South West Yarragadee Water Supply Development: Sustainability Evaluation/Environmental Review & Management Programme

Response to Public Submissions

December 2006

Prepared for
Water Corporation
by Strategen

strategen

WATER CORPORATION

South West Yarragadee Water Supply Development: Sustainability Evaluation/Environmental Review & Management Programme

Response to Public Submissions

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SOUTH WEST YARRAGADEE WATER SUPPLY DEVELOPMENT: SUSTAINABILITY EVALUATION/ENVIRONMENTAL REVIEW & MANAGEMENT PROGRAMME

RESPONSE TO PUBLIC SUBMISSIONS

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RESPONSE TO PUBLIC SUBMISSIONS

1. INTRODUCTION

The South West Yarragadee Water Supply Development proposal involves the abstraction, treatment and conveyance of 45 GL/yr of groundwater from a wellfield on the eastern Blackwood Plateau in the south-west of Western Australia. The proposal is intended to provide the next major water source for the Integrated Water Supply Scheme[1] (IWSS).

The proponent is the Water Corporation, a corporatised government trading enterprise that provides water services across Western Australia. The Corporation has the role of providing water supply services to operating areas within Western Australia for which it has a licence under the *Water Services Licensing Act 1995*.

A Sustainability Evaluation of the proposal (Strategen 2006) was prepared for assessment by Government in accordance with the requirements of the *State Sustainability Strategy* (Government of Western Australia 2003a). The Sustainability Evaluation includes an Environmental Review and Management Programme (ERMP) prepared pursuant to Part IV of the *Environmental Protection Act 1986* (EP Act) and the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act). The Sustainability Evaluation/Environmental Review and Management Programme (Sustainability Evaluation/ERMP) document also provides information supporting the Water Corporation application to the Department of Water (DoW) for a *Rights in Water and Irrigation Act 1914* (RWI Act) licence for abstraction of 45 GL/yr from the South West Yarragadee aquifer.

The Sustainability Evaluation/ERMP describes the proposal, examines likely environmental, economic and social impacts and proposed management arrangements and procedures, including management plans for all specific issues. It includes information from an extensive program of environmental, social and economic investigations, reviews impacts and describes the management measures that include avoidance, minimisation and offsetting to mitigate any potential adverse effects of the proposal.

In addition to extensive community consultation conducted by the proponent during preparation of the Sustainability Evaluation/ERMP, the document was subject to a twelve week period of public review following its release on 21 March 2006. The public review period ended on 22 May 2006. Over 600 written submissions were received by the Environmental Protection Authority (EPA). Of these, approximately 400- were proforma responses. The responses have been collated and the proponent response to the issues raised is set out in this report. Of the responses, two individual responses were strongly supportive of the proposal, and the Busselton Water Board submission was also strongly supportive. The Aqwest submission noted that Aqwest has no major concerns with the proposal providing the regulators are satisfied that economic, environmental, social and cultural sustainability can be achieved.

[1] The Integrated Water Supply System (IWSS) is the integrated combination of surface and groundwater sources and their distribution system that services Perth, Pinjarra, Mandurah, Harvey, Waroona and the Goldfields and Agricultural Water Supply. Sources supplying this system currently extend as far south as the Harris Dam, and through this, the system is connected to the Great Southern Towns Water Scheme.

2. DOCUMENT STRUCTURE

This document presents a response to all issues raised within the public submissions on the Sustainability Evaluation/ERMP. The submissions were analysed to extract the issues raised, which were then sorted into the two broad categories of environmental issues, and socio-economic issues. Within those categories, the issues were sub-categorised into key issues and other issues considered to be of lesser importance. Key issues were considered to be those raised by a large number of submitters, or by the regulatory agencies, or with potential to impact on a substantial portion of the environment, community or stakeholders. These are discussed in Sections 4 through 6. All issues raised have been addressed.

The document also includes new information that has become available since release of the Sustainability Evaluation/ERMP and additional information that is presented in response to several of the submissions. This information is outlined in Section 3. Reports commissioned by the Water Corporation, relevant to the new information, are presented in the appendices.

The appendices also contain:

- a revised Groundwater Abstraction Management Plan (Appendix 1)
- a Wetland Management Plan and Watercourse Crossing Management Plan for the pipeline construction component of the project (Appendix 2 and Appendix 3 respectively)
- a specific response to the issues raised by the Department of Environment and Heritage as relevant to the *Environmental Protection and Biodiversity Conservation Act 1999* (Appendix 8)
- a response to a letter from the EPA to the Water Corporation regarding specific issues of interest to be addressed (Appendix 9).

The responses within the sub-categories of submission issues are presented in the following sections of this report:

1. Responses to key environmental issues: Section 4.
2. Responses to other environmental issues: Section 5.
3. Responses to socio-economic issues: Section 6.

The full list of submitters and the issues raised is presented in Section 7.

Changes to the proposal and associated commitments that have been made in response to the submissions received are presented in Section 8.

Section 9 contains the conclusions drawn regarding the submissions and responses that have been developed and presented.

It should be noted that the focus of this response to submissions relates to the potential impacts of the Water Corporation proposal alone, although occasional reference is made to the impacts of future abstractions by regional groundwater users. This approach has been taken because the submissions were strongly directed to the impacts of the Water Corporation proposal and the potential impacts of regional abstraction have been comprehensively discussed in the Sustainability Evaluation/ERMP.

3. NEW AND ADDITIONAL INFORMATION

Since submission of the Sustainability Evaluation/ERMP, several new studies have been completed and taken into account in preparing this response to submissions. The key studies were:

1. Development of a local scale groundwater model of the eastern Scott Coastal Plain for the
2. Review of the detailed hydrogeology of the Swan Coastal Plain and tributaries of the Blackwood River by URS Australia (2006a).
3. Examination of the feasibility of streamflow supplementation by URS Australia (2006b).
4. Surveys of the distribution and abundance of Balston's pygmy perch in Milyeannup Brook by the Centre of Excellence in Natural Resource Management (2006).
5. A review of the extent of occurrence of Balston's pygmy perch and the mud minnow, prepared by Wetland Research & Management (2006).

These studies are briefly outlined in the following sections, and the results incorporated in the response to the issues raised in submissions in later sections of this report.

In addition, URS Australia has been commissioned to develop a local scale model of the Blackwood River and tributaries to improve the estimates of drawdown in these areas, and consequent impact on streamflows and groundwater dependent ecosystems. The complexity of this modelling is such that the results were not available within sufficient time to be incorporated in this report. However, the results will be made public, and the proposal modified accordingly if those results suggest that the potential environmental impacts will be greater than currently expected and likely to cause significant additional impact.

3.1 EASTERN SCOTT COASTAL PLAIN MODELLING

The DoW applied the model developed by Aquaterra (2006) to consider the drawdown effects from the Water Corporation proposal and produced watertable drawdown maps and hydrographs that have been provided to the Water Corporation. The results of the modelling have confirmed the Water Corporation interpretations of watertable drawdowns in this area as presented in the Sustainability Evaluation/ERMP as being conservative estimates. The results are discussed in more detail in Section 4.6 of this report.

3.2 HYDROGEOLOGY OF THE SWAN COASTAL PLAIN AND TRIBUTARIES OF THE BLACKWOOD RIVER

URS Australia (2006a) reviewed the detailed hydrogeology and hydrostratigraphy of the Swan Coastal Plain, Milyeannup Brook and the St John Brook area to provide more detail on the relationships between the Yarragadee aquifer and the watertable in the key areas. The report is presented in Appendix 4 and the results discussed in relevant sections of this report.

3.3 FEASIBILITY OF STREAMFLOW SUPPLEMENTATION

URS Australia (2006b) undertook a desktop examination of the feasibility of pumping groundwater to supplement streamflows in the Blackwood River, St John Brook and Milyeannup Brook. This action is proposed if assessment of monitoring results indicates that such action will be required as a contingency, as proposed in the Sustainability Evaluation/ERMP. The study showed that the supplementation proposals are feasible in terms of providing sufficient water to meet the worst possible shortfall case, with water of appropriate quality to meet ecological requirements, without any adverse impacts. The report is presented in Appendix 5 and the results discussed in Section 4.14.3 (Feasibility of flow supplementation) of this report.

3.4 DISTRIBUTION AND ABUNDANCE OF BALSTON'S PYGMY PERCH IN MILYEANNUP BROOK

The Centre of Excellence in Natural Resource Management (CENRM 2006) undertook a series of surveys of Balston's pygmy perch in Milyeannup Brook to increase understanding of the habitat requirements, and distribution of the species in the upper reaches of the stream. This was considered necessary to better understand the implications of potential impacts of shortening the active stream length of the brook as a result of groundwater drawdown. This work has allowed better definition of the trigger point to supplement flow in the brook to ensure impacts on the species are within the management objectives. The report is presented in Appendix 6 and the results are discussed in more detail in Section 4.5 of this report.

3.5 OCCURRENCE OF BALSTON'S PYGMY PERCH AND MUD MINNOW

This review by Wetland Research & Management (2006) was intended to provide context for considering the potential effects of the proposal on the two key fish species, in terms of their occurrence and relative abundance in the locality, and in the South West region. The report is presented in Appendix 7 and the results have been considered and the implications discussed in more detail in Section 4.5 of this report.

4. RESPONSES TO KEY ENVIRONMENTAL ISSUES

Several key issues were commonly raised in submissions and these are summarised and discussed in the following sections. The key issues raised were:

- biodiversity, flora and fauna, groundwater dependent ecosystems – general threat to the environment of the South West
- threatened or rare flora, fauna or ecological communities
- hydrogeological interpretation
- Blackwood River
- Blackwood River tributaries
- coastal plain impacts, including acid sulphate soils
- uncertainty
- mitigation and offsets
- cumulative impacts
- climate change
- saltwater intrusion
- monitoring
- contingency actions
- pipeline route
- consultation process.

4.1 BIODIVERSITY AND GROUNDWATER DEPENDENT ECOSYSTEMS

4.1.1 Submission issues

Several submissions raised matters associated with the general threat of watertable drawdown to the South West ecosystems. The submissions raised that the South West is recognised as one of the world's biodiversity hotspots and that the project poses a threat to the flora and fauna of the region. Specifically, the submissions quoted that up to 1000 ha of vegetation would be affected on the Blackwood Plateau and this was considered unacceptable.

The concerns related to several aspects:

- groundwater drawdown results in a loss of biodiversity
- lack of certainty regarding the impact of the project on biodiversity
- inappropriate to aim for "a net increase in ecological function or biological diversity"

4.1.2 Response to submission issues

Each of the above concerns is addressed in detail in the following sections.

4.1.3 Loss of biodiversity

The initial approach to mitigation of biodiversity impacts by the Water Corporation was to minimise water table drawdowns in sensitive areas at the project design phase. Modelling of several different wellfield configurations was carried out to determine which would have the lowest overall environmental impact. The 'Eastern split' wellfield was chosen on this basis as it minimised potential for impacts on the Scott Coastal Plain, Poison Gully, Milyeannup Brook and the Reedia wetlands.

If the project proceeds, an extensive monitoring program will be established as part of an adaptive management approach which includes independent review of the monitoring results (by the proposed South West Monitoring Review Group – Volume 1 Chapter 8 Section 3.2.3 of the Sustainability Evaluation/ERMP). The revised Groundwater Abstraction Management Plan (Appendix 1) outlines the monitoring, triggers and contingencies that form the basis of the adaptive management framework.

The proposed groundwater abstraction may cause some ecological changes in the key risk areas and the question is whether the changes are acceptable and sustainable given the contingencies measures available.

The following statement in the CALM comments captures many of the concerns raised by many submitters regarding biodiversity and groundwater drawdowns:

> *"CALM opposes any (including gradual) drawdown associated changes in vegetation community compositions as a result of the proposal. Any 'adaptation' to alterations in the quality, quantity, seasonal patterns and trends of the South West Yarragadee aquifer due to water abstraction, in terms of vegetation, usually means changes in community composition towards xerophytic (dryer adapted) species. This may result in a direct reduction in available habitat for aquatic fauna and flora and/or a loss of ecosystem integrity and function. Any changes in vegetation structure will also alter other fauna habitat and may also affect other processes. A change in vegetation may well result in an escalation of threats to these communities as well as loss of key community units and a destruction of the more sensitive groundwater dependent ecosystems (GDE's)."*

The issues are discussed in the following sections, in terms of the potential impacts on the key risk areas.

Blackwood Plateau

Within the potentially affected valley systems on the Blackwood Plateau (Poison Gully, Milyeannup Brook and St John Brook), there is a gradient in vegetation types from the valley floor to the upslope areas. Vegetation units with varying degrees of groundwater dependence occur on the valley floor, lower slopes and mid slopes where the depth to groundwater is less than 10 m. The vegetation units most susceptible to groundwater drawdown occur on the lower slopes of the valleys where there is a high level of groundwater dependence (as the depth to groundwater is shallow). The valley floors are less at risk as they are likely to remain wet as surface and subsurface flow accumulates in these areas and in most places, groundwater will continue to discharge as the hydraulic head is still above the surface (artesian). The mid and upslope vegetation are unlikely to be significantly affected as they have a lower level of groundwater dependence.

In those lower slope areas where groundwater drawdown is predicted to occur, there is the potential for a down–slope shift of the vegetation units. The total extent of the lower slope vegetation units may also reduce slightly as the width of lower slope units contracts across a valley transect. However, the wettest vegetation unit will continue to exist at the lowest point of the landscape and therefore, the full continuum of vegetation types will exist in each valley.

At a single point on the lower slope, the vegetation may change to a drier vegetation unit. This would represent a change in the biodiversity at that point. However, the potential changes would be limited to a comparatively small redistribution of the relative populations of species and without loss of species or overall habitat. The changes would occur very gradually over time and would only be evident to a trained botanist though detailed monitoring. Consequently, the biodiversity and ecological function of the valley will not be adversely affected.

Regarding fauna habitat, as the full range of vegetation units will continue to exist in the valley systems, the full range of habitats will also be retained. Wetland vegetation types will still exist along creeklines, so fauna habitat corridors associated with these systems will not be affected. The total width of each habitat type along the creeklines may contract but this would not be expected to significantly affect the fauna occurrence or abundance in the area.

