LSP stage to the requirements of the RA with the concurrence of the DEP and CALM. • CALM raised concerns about the management of fire and the allocation of landuses within the Amendment area. • The Urban Bushland Council and the Wildflower Society of WA. raised concerns about the retention of locally significant vegetation with a view to creating wildlife corridors for fauna movement, the use of provenance seed in rehabilitation, the retention of mature trees and the adequacy of the draft environmental conditions to manage indirect impacts. • To address these concerns the DEP negotiated with the RA and the landowner to include consultation with relevant community groups including the WA Wildflower Society and the Urban Bushland	Having particular regard to: a) the values inferred in System Six Area M1 being replaced at Wilbinga which has higher conservation value; b) the adjacent areas supporting regionally significant vegetation either reserved as P&R in the MRS or proposed for inclusion in "Gnangara Park" which will be established and managed by CALM; c) the identification of three "locally significant" stands of trees within the amendment area which provide wildlife habitat; d) the identification of a species of DRF occurring to the north and west of the Amendment area; e) concerns raised by the Urban Bushland Council, the Wildflower Society of WA and CALM; and f) revised environmental conditions proposed by the Responsible Authority; it is the EPA's opinion that given the environmental conditions discussed above the amendment can be managed to meet the EPA's objective for vegetation.

RELEVANT FACTOR	RELEVANT AREA	EPA OBJECTIVES	EPA ASSESSMENT	EPA ADVICE
			Council during the preparation of the Vegetation Management Plan. The plan should also be referred to as the "Vegetation and Fauna Management Plan" and, as such, should recognise that the preservation of vegetation will also assist in maintaining the diversity of the fauna utilising the remnant vegetation as habitat. Therefore, the fauna values of the vegattion shoulod be addressed in the Plan which should be modified to include the following: ⇒ the definition and retention of "locally significant" areas of vegetation within the amendment area (which provides fauna habitat) with consideration to the creation of vegetation corridors to facilitate the movement of fauna and floristic genepools; ⇒ retention of all three significant stands of trees to avoid habitat loss for fauna, particularly threatened fauna including the Peregrine Falcon and the Short-billed Black Cockatoo; ⇒ the selection of landuses adjacent to the Bushplan sites in consultation with CALM; ⇒ fire management; ⇒ control of off-road vehicle use, dumping of rubbish and enhance community awareness of bushland protection; ⇒ the development of bridle paths within the Amendment area only; and ⇒ the use of provenance seed in rehabilitation. The EPA recommends that these modified environmental conditions be included in the Scheme so that at the LSP stage a Vegetation Management Plan should be prepared to ensure that the potential direct and indirect impacts on vegetation are minimised.	
Stygofauna and troglobitic fauna	Wanneroo Cave Belt	i) Ensure that stygofauna and troglobitic fauna are adequately protected, in accordance with the *Wildlife Conservation Act 1950;* and ii) Maintain the abundance, diversity and geographical distribution of stygofauna and troglobitic fauna.	The EPA considers that the Responsible Authority (RA) has provided sufficient information to confirm that the potential impacts upon stygofauna and troglobitic fauna can be managed under the draft environmental conditions to go into the scheme (as revised) to meet the EPA's objective. The EPA notes that: • Two species of stygofauna (crangonyctoid amphipods and calanoid copepods) have been identified within the Amendment area. These species appear to be not restricted to the critically endangered "Aquatic Root Mat Communities of Caves of the Swan Coastal Plain" which have been identified to the south of the Amendment	Having particular regard to: a) the known presence of two species of stygofauna within the amendment area; b) the fact that these species of stygofauna are not confined to root mat habitats and that there is no evidence of underground streams, hence, root mat habitats within the Amendment area; c) the two most significant impacts on stygofauna and troglobitic