Many submissions interpreted the Sustainability Evaluation/ERMP as indicating that up to 1000 ha on the Blackwood Plateau will be affected by the proposal. However, the 1000 ha refers to the areas within which an impact may occur; it is not the specific measure of the area of impact. This may have been a consequence of the Sustainability Evaluation/ERMP not being clear enough. The potential impacts have been further defined qualitatively in relation to the known characteristics of the site vegetation types and their likely groundwater dependence (Refer to Volume 2 Chapter 7 Section 2.3.2 *Potential effect on site-vegetation types* and Section 4.3.2 *Potential effect on site-vegetation types* in the Sustainability Evaluation/ERMP). For example, in St John Brook, only the lower slopes are expected to be affected with a small down slope shift of these vegetation types. As concluded in the ERMP, although 700 ha in the area is potentially affected, impacts on site-vegetation types in St John Brook are not expected to be significant, as the full range of site-vegetation types will still exist in the valley, and only small shifts in extent expected.

The potential impacts of the groundwater drawdown on biodiversity and groundwater dependent ecosystems are addressed in Volume 2 Chapter 7 of the Sustainability Evaluation/ERMP with respect to:

- total area within which a groundwater drawdown may occur (i.e. areas with a hydraulic connection to the Yarragadee aquifer)
- vegetation complexes
- potential effect on site vegetation types based on their position in the landscape, soils and likely groundwater dependence
- ecosystem function
- Declared Rare and Priority species
- conservation areas
- potential effects on creek hydrology
- aquatic fauna
- terrestrial fauna.

The hydrological changes and potential impacts on aquatic fauna are addressed in Section 4.5.

Scott Coastal Plain

The modelling undertaken by Aquaterra (2006) demonstrated that drawdowns in these areas would be generally less than 0.25 m after 30 years, with some small areas where drawdowns could be as high as 0.5 to 0.75 m (see Figure 4.4 page 31 of this report).

To maintain terrestrial groundwater dependent ecosystems at a low level of risk, Froend & Loomes (2006) recommend that the following maximum drawdowns are not exceeded:

- 0-3 m depth to groundwater category: 0.75 m maximum drawdown
- 3-6 m depth to groundwater category: 1 m maximum drawdown
- 6-10 m depth to groundwater category: 1.75 m maximum drawdown

Therefore, the predicted drawdowns of 0.1 to 0.75 m after 30 years on the Scott Coastal Plain are not expected to have a measurable impact on the terrestrial ecosystems in the area.

The drawdowns and their potential impacts on the Scott Coastal Plain are further discussed in Section 4.6 of this report.

Swan Coastal Plain

On the Swan Coastal Plain, the predicted drawdowns from the Water Corporation abstraction were between 0.25 and 0.5 m (Strategen 2006). Combined with future regional abstraction, drawdowns in most areas are still <0.5 m, with an area south of Bunbury having up to 1-2 m drawdowns. The extent to which this latter drawdown extent eventuates will depend on the specific magnitude, timing and location of future growth in local regional abstraction of groundwater.

The drawdowns from the Water Corporation abstraction (<0.5 m) would not be expected to result in a measurable change in the terrestrial ecosystems of the area. Future regional abstraction may cause more substantial drawdowns in the area.

The drawdowns and their potential impacts on the Swan Coastal Plain are further discussed in Section 4.6 of this report.

Fire risk

CALM raised concerns hat drawdowns in peat areas may increase the risk of fire in these areas.

Peat builds up in wetland environments and may spontaneously ignite if exposed to the atmosphere. The areas of potential drawdown on the Blackwood Plateau are the valley systems. The soil in the valley systems is alluvial material that includes clays, silts and sands; the drilling logs do not indicate the presence of peat material. The wetlands such as Pig Swamp that may have peat are perched as described in the SE/ERMP.

Peat is likely to occur in some of the wetlands of the coastal plains. However, the groundwater drawdowns in these areas are not expected to be significant as described in Section 4.6 of this report. The expected watertable drawdowns are expected to substantially less than the natural variations and the resultant exposure of peat to presenting a fire risk is expected to be insignificant in comparison.

Flora and fauna near wellfield

The South West Zone of the WA Local Government Association commented that there had been no flora and fauna surveys near the wellfield. There are no water table drawdowns expected to occur near the wellfield within 10 m of the ground surface. Therefore, no surveys are required to investigate potential drawdown impacts. A flora survey of the areas to be cleared for the wellfield will be undertaken prior to construction. The Water Corporation has committed that construction activities will not directly or indirectly disturb threatened ecological communities, Declared Rare Flora unless the disturbance is approved under the *Wildlife Conservation Act 1950* or significant habitat for Threatened or Priority listed fauna.

4.1.4 Lack of certainty

Uncertainty is addressed in Section 4.8 of this report.

4.1.5 Biodiversity and ecological function principle

CALM commented that the *Sustainability Principle* "…will result in a net increase in ecological function or biological diversity in the region." should be replaced with a "no net loss" principle. The submission proposes that a "net increase" in biodiversity is unachievable. However, a net increase in ecological function or biological diversity in a region is not only related to the number of species but also the viability of those species and this has been a focus for the proposed actions addressing these aspects.

An example of actions that result in a net increase in ecological function and biodiversity is the Western Shield Program. The 2006 State of the Environment Report recognised that introduced species were a significant threat to the environment and that the abundance and distribution of pigs and cats have increased over the last five years (EPA 2006). The report also recognised that there has been recovery of some species of native fauna (i.e. a net increase in biodiversity in the region) as a result of predator control programs such as the Western Shield Program.

The Water Corporation proposes the management of threatening processes (e.g. control of feral pigs) as one of the biodiversity offsets of the anticipated impacts in areas that may be affected by the proposal. This is expected to contribute to a net increase in biological diversity in the region, and consequent achievement of the objective as stated. Discussions have been held with DEC officers regarding sponsorship of a threatening process program and this has resulted in an increase in the proposed level of funding to $1.5M (compared with $1M in original commitment). This has been included in a modified commitment (see Section 8.4).

4.2 THREATENED OR RARE FLORA, FAUNA OR ECOLOGICAL COMMUNITIES

4.2.1 Submission issues

Submissions were received that raised concerns about the impact of the groundwater drawdowns on particular rare species or communities. The Reedia wetlands, the coastal plain ironstone communities, the Balston's pygmy perch, mud minnow and three frog species (*Geocrinia rosea, G. alba* and *G. vitellina*) were all raised specifically as already rare species that were threatened by the proposal.

The honey possum was listed in many public submissions as a threatened species that would be further endangered by the proposal.

4.2.2 Response to submission issues

In the Sustainability Evaluation/ERMP the groundwater drawdowns are discussed in relation to all threatened or rare flora, fauna and ecological communities that occur within the potentially affected areas. The potential impacts on each issue raised are addressed in the following sections.

4.2.3 Reedia wetlands

The level of risk of drawdowns from the Water Corporation abstraction occurring in the Reedia wetlands area is very low. The hydrogeological investigations and results that underlie this risk assessment are discussed in detail in Volume 2 Chapter 5 Section 4.7 of the Sustainability Evaluation/ERMP. Therefore, the significant frog species that occur in the Reedia wetlands (*G. alba* and *G. vitellina* are rare, *G. rosea* and *Metacrinia nichollsi* is locally significant) are also at very low risk from the proposal.

CALM raised concerns that due to the significance and high groundwater dependence of the Reedia wetlands, groundwater levels should be monitored in this area even though risks in this area appear to be minimal. The water levels at one deep well site will monitor levels in the Lesueur Sandstone within the Reedia wetland area (Figure 4.1) as detailed in the revised Groundwater Abstraction Management Plan (Appendix 1). This monitoring will provide information on whether drawdowns in the Yarragadee aquifer are being transferred across the Busselton Fault into the Lesueur Sandstone aquifer. This is not expected to occur, but if it does, information will be available from the shallower wells at the site to determine whether pressure changes at depth are affecting surface watertable levels.

4.2.4 Coastal plain ironstone communities

The Scott River Ironstone Association vegetation communities are listed as Endangered by the Department of Conservation and Land Management (CALM 2005a). This community has not yet been formally listed by the State Minister for Environment, and is not listed as a Threatened Ecological Community under the EPBC Act. This community occurs in the western Scott Coastal Plain and is outside the potential areas of impact.

The *Shrublands on southern Swan Coastal Plain Ironstones* occurs within the areas of proposal drawdown of between 0.1 and 0.25 m on the Swan Coastal Plain (Table 4.1). To maintain terrestrial groundwater dependent ecosystems at a low level of risk, Froend & Loomes (2006) recommend that the following maximum drawdowns are not exceeded:

- 0-3 m depth to groundwater category: 0.75 m maximum drawdown
- 3-6 m depth to groundwater category: 1 00m maximum drawdown
- 6-10 m depth to groundwater category: 1.75 m maximum drawdown

As the drawdowns are expected to be between 0.1 and 0.25 m after 30 years, the potential impact is low, with no measurable change expected.

Figure 4.1 Vegetation and groundwater monitoring sites in the Reedia wetlands area

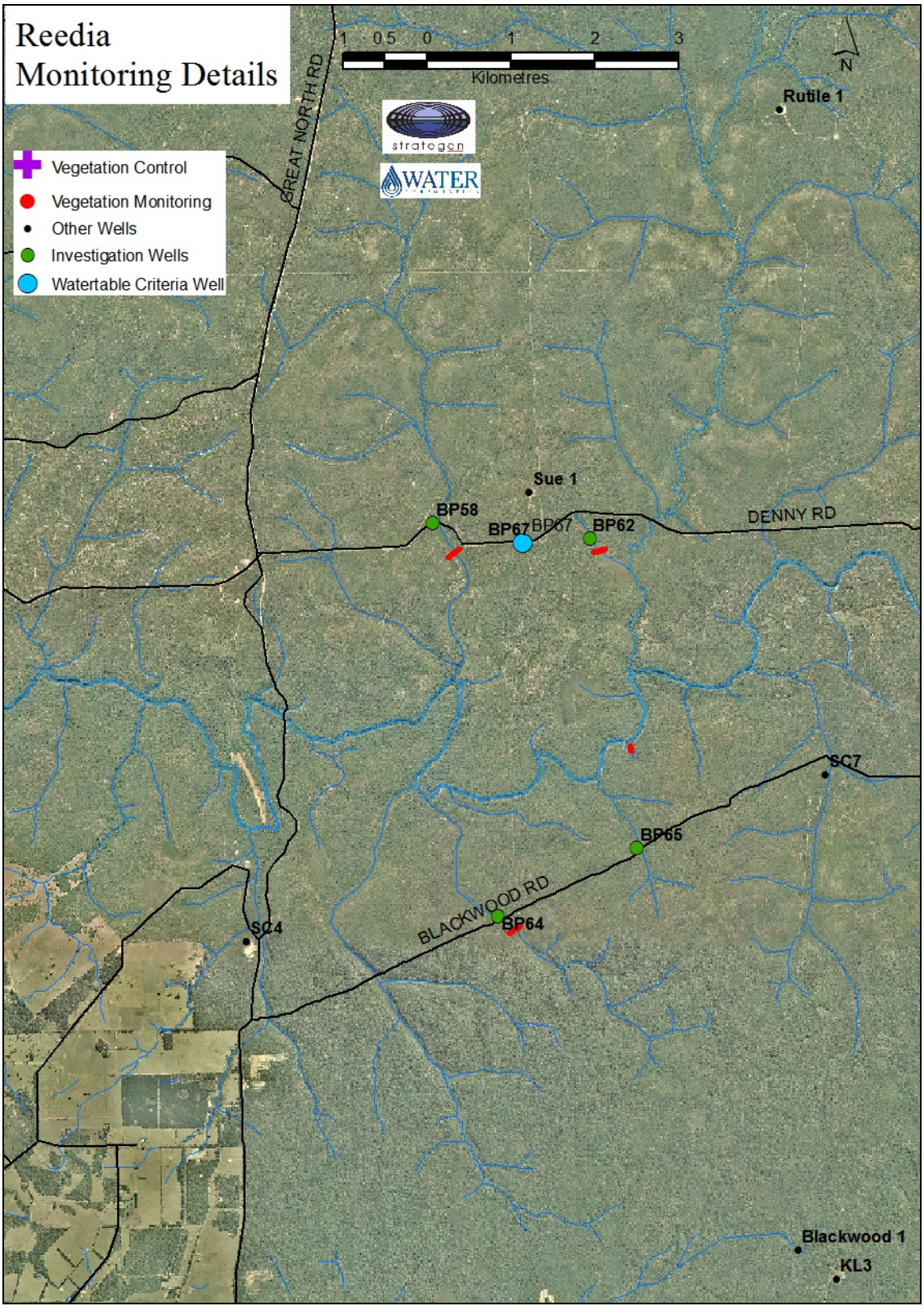


Table 4.1 EPBC listed TECs within predicted drawdown areas on the Swan Coastal Plain

TEC	Location	EPBC category	Water Corporation predicted drawdown	Impact on TEC
Shrublands on southern Swan Coastal Plain Ironstones (Busselton area)	Five known areas on the Southern Swan Coastal Plain, east of Busselton	Endangered	Two sites: 0.1 – 0.25 m	Low

Refer to Section 4.6 of this report for further discussion of coastal plain impacts.

4.2.5 Freshwater fish

The Balston's pygmy perch, *Nannatherina balstoni*, is the rarest of all south west endemic freshwater fishes (Morgan et al. 1998). Historically, the perch were distributed from the Moore River to Two Peoples Bay. However, due to anthropogenic disturbance and habitat degradation (salinisation, damming, eutrophication and dewatering), their range now consists of highly fragmented populations in the extreme southwest of the State, between Margaret River and Two Peoples Bay.

N. Balstoni is listed under the International Union for the Conservation of Nature and Natural Resources (IUCN) Redlist of Threatened Species as 'Data Deficient' (World Conservation Monitoring Centre 1996). In 1999 it was listed as 'Vulnerable' with the Australian Society for Fish Biology, however, this was amended to 'Data Deficient' in 2001. More recently, it was nominated in February 2005 for inclusion as 'Vulnerable' under the *Environmental Protection and Biodiversity Conservation Act 1999*. The nomination was primarily based on their restricted distribution and considerable contraction of range over the past century. CALM (2005) have also listed *N. balstoni* on their List of Priority Fauna as 'Priority 1'. The criterion for inclusion in this Priority category is "taxa with few, poorly known populations on threatened lands" (CALM 2005).

A review of the available literature on the perch by Wetland Research and Management (2006) concluded that while the perch appears to be quite widespread, there are no large or extensive populations and they are generally recorded in low numbers despite a large sampling effort. They are therefore prone to progressive losses and, in the extreme case, local extinctions may result. Given their conservation status, and relative rarity, individual populations warrant protection, and every effort must be taken to ensure their continued survival.

CENRM (2006) conducted a survey of Milyeannup Brook in July 2006 after an extremely dry autumn and early winter. The CENRM (2006) survey was conducted to obtain a greater understanding of the distribution, abundance and size of the Balston's pygmy perch population in Milyeannup Brook. The report is presented at Appendix 6. In summary, the results were:

1. Balston's pygmy perch is the most abundant fish species in Milyeannup Brook making up 55% of the 501 specimens caught in the survey.
2. Over 90% of the Balston's pygmy perch were caught at the sampling site closest to the Blackwood River (approximately 400 m from the confluence).
3. One specimen of Balston's pygmy perch was caught in an upstream reach of Milyeannup Brook, in a pool isolated from the lower reaches and without any flow.

This research indicates that the majority of the Balston's pygmy perch naturally contract to within 500 m of the Blackwood River during summer/autumn. This section of Milyeannup Brook is protected by artesian heads in the Yarragadee that will buffer any drawdown that occurs. Therefore, there should be no impact on this population of the Balston's pygmy perch. To further protect the population, a contingency has been put in place so that supplementation of summer baseflows in Milyeannup Brook will be triggered if streamflow observations indicate the brook does not have permanent and continuous flow 1500 m from the confluence with the Blackwood River (i.e. just down stream of the known historical lows measured by CENRM 2006).

4.2.6 Honey possum

Some submissions mentioned that the honey possum is a threatened species. However, the honey possum is not protected by State legislation (i.e. not listed in the Wildlife Conservation [Specially Protected Fauna] Notice 2006 pursuant to *Wildlife Conservation Act 1950*) or Federal legislation (i.e. not listed as a Threatened Species pursuant to the *Environmental Protection and Biodiversity Conservation Act 1999*) and is not listed as a Priority species by DEC. The honey possum is represented by 597 specimen records in museum collections.

The honey possum is endemic to the coastal sand plain heaths in the south west of Western Australia and has been described as common in limited winter rainfall areas of sand plain heathland where Proteaceous are abundant (Strahan 1995). This species is widespread and its range extends from Jurien Bay and Kalbarri in the north, to pockets within the Wheatbelt (including records at Dryandra, Dongolocking and Boddington) and the south west forest regions to the sandplain heaths on the south coast and eastwards to Fitzgerald National Park. Honey possums are known to occur on the Scott Coastal Plain.

The honey possums are most common in areas supporting heath communities with continuous nectar producing plants (especially Proteaceae species such as *Banksia, Dryandra* and *Adenanthos* and Myrtaceae species such as *Calothamnus*). The honey possum cannot supplement their diet with insects as a protein source (as does the pygmy possum – *Cercatetus concinnus*). Animals are most abundant in mature heath that has not been burnt for 10-15 years.

As the proposed South West Yarragadee Water Supply Development is only likely to have minor impacts in localised areas the proposal as such would not influence the status of this species. The critical aspect for the honey possums is that there is a continuous food supply and this would not be impacted on by local shifts in vegetation.

4.3 HYDROGEOLOGICAL INTERPRETATION

4.3.1 Submission issues

A number of submissions (Wetlands Research Association submission in particular) raised concerns with the hydrogeological interpretation presented in the Sustainability Evaluation/ERMP, in terms of:

- stratigraphy and structural geology
- hydrology
- radio carbon dating
- water budget.

4.3.2 Response to submission issues

Each of the above concerns is addressed in detail in the following sections.

4.3.3 Stratigraphy and structural geology

The submissions claimed that there are errors in the interpretation of several aspects of the stratigraphy and structural geology, as discussed in the following sections.

Mowen Member

The submissions claim that the Mowen Member is not as clayey as assumed, and bases this claim on observed surface soils upon the plateau and an outcrop of the Leederville Formation near Nannup. The outcrop referred to is a highly weathered sandy clay and clayey sand belonging to the Vasse Member of the Leederville Formation, and is typical of this unit, but is not part of the Mowen Member as assumed in the submission. The surface outcropping material referred to as sand, muddy sand, gravely sand and laterite are a mixture of soils developed upon the highly weathered surface of the outcropping formations and a veneer of colluvial material washed down slope. It is not representative of the underlying geological unit. The surface soil can be permeable, but this characteristic does not translate to deeper sections of the formation.

The extensive drilling and down-hole geophysical logging clearly show that the Mowen Member is dominated by clays and silts, with minor sand bedding. The poor vertical permeability is conclusively demonstrated by the high water levels observed at the top of the unit and the large vertical hydraulic gradient through the unit. For these observed levels in water to be maintained in a situation of much greater vertical permeability would require a proportionally greater downward flux of groundwater and unrealistically high levels of groundwater recharge.

The Sustainability Evaluation/ERMP identifies those areas where the Mowen Member is the uppermost geological unit upon the Blackwood Plateau, and the groundwater recharge areas of outcropping Vasse Member and Yarragadee Formation. It does not imply that the Mowen Member of the Leederville Formation forms a ubiquitous unit throughout the Blackwood Plateau, although it does cover almost 3000 km^2 of the plateau and in these areas, there is a very low risk of watertable changes resulting from pumping from the Yarragadee Formation.

Faults acting as conduits for groundwater

The Wetlands Research Association made the comment that faults will act as conduits for groundwater flow in the region is not accurate. The faults present within the basin form shear zones of sediments that are a mixture of adjacent sediments of sand and clay smeared through the zone. Consequently, the faults form zones of lower permeability, and are not conduits for groundwater flow. The submission may be confusing faults with fractures in crystalline rocks which can function as conduits to water.

Faulting of the Mowen Member does not provide substantially higher permeability zones by which groundwater could circumvent the aquitard. If extensive higher permeability fault zones did exist, then vertical hydraulic gradients lower than those observed would occur. Within other units, the effect of faulting on the vertical permeability has been considered and incorporated in the evaluations and modelling.

The Busselton Fault, as the major fault traversing the region, has substantial head differences across it, demonstrating the extent to which the fault forms a hydraulic barrier.

Lithologies

The Wetlands Research Association submission claims, "*allocation of lithologies in the region to establish formations and members is too gross and too assumptive, and the detail has not been provided to critically assess the validity of the hydrologic structure and processes.*"

The investigations of the regional hydrogeology are the most intensive and detailed undertaken in Australia for development of a new regional groundwater resource. The geological complexity of the region was recognised and described in supporting documentation, and the work has been reviewed by an expert panel who considered it to be of a very high standard.

4.3.4 Hydrology

The Wetlands Research Association submission comments on the inconsistent patterns in hydrographs from a range of monitoring locations in the Yarragadee Formation, suggesting that the data is either erroneous or represents a more complex system that has been interpreted in the Sustainability Evaluation/ERMP.

The difference between hydrographs is normal and provides valuable information on aquifer properties and groundwater recharge. These hydrographs were important in capturing the hydrogeological complexity within the groundwater model.

There is significant variability in groundwater recharge rates across the region that will influence the magnitude of seasonal water level fluctuation from location to location, while at any particular site the seasonal response observed within observation wells will depend on:

- depth of the screened interval
- whether the aquifer is unconfined or confined
- permeability of the aquifer units
- distance from the recharge area of the aquifer unit.

Hydrographs typically show the greatest seasonal magnitude for wells screened within unconfined aquifers close to the surface watertable, while wells within deep confined aquifers have only a small season variation that is normally lagging shallower wells by several months.

4.3.5 Radiocarbon dating

The Wetlands Research Association submission comments that groundwater of an age greater than 15 000 years cannot exist at elevations greater than sea-level during the last interglacial period, which was approximately -100 mAHD. This level occurs mostly within the Yarragadee Formation where current potentiometric heads are typically between 20 and 40 mAHD, which is above the existing sea-level. During the previous interglacial, potentiometric heads within the Yarragadee Formation would have been similar to those observed today. Although sea-level was substantially lower at this time, the coast was situated about 50 km beyond its current position. Groundwater potentiometric heads would have declined the additional 100 m over this distance under a similar hydraulic gradient as currently observed on-shore.

The age of groundwater at a specific point within the aquifer reflects the distance that water has travelled since recharge and rate of groundwater flow, which is a function of formation permeability and the hydraulic gradient (or force) driving the flow. The age of groundwater higher within the Yarragadee aquifer is considerably younger, as observed in other monitoring wells on the plateau.

Results from radiocarbon dating of groundwater are consistent with groundwater flow patterns and rates determined by the hydrogeological investigations.

4.3.6 Water Budget

The Corporation has put considerable effort to quantify the key components of water balance in the regions. Various studies were undertaken as part of this extensive investigation using numerical models or methods, which have successfully been applied to the Southwest region in other studies. These include:

- water yield estimate using CSIRO model WAVES (Xu 2004)
- recharge estimate using WEC-C model (Mauger 2003)
- catchment modelling using Lucicat model (Bari 2003)
- water balance analysis using Watbal (Sun 2004)
- water balance studies using simple models (Xu 2003; Strategen 2003)
- recharge estimate using chloride balance method (Peck 2003).

These studies have made extensive use of the data from the study area (rainfall, land use and vegetation conditions, soil properties, geology, runoff, etc.). In many cases, studies were carried out for a local catchment where observed flow data are available and then extended to the whole of the study area. These independent studies provide a range of results for the groundwater recharge and other components of regional water balance.

The regional groundwater model has been calibrated using observed hydrographs from various parts of the aquifers and measured runoff from the major rivers in the region. Good agreements between the observed and simulated suggest that the model approximates the hydrological system reasonably well. Components of the water balance produced by the groundwater model are consistent with the observed (e.g., discharge into Blackwood river and runoff in the Scott catchment) and those estimated by using other independent methods, adding further confidence in the regional scale model accuracy.

4.4 BLACKWOOD RIVER

4.4.1 Submission issues

Submissions raised matters associated with the potential impacts of the project on the flows and salinity of the Blackwood River. The concerns related to several aspects:

- Blackwood River salinity (current and future)
- Blackwood River nutrients
- Blackwood River biodiversity
- impacts on Hardy Inlet.

4.4.2 Response to submission issues

Each of the above concerns is addressed in detail in the following sections.

4.4.3 Blackwood River salinity

Submissions raised concerns that the increase in salinity in the Blackwood River may result in the loss of some salt intolerant species from the main channel. In already altered systems that have become brackish or saline, the tolerance thresholds of sensitive species have already been exceeded and further small changes are unlikely to affect the remaining species (Edward et al. 1994).

In the past 50 years, the winter salinity of the Blackwood River has increased ~700% and this has been associated with significant changes in land use. The existing fauna in the Blackwood and tributaries have already been exposed to changes in both water quantity (increased runoff due to clearing) and quality and this shows a level of resilience typical of species with broad ecological niches without highly specific habitat requirements.

The proposal is predicted to reduce the minimum summer flows (in the driest years) in the Blackwood River by up to 6% after 30 years of operation (Water Corporation abstraction with estimated regional growth would result in a 13% reduction). The associated increase in salinity in the two driest months (when the water quality is freshest) would be around 7% for the Water Corporation proposal alone (14% for Water Corporation plus regional growth).

CALM commented that there was no evidence to support the conclusion that an average 14% increase in summer salinity is not likely to have a significant impact on the fauna of the river and indicated that known salinity tolerance of the species present should be discussed. Published work on salinity tolerances of fauna is extremely patchy and most information consists of water chemistry measurements during sampling, which does not indicate a range of tolerance and has little use in setting threshold values.

At present, there is a study in progress funded by Land and Water Australia that will address the salinity tolerance levels of sensitive aquatic fauna using a controlled “lethal dose” approach. The CALM request for a discussion of the known salinity tolerances of species is beyond the scope of current knowledge. However, most freshwater fish species recorded in the Blackwood River were found there in both summer and winter indicating that they must be tolerant of a broad range of salinity concentrations. The small and gradual change in summer salinities over 30 years is not expected to affect these species.

4.4.4 Blackwood River nutrient levels

CALM stated that the ANZECC/ARMCANZ trigger levels were used inappropriately for the Blackwood River system and that the system would require monitoring and investigation to determine appropriate trigger values. However, the guideline trigger levels are designed to be conservative so that if exceeded, they trigger exactly the kind of further investigation and refinement suggested by CALM. Therefore, it is considered that the ANZECC/ARMCANZ guidelines are used appropriately in the Sustainability Evaluation/ERMP.

4.4.5 Blackwood River biodiversity

CALM commented that the conclusion from the macroinvertebrate sampling that the biodiversity of the Blackwood River system is generally low, does not appear to be reflected in the results of other studies in the area. CENRM (2005a) attributed the low biodiversity to the salinity of the Blackwood River which has increased approximately 700% in the past 40 years, and to the high flow conditions at the time of sampling. Low biodiversity following increases in salinity has been shown for a number of studies on saline systems in south–western Australia, as typically the freshwater fauna is intolerant of increased salinity and the only species remaining are often salt lake forms (Bunn & Davies 1992, Edward et al. 1994). To provide a more thorough description of the aquatic biodiversity the Sustainability Evaluation/ERMP did not limit its description of aquatic fauna only to CENRM (2005a), the document also drew on relevant work by Morgan & Beatty (2005), Morgan et al. (2004) and Bamford (2003).

Other studies in the Blackwood catchment have combined the fauna sampling results from the fresher tributaries with the saline Blackwood and the combined species list indicates a 'higher' biodiversity. CENRM (2005a) presented the sampling results from the main stem of the river separately, resulting in a reduced biodiversity for the river compared to other studies. The separation of sampling results in the main stem and the tributaries was appropriate as they have very different water quality and flows. In addition, the biodiversity of macroinvertebrates is very similar to that recorded in the Hotham River, a saline river system in south–western Australia (Bunn & Davies 1992). It should be noted, CENRM (2005a) used AusRivAs sampling protocols (as recommended by CALM in their submission) and a critical component of this methodology is the identification of taxa to Family. Where possible, CENRM (2005a) identified to Species level. Family-level identification will always limit the assessment of overall biodiversity.

4.4.6 Hardy Inlet

CALM raised concerns regarding the potential impact of reduced flow or increased salinity on the hydrological regime and ecology of Hardy Inlet. The Sustainability Evaluation/ERMP concluded that due to the relatively small change in flows and salinity (discussed in detail in Volume 2 Chapter 7 Section 1 in the Sustainability Evaluation/ERMP) and the nature of the receiving estuarine environment, which is highly adapted to fluctuations in salinity, there would be no significant impact on Hardy Inlet.