RELEVANT FACTOR	RELEVANT AREA	EPA OBJECTIVES	EPA ASSESSMENT	EPA ADVICE
			area in Yanchep National Park. • A limited stygofauna assemblage would be expected to occur within the Amendment area because of the lack of evidence to support the presence of subterranean streams or pools in the Amendment area (within which diverse communities of aquatic cave dwelling animals live) and the absence of surface waters in the amendment area as surface waters are a causal factor for the significant stygofauna assemblages recorded at Yanchep National Park. • No species of troglobitic fauna have been identified within the Amendment area, although there is a possibility that they do exist in the area as a second possible cave was not surveyed due to the unstable nature of the sediments. • The impact of the development on water quality and water table levels could significantly affect the habitat of stygofauna and troglobitic fauna. • In the worst case scenario (cluster development with 200ha of agriculture) water table drawdowns in the Amendment area could vary between 0.5m (after 12 months average pumping) and 0.9m (after 6 months summer pumping) at a distance of 200m from the line of the wellfield, and 0.4m at a distance of 500m. • Dr Brenton Knott's advice that a 0.5m drop at a distance of 200m from high risk karst areas is acceptable given that stygofauna species identified within the Amendment area are not restricted to root mat habitats (which are susceptible to water table drawdowns of 0.1m or more) and that this level is within seasonal fluctuations. • If this worst case scenario is to be considered further, given that drawdowns could be 0.9m after peak pumping more detailed modelling will be needed to determine suitable locations for the bores. • Levels of phosphorus in the groundwater after development are expected to be low and not adversely impact on stygofauna and troglobitic fauna as the soils within the Amendment area have high PRI's and the proposed methods of effluent disposal have been approved to attenuate phosphorus.	fauna being water table fluctuations (beyond natural levels) and pollution of groundwater; d) that modelling has indicated that water table drawdowns can be managed to be within seasonal fluctuations if only 100ha of agriculture developed, if more than this area to be developed further modelling and management is required; e) that the high PRI's of the soils, the depth to groundwater and the use of phosphorus attenuating effluent disposal systems should minimise pollution from phosphorus; f) no criterion has been developed for levels of Nitrogen which can be tolerated by stygofauna and troglobitic fauna; g) limited evidence to indicate that stygofauna may be able to tolerate a level of 37.1mg/L of NO_3 - N; h) the requirement for the development to not exceed a level of 5.7mg/L NO_3 - N in recharge with respect to drinking water quality requirements and limited evidence to suggest that this is achievable; and i) revised environmental conditions proposed by the Responsible Authority; it is the EPA's opinion that given the environmental conditions discussed above the amendment can be managed to meet the EPA's objectives for

RELEVANT FACTOR	RELEVANT AREA	EPA OBJECTIVES	EPA ASSESSMENT	EPA ADVICE
			• Little evidence is available on the levels of nitrogen that stygofauna and troglobitic fauna can tolerate. • A measurement of nitrate levels and stygofauna diversity in Gilgie and Twilight caves just south of the Amendment area has found levels of nitrate at 37.1mg/L (allowable concentration for a P3 UWPCA is 5.7mg/L) and approximately 40 species of stygofauna in each cave. • Based on numerical modelling either a cluster development with 100ha of agriculture or a conventional development can meet the required level of 5.7mg/L of nitrate in recharge. • If 200ha of agriculture is to be developed then potential nitrate levels will exceed 5.7mg/L unless measures such as slow release fertilisers and soil improvers are implemented. • The draft scheme amendment has environmental conditions to manage the potential impacts on stygofauna and troglobitic fauna which include the preparation and implementation of a Drainage, Nutrient and Water Management Plan by the subdivider at the LSP stage to the requirements of the RA and on the advice of the DEP, WRC and Water Corporation. Another provision includes the protection of the confirmed cave in a lot no less than 3ha. • Submissions raised concerns that the surveys were largely restricted to stygofauna, therefore, further surveys for troglobitic fauna should be undertaken. Other concerns included that the management of stygofauna could not provide for the management of troglobitic fauna, and that the hydrological assessment was not adequate. • The EPA considers, however, that further surveys of the caves/s for troglobitic fauna is not warranted given the relative low density of the development, the evidence to suggest that the area would support a limited assemblage of stygofauna and troglobitic fauna and proposed environmental conditions to protect the one confirmed cave in a lot of 3ha. In addition further investigations of the outcrop areas will be undertaken as part of draft environmental conditions which require the development of a Karst Management Strategy. • To address the other concerns the DEP negotiated with the RA and the landowner to revise the draft environmental conditions to include	troglobitic fauna and stygofauna.