The proposal will not result in a change in the total salt load to the estuary, as the change in salinity concentration is due to a decrease in fresh water inputs not an increase in salt water inputs. In an assessment of risk to Hardy Inlet, the historic changes in flows and salinity in the Blackwood River should be taken into account, as there has been almost an order of magnitude increase in salinity over the past 50 years (flow-weighted values of 500 mg/L in 1939 to about 3500 mg/L at present). Consequently, a small change in summer salinity of the river (resulting in an even smaller percentage change in salinity in the Inlet where the water is mixed and evaporation concentrates the salts over summer) due to the proposal is highly unlikely to be significant given the ~700% increase in salinity since European settlement.

Whilst the influence of changes to fish migration patterns due to changes in salinity regimes are not well known, it is known that native fish species "specialise at being generalists" (Pusey et al. 1989) and therefore given the large natural variations in Australian systems, fish are not tightly "cued" for migration to specific water quality and quantity, other than broad seasonal signals.

4.5 BLACKWOOD RIVER TRIBUTARIES

4.5.1 Submission issues

Several submissions raised matters associated with the potential impacts of the project on the flows and stream length of St John Brook, Poison Gully and Milyeannup Brook.

The concerns related to the following key aspects:

- potentially unacceptable impacts on fauna due to reduced flow, stream length and other unknown changes to riffles and wet banks
- fauna investigations
- St John Brook – impacts not quantified or sufficiently studied
- cumulative impacts with climate change.

4.5.2 Response to submission issues

Each of the above concerns is addressed in detail in the following sections.

4.5.3 Hydrological changes

Several submissions raised the concern that the predicted changes or the risks of even greater impacts, to the tributaries were unacceptable. Most submitters did not clarify the basis for judging the impacts unacceptable but most specific concerns related to aquatic fauna impacts. The focus is on St John Brook, Poison Gully and Milyeannup Brook as these are the areas that are potentially affected by groundwater drawdowns.

The impact assessment in the Sustainability Evaluation/ERMP of the potential hydrological changes on aquatic fauna was based on the environmental water requirements defined in CENRM (2005a), aquatic sampling results in the area (CENRM 2005a, Morgan & Beatty 2005) and an assessment of the habitat values of Poison Gully and Milyeannup Brook (CENRM 2005b). The conclusion of these investigations was that all the defined ecological water requirements would continue to be met in Poison Gully and Milyeannup Brook and the instream ecology would not be significantly affected.

The Sustainability Evaluation/ERMP stated that the changes to the tributary riffle zones are largely unknown and CALM considered that this uncertainty was unacceptable. The Sustainability Evaluation/ERMP goes on to discuss that as the cross-sectional profile of the riffles shows a flat streambed, any reduction in flow will reduce the depth rather than the width of the active channel. The EWR analysis calculated that the flow required to maintain a depth of 0.05 m over the riffle zones is 15 L/s in Milyeannup Brook and 11 L/s in Poison Gully. If a 30% reduction in flow occurred, these EWRs (which are inherently conservative) would still be met. The flows will be monitored constantly, and flow supplementation triggered if required. This adaptive management approach is considered precautionary.

CALM commented that the importance of "very wet banks" to aquatic fauna is unknown. This may be the case but there are unlikely to be significant changes to wet banks except in areas where the permanent stream length may contract, in which case, the banks would no longer be potential habitat for the aquatic fauna. Where permanent flow is maintained, there would not be expected to be any change in bank wetness as the watertable is still intercepting the ground surface.

Further detail on the monitoring is provided in the Groundwater Abstraction Management Plan in Appendix 1.

St John Brook

The summer flows of St John Brook are naturally very low. There is potential for the permanent summer groundwater discharge (permanent stream length) to slowly migrate downstream over a small section in the upper reaches of the brook near the junction with St Paul Brook as a result of the proposal. This section of the brook is a first order stream and has low habitat diversity (CENRM 2005b). CENRM concluded that if a previously perennial first order stream became ephemeral, the risk to regional aquatic biodiversity would be considered low, for the following reasons:

- first order streams have low flows, with gentle channel slope, and lack the pool and riffle zones that provide important aquatic habitats in second and third order streams
- fish biodiversity is concentrated in pool habitats in second and third order streams
- any macroinvertebrates in the first order reaches would also be found downstream.

The predicted impacts on St John Brook are considered acceptable but if unexpected reductions in flow occur, summer flows will be supplemented as a contingency. This is detailed in the revised Groundwater Abstraction Management Plan (Appendix 1).

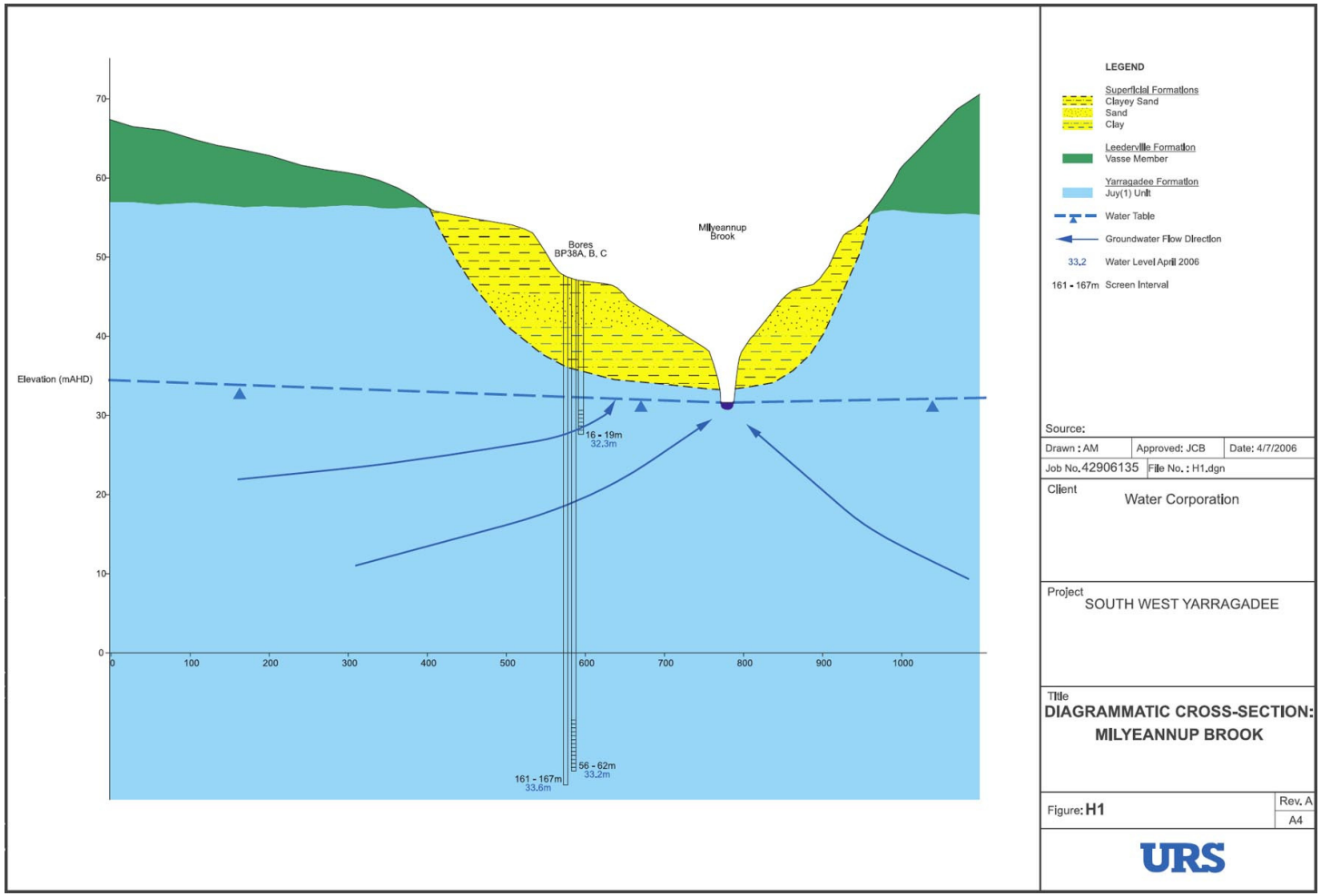
Poison Gully and Milyeannup Brook

CALM commented that there should be supporting information to the conclusion that the 30% reduction in minimum summer flows in Milyeannup Brook and Poison Gully is not expected to change pool depths to a degree that would impact on the resident fauna. The supporting evidence is provided in the EWR assessment in Appendix 26 and discussed in Volume 2 Chapter 7 Section 2 in the Sustainability Evaluation/ERMP. The EWRs were set by linking pre-determined ecological values and key processes to components of flow. The channel cross sections were used as they relate flows to stage heights. In this way, EWRs have been determined independently of the existing flow regime. This enables the statement "a 30% in summer flows…" to be supported by the quantitative assessment of EWRs.

Milyeannup Brook is incised into the Yarragadee Formation and discharge from the aquifer maintains a permanent flow in the lower reaches of the creek. The head in the Yarragadee Formation is upward in the vicinity of the lower sections of the brook, as shown by the piezometers at site BP38 (Figure 4.2). The superficial formations in the valley of the brook are generally clayey and are above the watertable, demonstrating that the vegetation along the brook is maintained by soil moisture replenished from winter rainfall rather than being highly dependent on the regional watertable. The relatively low gradient watertable and topography shown in Figure 4.2 illustrates that only a narrow band of vegetation within the steeply incised valley would have access to the watertable and in these areas surface water is more readily available.

The Sustainability Evaluation/ERMP concluded that Milyeannup Brook was the most important tributary in the Blackwood River system as habitat for the rare Balston's pygmy perch. CENRM (2006) conducted a survey of Milyeannup Brook in July 2006 after an extremely dry autumn and early winter. In July 2006, continuous flow started approximately 2000 m from the Blackwood River whereas it was previously thought the summer baseflow had maintained flow 2500 m from the river. Therefore, there is a lower dependence on regional groundwater in the upper reaches.

Figure 4.2 Diagrammatic cross-section of Milyeannup Brook



The CENRM (2006) survey was conducted to gain a greater understanding of the distribution, abundance and size of the Balston's pygmy perch population in Milyeannup Brook. The key findings of the research are:

1. Balston's pygmy perch is the most abundant fish species in Milyeannup Brook making up 55% of the 501 specimens caught in the survey. *Galaxias occidentalis* (Western minnow) was the second most abundant species overall (38% of total catch) with much lower numbers of *Edelia vittata* (Western pygmy perch, 3%), *Bostockia porosa* (nightfish, 2%) and *G. munda* (mud minnow 2%).
2. Over 90% of the Balston's pygmy perch recorded in the survey were caught at the sampling site closest to the Blackwood River (approximately 400 m from the confluence). The "concentration" of individuals in a series of pools in the lower reaches is a typical late summer pattern, but observing this state in July is a consequence of the extreme drought condition of 2006.
3. One specimen of Balston's pygmy perch was caught at a site in the upper reaches of the Brook, in a pool isolated from the lower reaches and without any flow. This indicates that the fish do utilise the upper reaches of Milyeannup Brook but that most contract into the lower reaches in the low flow conditions of the late summer months.
4. The very dry conditions in July 2006, raised the issue that if low flows persist through to September/October when the fish usually migrate upstream to spawn, this would pose a threat to the reproductive process and the population. This is a winter rainfall driven process that is not groundwater dependent (the flows required far exceed groundwater inputs). The July 2006 results also indicate that groundwater flow is not able to buffer drought effects during autumn/winter in the mid to upper reaches. Therefore, there is no risk to spawning from groundwater abstraction.

The key risk identified in CENRM (2005) to the Balston's pygmy perch due to groundwater abstraction is the concentration of fish within the lower reaches of Milyeannup Brook. This happens naturally every summer in any event, however, the concentration of fish may be greater if the permanent flow length of the stream is reduced. A severe restriction of available habitat may result in density-dependent impacts such as increases in predation and, competition for food and shelter. This is a possibility; however, in practice density dependent effects are often difficult to measure and are often overstated. Current genetic work being undertaken by CENRM for the Water Corporation on genetic diversity of the Balston's pygmy perch will show (using first analysis) levels of differentiation and consequently the likelihood of these effects having occurred previously.

A new trigger for the supplementation contingency for Milyeannup Brook is proposed based on the findings of the CENRM (2006) survey. If stream flow observations indicate that Milyeannup Brook does not have permanent and continuous flow 1500 m from the confluence with the Blackwood River, the contingency of summer flow supplementation will be implemented to ensure the population of Balston's pygmy perch is supported in the critical lower reach. The new trigger is easy to measure and is downstream of historical lows (i.e. 2000 m from the confluence of the Blackwood River in July 2006). As the Balston's pygmy perch occur mainly within 500 m of the Blackwood River, this trigger is considered appropriate to enable supplementation to sustain this key habitat during low flow periods.

CALM was concerned that the sampling requirements for monitoring the Balston's pygmy perch population in Milyeannup Brook would have a deleterious effect on the fish population. The proposed fish sampling techniques are non-destructive (i.e. Fyke nets) consistent with previous surveys by CENRM (2006).

4.5.4 Fauna

CALM was concerned that there were no studies undertaken on macroinvertebrates or aquatic flora, despite the potential impacts on these components of biodiversity. A detailed fauna survey would establish a more comprehensive understanding of the biodiversity but would not help the determination of EWRs and potential impacts. CENRM (2005a) was contracted to determine EWRs of water dependent ecosystems. No studies were undertaken on macroinvertebrates as this would have had limited implications to the determination of EWRs or the assessment of impacts. It is noted that there are no studies in Australia where the specific water requirements of macroinvertebrate species has been quantified.

Many submissions recognised the high level of biodiversity and endemism in the south west of Western Australia. An example given is 80% of native freshwater fish found in the south west are endemic. The South West encompasses a vastly greater area than the Blackwood valley in the area of Yarragadee influence. For example, the most restricted fish species (Balston's pygmy perch) also occurs in a wider area between Margaret River and Two Peoples Bay, east of Albany.

CALM raised the issue of the requirements for burrowing crayfish whose established and long-term burrows are at the water line and often contain an assemblage of other fauna. The Blackwood River and its tributaries have highly seasonal flow regimes so there is no one static 'water line' and the macroinvertebrates are adapted to these conditions. Clearing for agriculture has also resulted in increased runoff, groundwater discharge and streamflow, and elsewhere in south-western Australia, catchment clearing has approximately doubled flows in streams compared to fifty years ago. Consequently, the fauna in the Blackwood River has dealt with large scale changes to soil wetness, peak flows and groundwater levels.

4.5.5 St John Brook

Through the proposal development phase of the sustainability evaluation, the proposed location for the wellfield was moved further north than originally planned (as described in the Sustainability Evaluation/ERMP). Modelling indicated that this reduced the overall environmental impacts of the abstraction (i.e. impacts were reduced on the Scott Coastal Plain, Poison Gully and Milyeannup Brook). The resultant proposed wellfield has some very limited connection with St John Brook and therefore, this creek became one of the potentially affected areas. Given the extensive clays in the St John Brook valley between the surface and the Yarragadee Formation (approximately 30 m thickness of Mowen member), the potential risk to surface water levels and vegetation is very low. The vegetation along two stretches of St John Brook had been surveyed by Mattiske Consulting and this information was used as the basis of the impact assessment.

Four permanent vegetation monitoring transects will be established along St John Brook as a means of monitoring local groundwater changes in relation to vegetation. One transect will be established near Barrabup Pool and the water level monitoring site BP63 and another two transects will be established between Barrabup Pool and St Paul Brook. A control vegetation monitoring site will be established on St Paul Brook as this creek is underlain by Bunbury Basalt and cannot be influenced by abstraction from the Yarragadee aquifer. All vegetation transects will be established near current or proposed monitoring wells so that the relationships between the vegetation and the local groundwater system can be investigated.

CALM commented that the Sustainability Evaluation/ERMP did not provide an adequate impact assessment of the tributaries of St John Brook, particularly St Paul Brook. St Paul Brook is an ephemeral tributary indicating that its flow is not groundwater dependent. St Paul Brook is underlain by impermeable Bunbury Basalt (Figure 4.3) so the watertable would have no hydraulic connection to the Yarragadee aquifer and is, therefore, outside of the drawdown area. As shown in the impact assessment of St John Brook in Volume 2 Chapter 7 Section 4 of the Sustainability Evaluation/ERMP, only the main stem of the creek is potentially affected by groundwater drawdowns.

CALM commented that the aquatic fauna of St John Brook was under sampled. The CENRM (2005a) survey was conducted using AusRivAs protocols and conducted during high flows, during which catch rates are often lower. The study was not intended as a survey to identify the maximum number of species but an identification of key species for an assessment of EWRs.

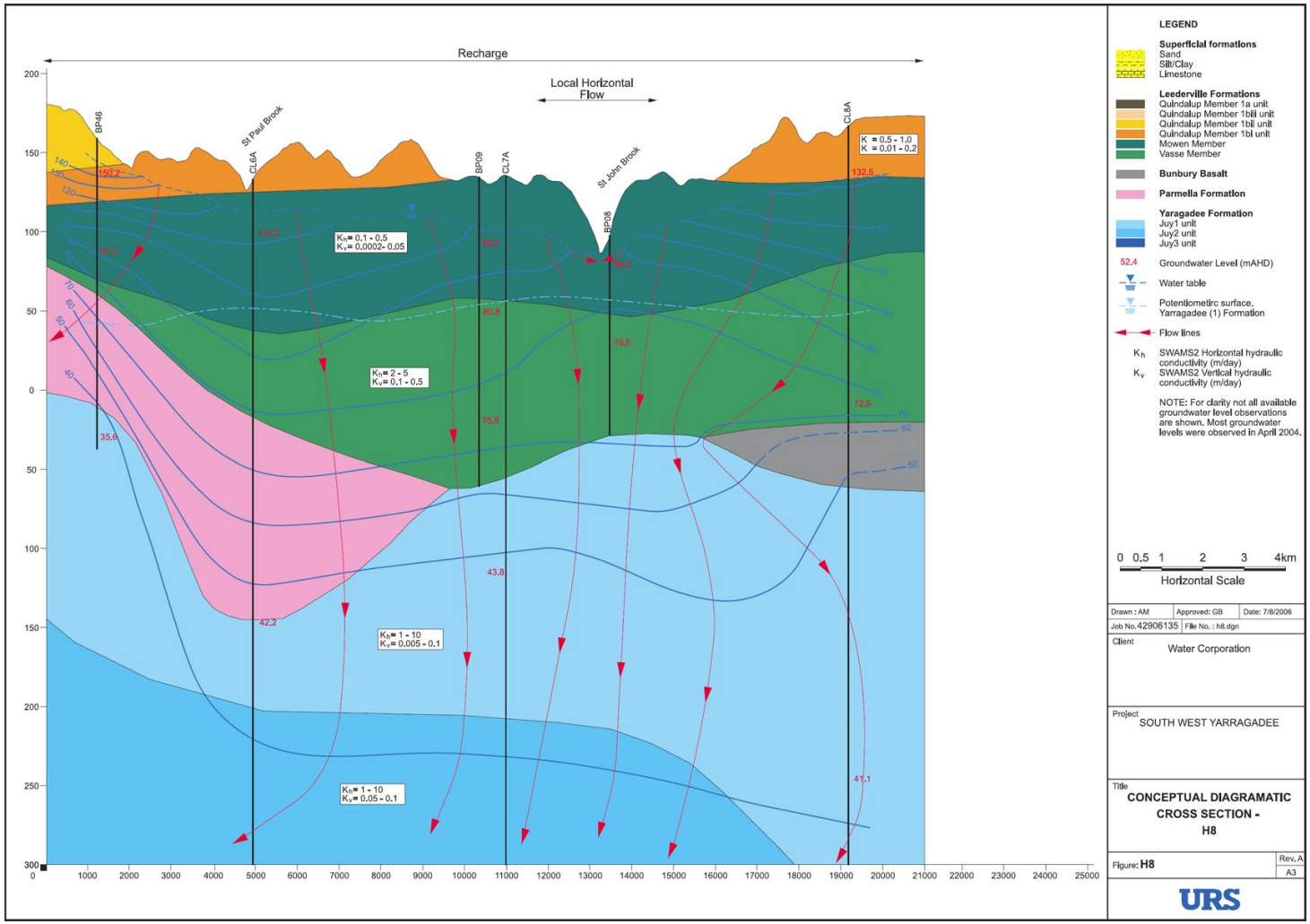
URS Australia (2006a) reviewed the hydrogeology of the St John Brook at a local scale to produce several cross-sections with flow nets (Figure 4.3). The key conclusions of the work were:

1. The cross-sections showed that north of the St Paul Brook confluence, St John Brook is a losing stream (stream level is higher most of the year than groundwater level). This supports the observations (URS Australia 2004, Strategen 2006) that the upper end of perennial baseflow in St John Brook is several hundred meters below the confluence of St Paul Brook.
2. The large downward vertical gradient measured in the wells in the area and illustrated in the cross sections appears to be an effective barrier to transmitting changes between the Yarragadee and Leederville Formations.

4.5.6 Cumulative impacts with climate change

The changes predicted in the Blackwood River tributaries include both regional abstraction impacts and the Water Corporation abstraction impacts. The cumulative effects of climate change were included through adoption of recharge rates based on a 9% drier climate regime than has been observed historically and this was applied to all modelling scenarios.

Figure 4.3 Diagrammatic cross section of St John Brook



4.6 COASTAL PLAINS

4.6.1 Submission issues

Concerns were raised about risk to the unique ecosystems and wetlands of the Swan and Scott coastal plains in a time of climate uncertainty. Lake Jasper, Scott National Park, the Scott River, Hardy Inlet and the Vasse-Wonnerup wetlands were all raised as areas that could be put at risk by the proposal.

The concerns related to several aspects:

- interpretation of watertable drawdown impacts
- impacts on the hydrologic regime of seasonally inundated wetlands and groundwater dependent ecosystems
- impacts on Scott Coastal Plain (eastern and western) and Scott River
- impacts on specific areas (Scott River, Lake Jasper, Scott National Park, Tutuup Wetlands, Muddy Lakes, Hardy Inlet and the Vasse-Wonnerup wetlands)
- acid sulphate soils.

4.6.2 Response to submission issues

Each of the above concerns is addressed in detail in the following sections.

4.6.3 Interpretation of watertable drawdown impacts

Several submissions expressed concern that the interpretations of the drawdowns modelled by the SWAMS V2.0 model on the coastal plains were optimistic, and questioned the following:

- shortcomings in the monitoring well networks and available monitoring data that compromise the ability to prepare reliable hydrogeological interpretations
- interpreted modelling results, particularly the concept of rejected recharge counterbalancing watertable drawdowns and consequential environmental impacts
- non-accounting for irrigation return water.

Monitoring well network

The monitoring well network through the region is extensive and comprises several distributed suites of wells resulting from a range of investigation programs conducted over the past half-century. Both coastal plains have been subjected to major drilling programs (the Bunbury Shallow Drilling Program, Busselton Shallow Drilling Program, and the Scott Coastal Plain Drilling Program) conducted by the Geological Survey of Western Australia in between 1975 and 1992 (Strategen 2004). This work resulted in a network of investigation wells penetrating the various geological formations comprising the coastal plains, which have since been regularly monitored.

Other localised investigations for various specific projects (eg numerous sand mining projects) have complemented this network and the aggregated data was used in developing the conceptual model of the hydrogeology, which was then converted into the digital model (SWAMS V2.0).

The capital value of the investigation and monitoring network would total several tens of $ millions in present day terms, and includes approximately $6 million expended by the Water Corporation in the 2003-2005 drilling and testing programs.

Groundwater abstractions for private use and local town water supplies have been progressively growing over the last 100 years or more on the Swan Coastal Plain. Abstraction on the Scott Coastal Plain has only been undertaken to any substantial extent during the last two decades. The abstractions and their drawdown impacts on both plains have been monitored through the available network by the DoW and its predecessor organisations with additional monitoring by the Water Corporation of its local town water supply wells.

This information constitutes a substantial dataset to support the modelling work, and interpretations of the results.

Rejected recharge concept

Several submissions, notably the CALM and the NRM and Salinity Division of the DoE questioned the validity of the rejected recharge concept. There are several aspects that have been questioned:

- applicability of the concept over the entire area of the coastal plains
- the volume of rejected recharge required to offset drawdowns and impact on water available to the environment.

Areal applicability

For rejected recharge conversion to occur, there is a need for a relatively high vertical hydraulic conductivity to occur, and it is expected that there is a degree of variability of this parameter across the extensive areas of the plains. This variability has resulted in perching of groundwater and perched wetlands in areas where there is restricted vertical water flow through the soil profile. In these areas, the transmission of impacts of pumping from deeper aquifers to the watertable, or in the perched wetlands, would be inhibited as a direct result of the low vertical permeability.

Conversely, in areas where there is a high vertical permeability, the rejected recharge would have the opportunity to enter the groundwater, and correspondingly offset the drawdown effects that do transmit to the surface aquifers in those areas.

Rejected recharge required and impact on environment

The submissions note that approximately 200 mm of rainfall would be required to offset 1 m of drawdown on the Swan Coastal Plain and similarly 400 mm of rainfall would be required to offset 2 m drawdown on the Scott Coastal Plain (assuming a storage coefficient of 0.2). These values have been compared to the estimated values of rejected recharge of 300 mm/yr and 240 mm/yr on the Swan and Scott Coastal Plains respectively, and the submitters conclude that there is insufficient, or close to insufficient rejected recharge available to completely offset the drawdowns.

The submissions do not recognise that the raw modelled drawdown values are final drawdowns after 30 years of pumping, not annual drawdowns, and reflect potential average annual drawdowns of 33 mm and 66 mm for the Swan and Scott Coastal Plains respectively. Consistent with the assumptions in the submissions of a storage coefficient of 0.2, offsetting these drawdowns would require approximately 6.5 mm and 13 mm of rainfall per year respectively. This corresponds to only 2.2% and 5.4% of the annually rejected recharge respectively, and is clearly well within the limits of that flux in both cases.

Reducing the rejected recharge will reduce surface water runoff. However, the reductions of the order of 2.2% and 5.4% of rejected recharge are considered to be clearly insignificant, assuming that the full impact is reflected in this component of the water balance. This impact would be lessened further if water leaves the area through means other than surface water flow. It is likely that rejected recharge leaves the area via a combination of surface flow and evapotranspiration. Some infiltration of surface flow to groundwater along the edge of the major sand dune systems along southern margin of the Scott Coastal Plain may also occur. The extreme depths to groundwater beneath these high dunes indicates that there are no associated GDEs that would be affected.

The DoW has developed a local scale model of the Scott Coastal Plain (Aquaterra 2006), that accounts for surface water-groundwater interactions in the area. The predictive application of this modelling to the Water Corporation proposal concluded that there is significant rejected recharge from standing water on the coastal plain that substantially attenuates the drawdowns projected by the SWAMS V2.0 modelling. This modelling confirms the validity of the rejected recharge concept as interpreted in the Sustainability Evaluation/ERMP.

The URS Australia report on the Swan Coastal Plain (Appendix 4) notes that lowered watertables would result in increased recharge in several areas, through the capture of rejected recharge.

Accounting for irrigation return water

Submissions commented on the non-accounting for irrigation return water in the modelling. It was acknowledged in the Sustainability Evaluation/ERMP that this was a shortcoming of the modelling. However, the lack of data in the region on the extent and variability of irrigation returns made accounting for this component of the water balance difficult. It was consequently decided to omit this component as it would ensure that the model results were conservative in these areas.

Data on irrigation returns is available on the Swan Coastal Plain in the Perth Region, however, the irrigation techniques in this area are different to those in the study area, and the results cannot be directly translated.

4.6.4 Hydrologic regime of seasonally inundated wetlands and GDEs

Several submissions expressed concern over the potential impacts on the hydrologic regime of seasonally inundated wetlands and other GDEs.

Seasonally inundated wetlands

The key issue of impact on seasonally inundated wetlands relates to the depth of inundation and period of inundation (hydro-period).

Depth of inundation

As explained in the Sustainability Evaluation/ERMP (Volume 2 Chapter 2 Section 4.2.2), the depth of inundation of groundwater dependent wetlands on the coastal plains should not be affected by the proposal due to the full recovery of groundwater levels expected to occur each winter through the contribution of rejected recharge. Full winter recovery is currently being observed on the coastal plains, in areas where summer water levels are declining as a consequence of local pumping.