RELEVANT FACTOR	RELEVANT AREA	EPA OBJECTIVES	EPA ASSESSMENT	EPA ADVICE
			consultation with the relevant scientific experts during the preparation of the Drainage, Nutrient and Water Management Plan. Also the plan is to be revised to include the following: ⇒ If more than 100ha of agriculture is to be developed within the Amendment area, more detailed modelling will need to be carried out to determine suitable locations for the bores. This modelling should be based on variable and site-specific data for aquifer parameters and calibrated against longer term modelling records given that the potential drawdown of the water table could go beyond seasonal fluctuations; ⇒ If more than 100ha of agriculture is to be developed within the Amendment area then additional management measures will be required to limit either the quantity of nitrogen applied to the soil or the quantity of nitrogen that leaches through the soil profile into the groundwater system; and ⇒ to protect the cave from sedimentation the entrance should be gated in addition to the protection of the cave in a lot of no less than 3 ha. The EPA recommends that these modified environmental conditions be included in the Scheme so that at the LSP stage a Drainage Nutrient and Water Management Plan and a Karst Management Strategy should be prepared, and the confirmed cave should be protected in a 3ha lot to ensure that the potential impacts on stygofauna and troglobitic fauna are minimised.	
Karst	Wanneroo Cave Belt	Maintain the environmental, scientific, cultural and recreational values of karst landforms.	The EPA considers that the Responsible Authority (RA) has provided sufficient information to confirm that the potential impacts upon karst and the risk to future residents from development in karstic areas can be managed under the draft environmental conditions to go into the scheme (as revised) to meet the EPA's objective. The EPA notes that: • A belt of karstic terrain crosses the amendment area in a northwest to southeast orientation which incorporates small-scale features (eg fissures) and massive collapse features (eg caves). • Small-scale features are not indicative of a zone of karstic activity but massive collapse features are. • One, or possibly two caves, and several dolines occur in the	Having particular regard to: a) the presence of massive collapse features (ie. dolines and one confirmed cave) within the Amendment area; b) the risk which karst poses to development; c) the confinement of high risk karst areas to isolated places within the valley floors of the south-western portion of the amendment area; d) the ability for cluster or conventional development to be

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			interdunal depression in the karstic zone in the Amendment area. • There is a risk associated with development in karstic areas because of the potential for subsidence and collapse. • The draft scheme amendment has environmental conditions to manage the potential impacts on karst which include the preparation and implementation of a Karst Management Strategy by the subdivider at the LSP stage to the requirements of the RA and on the advice of the DEP, WRC and a geotechnical consultant to avoid development over high risk karst areas subject to further assessment by a geotechnical engineer and an environmental scientist. Another provision includes the protection of the confirmed cave in a lot no less than 3ha. • The Australian Speleological Federation and the WA Speleological Group have raised concerns about the lack of survey of all outcrops within the amendment area, the impact of fire on karst and the need to include the high risk karstic terrain in the adjacent area (to the west) of P&R. • Other submissions raised concerns about the need to specify a minimum lot size of 2ha within the karstic zone and the need to involve speleologists experienced in the Yanchep area in the selection of road locations. • To address these concerns the DEP negotiated with the RA and the landowner to revise the draft environmental conditions to include consultation with the relevant scientific experts during the preparation of the Karst Management Strategy. Also the Strategy is to be revised to include further investigations of the areas of limestone outcrop. The environmental conditions will also be revised to ensure that the cave will be managed by the RA to ensure public safety and to protect the biodiversity and cultural values of the cave. • The EPA also considers that the revised environmental conditions and other management plans proposed for the protection of vegetation, stygofauna and troglobitic fauna will provide protection for the karstic areas without the need for reservation of these areas in the MRS. Fire management will be addressed in the Vegetation Management Plan.	designed around these high risk karst areas safely (subject to further geotechnical work); and e) revised environmental conditions proposed by the Responsible Authority; it is the EPA's opinion that given the environmental conditions discussed above the amendment can be managed to meet the EPA's objective for karst.

RELEVANT FACTOR	RELEVANT AREA	EPA OBJECTIVES	EPA ASSESSMENT	EPA ADVICE
			The EPA recommends that these modified environmental conditions be included in the Scheme so that at the LSP stage a Karst Management Strategy should be prepared, and the confirmed cave should be protected in a 3ha lot to ensure that the potential impacts on karst are minimised.	
Groundwater quality	Perth Coastal (P3) UWPCA	Minimise the risk of pollution to the water source	The EPA considers that the Responsible Authority (RA) has provided sufficient information to confirm that the potential impacts upon the P3 UWPCA can be managed under the draft environmental conditions to go into the scheme (as revised) to meet the EPA's objective. The EPA notes that: • The Amendment area lies in the Perth Coastal P3 UWPCA. • Levels of phosphorus in the groundwater after development are expected to be low within the amendment area as the soils have high PRI's and the proposed methods of effluent disposal [ie. ATU's, modified septic system and a small package treatment plant (for cluster development)] have been approved to attenuate phosphorus but not nitrogen, except for the package treatment plant (as advised by the Health Department of WA). • Based on the soil types and the constraints of a P3 UWPCA the Amendment area would most likely be assigned a 'B' vulnerability classification (maximum of 180kgN/ha/yr and 20kgP/ha/yr) based on WRC's recommended maximum nutrient loadings for the protection of public water resources. • Based on numerical modelling either a cluster development with 100ha of agriculture or a conventional development can meet the allowable level of 5.7mg/L of nitrate in recharge for a P3 UWPCA. • If 200ha of agriculture is to be developed then potential nitrate levels will exceed 5.7mg/L unless measures such as slow release fertilisers and soil improvers are implemented. • The draft scheme amendment has environmental conditions to manage the potential impacts on water quality which include the preparation and implementation of a Drainage, Nutrient and Water Management Plan by the subdivider at the LSP stage to the requirements of the RA and on the advice of the DEP, WRC and the Water Corporation. Another provision includes the undertaking of a	Having particular regard to: a) the high PRI's of the soils within the amendment area; b) these soils being well suited to perennial horticulture; c) the use of phosphorus attenuating Alternative Treatment Units, modified septic systems or a small package treatment plant (for cluster development) for effluent disposal; d) the requirement for the development to not exceed a level of 5.7mg/L NO_3 - N in recharge and limited evidence to suggest that this is achievable; e) the management of stormwater as per WSUD guidelines; f) the advice of the WC, Health Department of WA and the WRC; and g) revised environmental conditions proposed by the Responsible Authority; it is the EPA's opinion that given the environmental conditions discussed above the amendment can be managed to meet the EPA's objective for groundwater quality.