Hydro-period

The impacts of the proposal on the hydro-period of seasonally inundated wetlands are expected to be mitigated by several aspects related to perching and the rainfall-groundwater-wetland interaction process.

The hydro-period of perched wetlands would not be affected by drawdowns in the Yarragadee Formation as a direct consequence of perching separating the wetland from the impacts of drawdowns in underlying formation. Perching occurs intermittently throughout the region through the occurrence of low permeability horizons in the shallow geological formations and in the case of wetlands, through accumulations of biomass and fine soil material in the wetland beds. There is insufficient data on the stratigraphy and hydrology of each of the wetlands in the region to characterise which wetland areas are perched and the hydraulic characteristics of such perching. However, as discussed later in this section, the hydro-period of wetlands appears to be dominated by rainfall rather than groundwater drawdown, provided drawdowns recover each year, as is expected.

Rainfall on the coastal plains enters the groundwater systems of the coastal plains largely by direct vertical infiltration. Where a wetland overlies the shallow groundwater, infiltration of rainfall would be through the wetland bed. This strongly suggests that where the bed has a low–medium hydraulic conductivity, the wetland would retain rainfall for a period before it percolated through the bed to the underlying groundwater. The length of period of water retention would relate to the hydraulic conductivity of the bed.

The hydro-period of groundwater dependent wetlands with low–medium hydraulic conductivity beds would be dependent on the occurrence of rainfall rather than groundwater level, provided there was full winter recovery of those groundwater levels to maintain wetland water levels after the end of the rain season.

Groundwater and wetland hydrographs from the Jandakot Mound on the Swan Coastal Plain south of Perth show a range of responses that demonstrate the highly variable groundwater-wetland water level relationships that can exist in an area where perching layers occur in the upper soil horizons (Strategen 2004b). The hydrographs all demonstrated responses that support the process described above.

North Lake, Shirley Balla Swamp and Forrestdale Lake were examined by Strategen (2004). North Lake and Shirley Balla Swamp showed good correlations between groundwater and wetland water levels. In North Lake, the wetland responses closely matched the groundwater responses, with the exception that lake water levels were continually above the underlying groundwater by between 0.1 to 0.6 m. The greater differences occurred when levels were low, and the smaller differences occurred when levels were high at the end of winter. This suggested that both the groundwater and wetland were responding simultaneously to rainfall, with rainfall percolating through the wetland as proposed above.

Hydrographs from Shirley Balla Swamp exhibited similar characteristics, but with the wetland and groundwater levels being more closely matched in elevation than in North Lake. The hydrographs also reflected rises in wetland levels in early winter that were ahead of the groundwater response, with the groundwater effectively matching the wetland by the end of winter. This suggests surface ponding occurring, with subsequent percolation.

The relationship for Forrestdale Lake was generally poor, with the exception of the falling stage (following the peak levels at the end of winter) when the correlation was moderate. Lake levels showed much lower amplitude variations than the groundwater, and groundwater levels varied from being above lake levels by up to 1.5 m at the end of winter to some distance below at the end of summer. Minimum water levels in the lake could not be measured because of limitations in the monitoring network.

Therefore, while the three wetlands demonstrated substantial differences in the nature of their relationships with the underlying groundwater, the two that were related to groundwater levels both presented responses that strongly suggested percolation from the wetland to groundwater and not vice versa. This supports the proposition that the hydro-period would not be affected by declining summer groundwater levels, provided there was full winter recovery.

Given the general similarities in the climate, physiography and geomorphology, it can be reasonably assumed that wetlands on the southern Swan Coastal Plain and the Scott Coastal Plain would reflect the range of characteristics evident in wetlands further north on the Swan Coastal Plain. This, combined with physical evidence of perching in a number of observed wetlands in the study area, supports the view that the hydro-period of seasonally inundated wetlands is unlikely to be significantly affected by the proposal. In addition, as discussed in the following section, the majority of the drawdown affected area on the Scott Coastal Plain does not coincide with any wetland areas.

Groundwater dependent ecosystems and biodiversity impacts

Wetlands

The impact on GDEs on the coastal plains as a result of the expected drawdowns was raised in a number of submissions. The issues essentially relate to impacts on groundwater dependent vegetation, with consequential impacts on habitat.

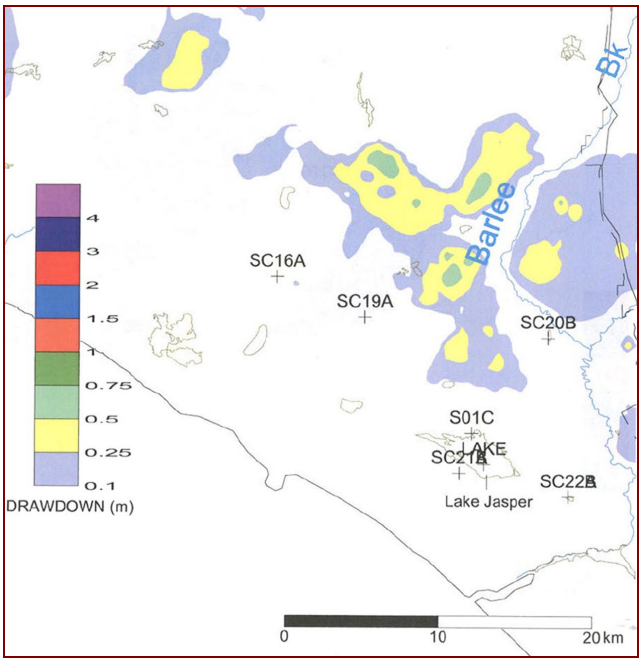
Froend and Loomes (2006) recommended a maximum decline of 0.25 m below the 2005 end-of-summer levels in the watertable at wetland sites within the expected area of impact of the Water Corporation proposal on the Scott Coastal Plain as the limit within which the most vulnerable dominant vegetation species would be maintained at a low level of risk.

The modelling undertaken by Aquaterra (2006) demonstrated that drawdowns in these areas would be generally less than 0.25 m after 30 years, with some small areas where drawdowns could be as high as 0.5 to 0.75 m (Figure 4.4).

These drawdowns have been overlaid on mapping of the geomorphic wetlands in the area (Figure 4.5) and show that the majority of the drawdown affected area does not coincide with any wetland areas. This outcome is intuitively correct, as the extent to which the rejected recharge concept would apply would be largely dependent on depth to watertable. The concept would apply to its maximum extent in inundated (wetland) areas, mitigating the drawdowns in those areas, and to its least extent in areas of high depth to watertable.

There is an area of drawdown in the 0.5 to 0.75 m range on the northern margin of the coastal plain that overlies a dampland (seasonally waterlogged basin). As this wetland occurs in the more elevated landscapes where depths to watertable are generally higher, there is a reasonable likelihood that this dampland area is perched above the regional watertable. Areas of perched watertables and associated wetlands/damplands, would by their nature, also tend to be areas of lower rates of local recharge to the regional watertable. The reduced rates of recharge in these areas would result in higher local drawdowns than in other areas. There is a high downward head gradient between the shallow watertable in this area and the underlying Yarragadee Formation (approximately 30 m) which strongly supports the possibility that the wetlands in this locality are effectively perched.

Figure 4.4 Drawdowns from Water Corporation abstraction of 45 GL/yr after 30 years



Local scale modelling of the Swan Coastal Plain has not been undertaken for this evaluation because:

- minor impacts are expected on the coastal plains because of distance from the proposed wellfield
- the substantial presence of clays in the superficial formations is expected to mitigate propagation of drawdowns in the Yarragadee Formation to the watertable
- there is a good conceptual understanding of the area from existing data
- the extensive existing investigation and monitoring network
- the long history of pumping in the area and monitoring of impacts.

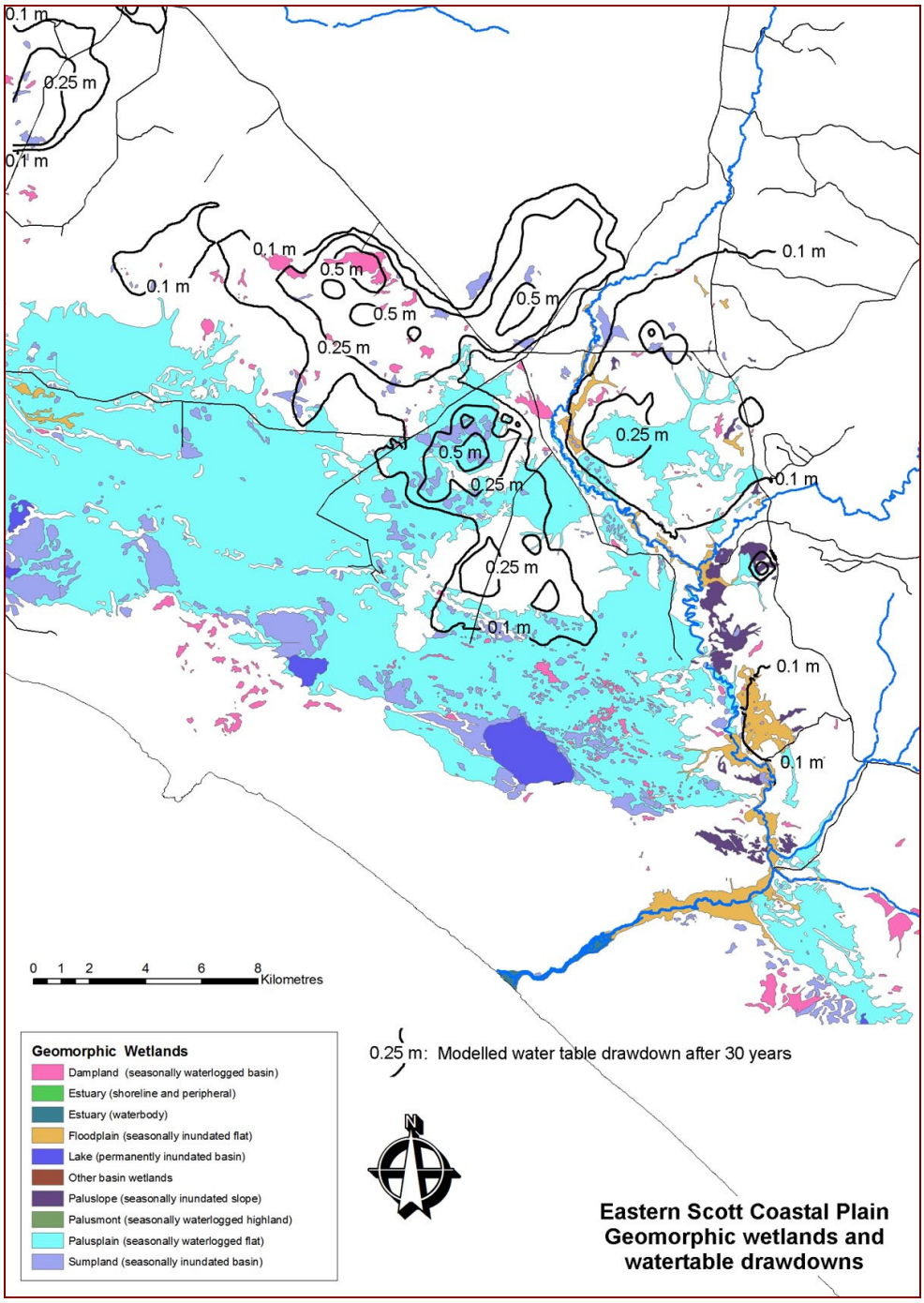
The results of any such modelling would be expected to result in similar conclusions to those drawn for impacts on the Scott Coastal Plain, as the hydrogeological processes associated with rejected recharge and perching are also present. The URS Australia report on the Swan Coastal Plain (Appendix 4) notes that lowered watertables would result in increased recharge in several areas, through the capture of rejected recharge.

Terrestrial

In the north east Scott Coastal Plain, the predicted watertable drawdowns are between 0.1 and 0.75 m after 30 years (Aquaterra 2006). In the terrestrial areas, the depth to the watertable ranges between 0 m and 10 m below ground level, with depths between 0 m and 6 m being most common.

On the Swan Coastal Plain, the predicted drawdowns were between 0.25 and 0.5 m after 30 years (Strategen 2006). The depths to groundwater are mostly shallow, between 0 m and 6 m deep.

Figure 4.5 Eastern Scott Coastal Plain – geomorphic wetlands and watertable drawdowns



To maintain terrestrial groundwater dependent ecosystems at a low level of risk, Froend & Loomes (2006) recommend that the following maximum drawdowns are not exceeded:

- 0-3 m depth to groundwater category: 0.75 m maximum drawdown
- 3-6 m depth to groundwater category: 1 00m maximum drawdown
- 6-10 m depth to groundwater category: 1.75 m maximum drawdown

The predicted drawdowns of 0.1 to 0.75 m after 30 years on the Scott Coastal Plain are within these limits and, therefore, not expected to have a measurable impact on the terrestrial ecosystems in the area. The Scott Coastal Plain ecosystems are adapted to high seasonal water level variation and Froend & Loomes (2006) recommends that the maximum drawdowns are not exceeded for more than two years.

Even with this generally low risk, some subtle changes in vegetation composition may occur in areas with specific site characteristics or cumulative impacts. Any impact would be expected to be small and localised, with the drawdowns occurring very gradually. No loss of species would be expected from the area and the regional biodiversity would not be expected to be significantly affected.

In addition, the areas with the shallowest watertables would be expected to have the lowest drawdowns. Therefore, although these areas are more sensitive to changes in watertable depth, the drawdowns in low-lying areas with shallow watertables also have high recharge as surface water accumulates in these areas.

On the Swan Coastal Plain, the drawdowns from the Water Corporation abstraction are predicted to be very low (<0.5 m) and would not result in a measurable change in the terrestrial ecosystems of the area.

4.6.5 Impacts on specific areas

Scott River

Several submissions expressed concern that the concept of rejected recharge offsetting drawdowns would result in significant changes to the surface water hydrological regime, with less water being available as surface runoff, particularly in the Scott River. The volumes of rejected recharge required to fully offset the summer drawdowns corresponds to only 2.2% of the annually rejected recharge on the Scott Coastal (Section 4.6.3 Rejected recharge concept). Rejected recharge discharges as a combination of evapotranspiration and surface water runoff, with a southerly groundwater discharge component under the coastal dunes. Although not specifically quantified, the consequential reductions in surface water runoff would be substantially less than the volumes by which rejected recharge is reduced. The impact on surface water flows in the Scott River would be virtually immeasurable because of the expected reductions in rejected recharge. Similar comments apply to discharges into the Donnelly River, an aspect of concern raised by CALM in its submission.

Lake Jasper

The recent modelling by Aquaterra (2006) confirmed that Lake Jasper and Lake Quitjup are outside of the area of groundwater drawdowns in the superficial formations. Consequently, there would be no change to the hydrologic regime of the wetland.

Scott National Park

The Scott National Park is located on the western Scott Coastal Plain. The proposed Water Corporation wellfield is some 70 km to the north east of the Scott National Park, Geologically, the Scott National Park is located in the south–western corner of the Southern Perth Basin and is underlain by the Vasse Shelf. The Yarragadee Formation does not extend beneath the Vasse Shelf, the eastern margin of which is delineated by the Busselton Fault. Drawdowns resulting from pumping from the Yarragadee Formation are not expected to propagate across the Busselton Fault. Being west of the Busselton Fault (which forms a hydraulic barrier), and at a considerable distance from the proposed wellfield, the park will not be affected by the proposal. The modelling undertaken and described in the Sustainability Evaluation/ERMP showed no effects of Water Corporation abstraction on the western Scott Coastal Plain, which underlies part of the park.

Tutunup wetlands

The Tutunup wetlands are located on an area of the Swan Coastal Plain where sandy, silty or clayey superficial formations overlie the Vasse Member of the Leederville Formation, which in turn overlies the Yarragadee Formation. There is a significant downward head gradient between the superficial formations and the Yarragadee Formation in this area (Figure 4.6). The proximity of the Bunbury Basalt may contribute to this large gradient. The downward head gradient will mitigate the vertical transmission of drawdowns from the Yarragadee Formation to the superficial formations and any wetlands in the area. This is discussed in more detail in the report on the Swan Coastal Plain section by URS Australia (2006a) at Appendix 4.

Vasse-Wonnerup wetlands

As outlined in the Sustainability Evaluation/ERMP (Volume 2 Chapter 5 Section 4.9.1), water levels in the Vasse-Wonnerup wetlands are not expected to be affected by the proposal because of their proximity to the ocean. The minimum wetland water levels would be controlled by the level in the ocean. The wetlands are situated on permeable sand and limestone sediments, with good hydraulic connection between the superficial aquifer and the coast. This has been confirmed by URS Australia (2006a) at Appendix 4.

Muddy Lakes

URS Australia (2006a) examined the hydrogeology of Muddy Lakes in detail and concluded that the lakes are situated over 10 to 15 m of superficial formation that directly overlie the Yarragadee Formation. There is a downward head gradient in this area, however, URS Australia (2006a) notes: "*The potential for upward propagation of drawdown from the Yarragadee (3) to the superficial aquifer may exist at Muddy Lakes and could manifest itself by additional (induced) downward leakage in the summer.*" However, URS Australia (2006a) also comments that the shallow depth to watertable in the locality indicates that the possibility of full winter recovery through the recovery of rejected recharge is likely.

A cross section of the coastal plain (Figure 4.7) shows the elevation of the water level in Muddy Lakes as being substantially above sea level, which, in view of the proximity of the coast suggests that these wetlands are perched. This is consistent with logs of nearby wells showing low conductivity fine organic matter to a depth of 1 or 2 m underlain by more pervious sands (URS Australia 2006a).

Figure 4.6 Hydrogeological cross section: Vasse-Wonnerup to Tutunup wetlands

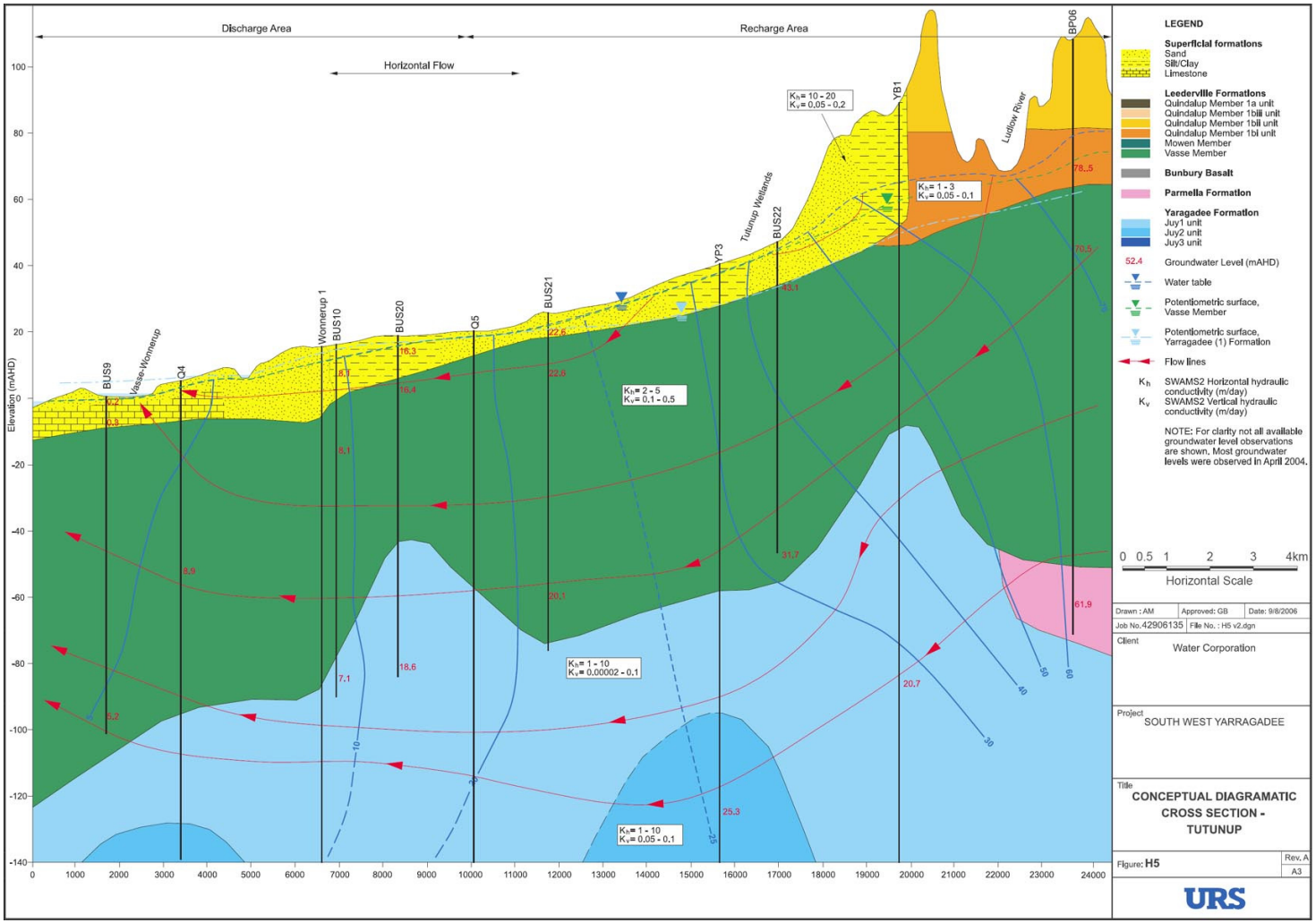
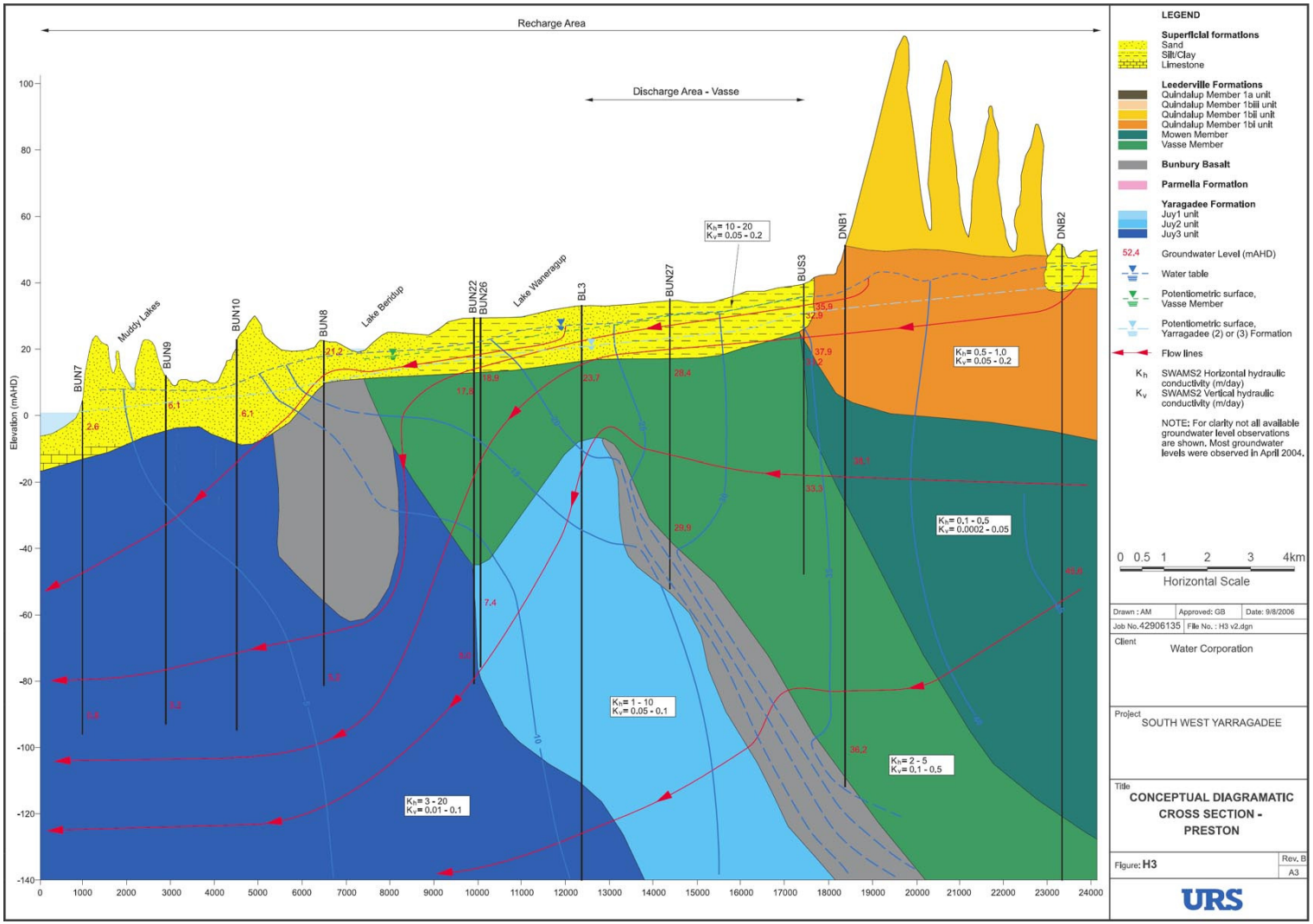


Figure 4.7 Hydrogeological cross-section through Muddy Lakes



Hardy Inlet

Hardy Inlet is discussed in Section 4.4.

4.6.6 Acid sulphate soils

Many of the submissions raised concerns with the potential for acid sulphate soils (ASS) present on the coastal plains to be disturbed[2] as a consequence of drawdowns in those areas.

The recent local scale modelling of the Scott Coastal Plain has demonstrated that drawdowns resulting from the proposal will only affect a relatively small area of the plain, and where impacts are expected, they will mostly be less than 0.1 m (Aquaterra 2006). It is acknowledged that regional declines in the watertable on the coastal plains may contribute to acid generation from acid sulphate soils existing in the area, however, the impacts of the Water Corporation abstraction on watertable levels will be restricted to the northernmost fringe of the eastern Scott coastal plain, where watertables appear to be subject to perching.

4.7 OTHER AREAS

4.7.1 Submission issues

Several submissions note the need to provide more information on:

- Margaret River pools
- caves
- Busselton International Bird Sanctuary
- Capel River

4.7.2 Response to submission issues

Each of these areas is addressed in detail in the following sections.

4.7.3 Margaret River pools

The potential for impact on the Margaret River pools was raised as an area of concern requiring further investigation.

The Margaret River pools were addressed in Volume 2 Chapter 5 Section 4.10 of the Sustainability Evaluation/ERMP. URS Australia Ltd was commissioned by the Water Corporation to assess connectivity of the pools with the regional groundwater system. The four pools in an area known as Canebreak are located within a proposed conservation park at the confluence of two tributaries in an area known as The Rapids.

[2] For acid sulphate soils, disturbance incudes any activity that may expose the material to oxygen, and does not only mean physical disturbance of the soil.

In examination of the pools, URS Australia (2005) noted that that the only visible surface flow into or out of any of the pools was at the top of the most downstream pool in the sequence. The electrical conductivity of the water was similar in all pools and chemical analysis of samples gave almost identical results, indicating that they are probably sustained by groundwater inflow from the upper part of the Leederville Formation. The pool level elevations conform to regional groundwater levels in the upper Leederville Formation suggesting that if watertable levels fall in this area, so too will pool levels. None of the modelled scenarios (interpreted or otherwise) show drawdowns being induced in the watertable in this location as a consequence of the proposal or of future regional use abstractions. Given that the proposal has been demonstrated as not having any effect on the pools, it was not considered necessary to evaluate this area further.

4.7.4 Caves

The impact on caves was raised in several submissions. The potential for impacts on water levels in the cave systems in the region were addressed in addressed in Volume 2 Chapter 5 Section 4.10 of the Sustainability Evaluation/ERMP. These caves of concern are understood to all be located in limestone areas overlying the granitic rocks of the Leeuwin–Naturaliste Ridge. They are hydraulically isolated from the Southern Perth Basin and the effects of groundwater abstraction in the basin. Groundwater abstraction from the Southern Perth Basin will not affect these caves.

4.7.5 Busselton International Bird Sanctuary

Concern was raised in one submission, relating to potential impacts on the Busselton International Bird Sanctuary. It was not possible to find information on the existence of this specific sanctuary, so it has been assumed that it refers to the Vasse–Wonnerup Wetlands as a Ramsar listed wetland. Impacts on this feature have been addressed in Section 4.6 of this report.

4.7.6 Capel River

Concern over the potential impacts of the proposal on the Capel River was raised in one submission. The river is perennial with groundwater dependence in the summer period. The watertable drawdowns expected on the Swan Coastal Plain as a result of the proposal are limited to several specific areas, remote from the river (Figure 7.41 Volume 2 Chapter 7 of the Sustainability/ERMP). At the closest point to the river (2 km away), the drawdown impact of the Water Corporation proposal will not exceed 0.1 m and there will consequently be no effect on the flows in the Capel River.