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			Land Capability Assessment and Site Analysis at the LSP stage to verify the suitability of the area for agriculture. • The Water Corporation has raised concerns about the concept of "cluster" development which may produce "hot spots" of contamination where natural remediating effects and dilution may not assist in protecting groundwater quality and hence, the requirements for a P3 UWPCA cannot be met. • The Water and Rivers Commission has advised that the layout of cluster subdivision should be suitably located downstream of any proposed production bores for drinking water supply. The Health Department has advised the EPA that none of the Aerobic Treatment Units systems or soil amendment systems which are available in WA have been approved for the purpose of retaining nitrates. • To address these concerns the DEP negotiated with the RA and the landowner to revise the draft environmental conditions to include consultation with the relevant scientific experts during the preparation of the Drainage, Nutrient and Water Management Plan. Also the plan is to be revised to include the following: ⇒ the concentration of contaminants and stormwater through cluster development will be appropriately investigated and managed; and ⇒ the layout of cluster subdivision should be suitably located downstream of any proposed production bores for drinking water supply. The EPA recommends that these modified environmental conditions be included in the Scheme so that at the LSP stage a Drainage, Nutrient and Water Management Plan is prepared to ensure that the development is managed to meet the requirements for a P3 UWPCA.	
Aboriginal Culture and Heritage	Amendment area	i) Ensure that the proposal complies with the requirements of the *Aboriginal Heritage Act 1972*; and ii) Ensure that changes to the biological and physical environment	The EPA considers that the Responsible Authority (RA) has provided sufficient information to confirm that the potential impacts on the Aboriginal site can be managed under the draft environmental conditions to go into the scheme (as revised) to meet the EPA's objective. The EPA notes that: • An Aboriginal mythological site has been identified in the southwestern corner of the amendment area.	Having particular regard to: a) the Aboriginal site in the southwestern corner of the Amendment area; b) the Aboriginal Affairs Department's advice; and c) revised environmental conditions

RELEVANT FACTOR	RELEVANT AREA	EPA OBJECTIVES	EPA ASSESSMENT	EPA ADVICE
		resulting from the project do not adversely affect cultural associations with the area.	• The proposed development could impact upon this site. • The draft scheme amendment has environmental conditions to manage the potential impacts on the site which includes the preparation and implementation of an Aboriginal Heritage Management Plan stipulating the protection of the site in a lot of not less than 3ha, to be fenced and signposted as appropriate should ensure that the site is protected. • The Aboriginal Affairs Department (AAD) raised concerns about further sites of Aboriginal significance and that to protect these sites the AAD has recommended that construction activities be carefully monitored to ensure that no potential sites are impacted upon. • To address these concerns the DEP negotiated with the RA and the landowner to revise the draft environmental conditions to include the following: ⇒ Prior to the commencement of site works, staff shall undergo a briefing on Aboriginal Heritage issues to enable staff to recognise materials that may constitute an Aboriginal Site. During earthworks all contractors will be supervised by a Site Manager, who if a suspected site is discovered, will seek specialist advice to confirm the identification of the site. The EPA recommends that these modified environmental conditions be included in the Scheme so that at the LSP stage an Aboriginal Heritage Management Plan is prepared to ensure that the development does not impact upon sites of Aboriginal significance.	proposed by the Responsible Authority; it is the EPA's opinion that the amendment can be managed to meet the EPA's objective for Aboriginal Culture and Heritage