4.8 UNCERTAINTY

4.8.1 Submission issues

A substantial number of submissions raised a range of issues associated with uncertainty in relation to impacts of the proposal. The submissions questioned all aspects of the hydrogeological investigations and modelling including recharge, downward leakage, age of water, water balance inconsistencies, sensitivity, etc. Many submissions stated that the risk was too high and that there was insufficient or inaccurate information to allow the project to proceed. The summarised issues of concern were:

1. Recharge estimates are inconsistent and modelling analysis is inadequate.
2. Abstraction will exceed recharge.

3. Baseline monitoring and scientific knowledge of the hydrology/hydrogeology and ecology is inadequate for an understanding of the potentially affected systems and consequent assessment of the proposal.
4. There is insufficient information on the ecological effects of the predicted drawdowns. This uncertainty and the potential for irreversible impacts means that the *Precautionary Principle* should be applied and the project should not be approved.
5. All investigations were focussed on the original location of the wellfield. No research has been carried out on the proposed Jarrahwood location.
6. Application of a cautious approach to decision making on the basis of the *Precautionary Principle*.

Full scientific certainty is impossible to achieve for a major groundwater development such as the South West Yarragadee Water Supply Development. This was clearly recognised and the overall approach to uncertainty adopted in developing the proposal was based on:

- developing an understanding of the critical risk areas
- taking a conservative approach in areas of critical risk
- peer review of the critical studies undertaken to underpin the proposal
- developing a response system based on adaptive management with triggers and prescribed auditable actions which meet predefined management objectives
- adoption of best practice methodologies.

4.8.2 Response to submission issues

Each of the above concerns is addressed in detail in the following sections.

4.8.3 Recharge estimates and modelling analysis

Several submissions commented on apparent inconsistencies in the recharge estimates quoted in the Sustainability Evaluation/ERMP and suggested that aspects of the modelling analysis were inadequate.

Recharge estimates

Groundwater recharge is difficult to estimate accurately, even in the most intensively researched groundwater systems. Recharge estimates, therefore, can always provide a significant point of contention in assessing the water availability from groundwater sources. Recognising the uncertainties, a range of methods was used to provide indications of recharge as inputs to the modelling process. These are described in detail in Volume 2 Chapter 5 Section 1.3 of the Sustainability Evaluation/ERMP. Four methods were used to provide estimates of recharge for use in preliminary calibration of the SWAMS V2.0 model. Through the process of calibrating the model, a re-estimation of recharge was made that is considered to most accurately represent this component of the water balance.

Table 4.2 presents the range of recharge estimates derived from the various methodologies as presented in the Sustainability Evaluation/ERMP. It should be noted that these values represent the total net recharge to the Southern Perth Basin, not just the Yarragadee Formation (under current use conditions). Of the 374 GL/yr recharge estimated by the SWAMS V2.0 modelling, 151 GL/yr is estimated to recharge the Yarragadee Formation. Recharge will increase as more water is taken from the aquifers.

Table 4.2 Annual net recharge estimations

Model	WEC–C	WAVES	Water balance	Chloride balance	SWAMS V2.0
Net recharge (GL/yr):	330	360	341	302 – 342	374

The values shown in Table 4.2 are sufficiently close to give a high degree of confidence that the SWAMS V2.0 modelling adequately represents recharge at the regional scale. The SWAMS V2.0 modelling results imply that net recharge is about 6.5% of annual rainfall. This has been commented on by the Chairman of the Peer Review Panel, when addressing the Sustainability Panel in early 2006, as being considerably lower than expected in an area with such high rainfall and low evaporation. The low salinity of groundwater at depth in the Yarragadee Formation (<300 mg/L at 1700 m) is an indicator of very high rates of recharge, implying that 6.5% is likely to be an underestimate. Suggestions by submitters that this is an over–estimate are not founded on any factual considerations, or data. Experience in areas of similar climate and geology suggest that recharge could be approximately 10 to 20% of rainfall.

The recharge value determined by modelling has been an outcome of the model calibration process, and is not a value selected because it was higher than the other estimates, as suggested in some submissions. The SWAMS V2.0 model takes consideration of a fuller range of factors than the specific individual recharge studies used to provide the initial estimates of recharge used to initiate calibration of the model.

Modelling analysis

There were a range of comments made regarding the veracity of the groundwater modelling and analysis relating to:

- scenarios used
- evaluating uncertainty in modelling
- prediction period modelled
- watertable surface adopted
- interpretation at the local scale.

Scenarios

CALM recommended that: "*Best practice suggests that multiple versions of the model should be produced utilising a range of recharge/conductivity ratios, allowing all model scenarios to be run using all versions of the model to look at the range in impacts. These impacts should then be presented as a bandwidth, given the size and potential impact or the project.*"

The extent to which this recommendation actually reflects best practice is questionable, particularly when considering how the results would contribute to decision–making. The Murray–Darling Basin Commission (MDBC) groundwater modelling guideline (MDBC 2001) suggests that: "*One way to reduce the uncertainty in model prediction is to analyse the results from performing a wide-ranging set of model simulation scenarios. While this will show likely ranges in aquifer response, it does not quantify the likelihood of each possible outcome. … … However, the process of analysing the results of prediction scenarios, presenting and discussing the findings with the clientele/community can often raise as many questions as are answered.*"

While there have been several versions of the model developed, (SWAMS V2.0) is considered to be most representative of the system. The other versions of SWAMS were developmental and running these versions would only provide extraneous information, with no real basis for its consideration as representing any likely outcome.

The approach taken in development and application of SWAMS V2.0 has been to develop a model that is believed to provide the closest representation of the conceptual hydrogeology possible with the available information. Uncertainty over future climate scenarios and other factors militates against spending excessive computational effort in evaluating a wide range of possible scenarios, particularly when the probabilities associated with several of the key factors cannot be estimated. However, to ensure that there can be some level of confidence in the modelling results to enable the information to be used in the decision–making process, a sensitivity analysis was undertaken as described by Sun (2005).

The Peer Review Panel (2005) commented that the investigative work and inputs to the conceptual model were of a high standard and that the SWAMS V2.0 model is suitable for evaluating wellfield layouts and for the development of local models.

Evaluating uncertainty in modelling

Sensitivity analysis is a key methodology for evaluating uncertainty in groundwater modelling and this was undertaken in accordance with the MDBC groundwater modelling guideline. The guideline recommends that: "*For high complexity numerical models, perform only a limited sensitivity analysis (not violating the calibration conditions) after calibration is completed, in order to indicate qualitatively the impact of key parameters in critical areas.*" The guideline also notes that: "*For a high complexity numerical model, a sensitivity analysis conducted by perturbation is extremely demanding computationally. A full sensitivity analysis is an unreasonable expectation when there are too many model parameters. Only a limited selective analysis is justified, perhaps for anticipated key parameters in critical areas only.*"

The sensitivity analysis combined with the validation through particle tracking and C^{14} data comparisons provided sufficient confidence in the results to adopt it for the evaluation, as a regional scale model. It may have been ideal to provide validation through reserving several years of observed head data from the calibration process. However, there was a tension between this and maximising the variations in head available to the calibration process to provide a higher level of confidence in the calibration. It was decided that, on balance, the longer calibration period would provide a more robust outcome and validation could be effected by alternative methods (particle tracking and C^{14} analysis).

Prediction period

The comment was made in the CALM submission that a model should only be used to predict into the future for the same length of time as the model calibration period, and use of the SWAMS V2.0 model for predictions of greater than 12 years into the future appears to be inconsistent with this requirement. This comment appears to be based on an interpretation of the MDBC groundwater modelling guideline which presents, "*a repeat of the historical record, or the development of a synthetic data set for prediction*" as examples of hydrological data sets that could be used in an initial set of prediction scenarios.

It is important to understand that "*a repeat of the historical record*" does not mean that the length of simulation runs should be limited to the length of the record. It means that the values of model stressors should reflect the historical record. This is intended to ensure that the simulation period is effectively subject to the same set of stressors as the historical period (with the same extent and overall frequency of variability), but does not allow for consideration of the effects of more extreme events than have been recorded. The modelling was based on recharge values calculated from average rainfalls from 1971 – 2003.

The alternative approach of generating a synthetic data set for prediction provides the means of including extreme events that may not have actually occurred during the historical record, based on the probability of such events occurring. This approach is usually applied to generating stressors for very long simulation runs, often many orders of magnitude longer than the calibration period. The intention of this stochastic modelling is usually to provide information on the likelihood of various outcomes occurring, rather than to predict specific outcomes. Such modelling requires a very good understanding of the probabilities of the various stressors occurring, and requires extensive computational capability when applied to groundwater systems. The technique is used more commonly in surface water modelling, in which the models generally require less computational resources than large complex groundwater models such as SWAMS V2.0.

Watertable surface

Comment has been made that the watertable surface used in the modelling has been generated from "*very small amounts of data*", and this has also been used to mask or interpret areas of impact and consequently introduces a high level of uncertainty.

The basis of this comment is unclear, as the watertable surface has been generated from an analysis of measured water levels at over 2000 locations throughout the model domain. The ground surface was developed from Department of Land Administration information to construct a high resolution topographic surface with a spatial resolution of 20 metres, and an elevation resolution of approximately ±2 m. Where available, survey data was used to quality check and the surface representation was amended accordingly.

The impact of any errors in watertable surface estimation on drawdown results are insignificant as the modelling results are based on considering differences in watertable level rather than absolute values. The accuracy of the surfaces is considered adequate for masking purposes in interpretation of the regional scale modelling.

Interpretation at the local scale

It was recognised by the Water Corporation (and acknowledged by the Peer Review Panel [2005]) that that the regional scale model would not be sufficient for consideration of ecological impacts at the local scale. The model was reinterpreted at the local scale in terms of expected impacts in key areas of potential impact and the results presented in the Sustainability Evaluation/ERMP. Subsequently, local scale models have been developed for the Eastern Scott Coastal Plain (Aquaterra 2006) , together with detailed cross-sections for Rosa Brook, St John Brook and the Swan Coastal Plain (Appendix 4) to confirm these interpretations (Section 3).

Modelling accuracy

Concerns were raised over the Sustainability Evaluation/ERMP conclusions that the modelled small drawdowns will be acceptable when the modelling accuracy is greater than those drawdowns. These comments appear to be based on interpretation of the reported calibration errors (Sun 2005) such as the absolute average error in the superficial and Yarragadee formations being 2.6 and 1.7 m, which is approaching the resolution of the model in terms of absolute elevation accuracy. These levels of accuracy are as high as can be expected for a regional model of the scale and complexity of SWAMS V2.0.

To address accuracy issues in considering areas where small drawdowns are important to be evaluated, the model was not used to predict absolute watertable levels. The drawdowns were derived from subtracting drawdown responses between various scenarios to establish differences in drawdown. This is a commonly used technique and effectively cancels any major errors in watertable predictions generated through the modelling. Other errors are still incurred, as the regional scale model is not capable of representing local scale variations in the suite of hydraulic parameters representing the aquifer systems, and the stressors on the aquifers. However, this is recognised and interpretation of the raw modelling output has been directed at accounting for these issues. The development of the local scale modelling (Section 3) and further conceptual evaluation has addressed these issues in a more systematic way, and has confirmed the drawdown interpretations in the key areas of interest.

4.8.4 Abstraction levels and recharge

Comments have been made in several submissions that future abstractions would exceed recharge. These conclusions appear to have been drawn by comparing the projected total groundwater abstraction in the region of 220 GL/yr (from all aquifer formations) with the current recharge to the Yarragadee Formation alone (151 GL/yr). This is an inappropriate comparison.

The recharge to all aquifer formations currently totals about 374 GL/yr and future groundwater abstraction can be more appropriately compared with this value. In addition, the modelling indicates that through recovery of rejected recharge and other changes to the dynamics of the water balance induced by abstractions, recharge to all aquifers formations would increase to over 400 GL/yr under an abstraction of 220 GL/yr, and recharge to the Yarragadee Formation would increase to about 202 GL/yr (Baddock 2005 – Sustainability Evaluation/ERMP Appendix 13). It is clear from this that future abstractions will not exceed recharge.

4.8.5 Adequacy of baseline monitoring

Comments were made that baseline monitoring and scientific knowledge of the hydrology/hydrogeology and ecology is inadequate for an understanding of the potentially affected systems and consequent assessment of the proposal.

The Southern Perth Basin is not a "greenfields" area in terms of groundwater abstraction. The resource has a history of groundwater abstraction that goes back over 100 years. Current estimated abstraction is more than 70 GL/yr, of which about 36 GL/yr is from the Yarragadee Formation. These abstractions and their hydrological/hydrogeological impacts have been monitored at increasing intensity over several decades, and progressive investigations since the 1960s have substantially added to the monitoring network and available data. The existing abstractions are predominantly located on the coastal plains, and there has been little groundwater abstraction from locations on the Blackwood Plateau. However, deep drilling investigations on the plateau by the Geological Survey of Western Australia have provided good baseline data on groundwater behaviour in this area, and some drawdown effects from coastal plain abstractions have been observed in the deeper aquifers.

The groundwater monitoring data has provided a good baseline for development and calibration of a model of the system, and more recent detailed local investigations in potential areas of impact have provided further data at the local scale on which to base local models.

Ecological monitoring systems, particularly vegetation transects, have been established as part of the project investigations and monitored. There has also been a range of aquatic fauna surveys carried out and reported on in key areas during recent years, and more recently to support this response to submissions, that provide valuable baseline information. Assuming commencement of pumping occurs on schedule in 2009, there will be several more years of biological data available by the time the project is commissioned.

Monitoring data currently being gathered will prove invaluable in increasing understanding of the hydrology/hydrogeology and ecology and in evaluating future impacts under such conditions.

4.8.6 Proposed Jarrahwood wellfield

Several submissions commented that all the investigations were focussed on the original location of the wellfield and that no research has been carried out on the proposed Jarrahwood location.

This is incorrect as the recent investigations were targeted at filling in the gaps in knowledge of the hydrogeology over the entire Southern Perth Basin, and in particular the area covering the Blackwood Plateau. Two investigation wells were constructed in the area of the proposed Jarrahwood wellfield, which together with existing deep aquifer investigations wells provide substantial information for consideration of this area.

The density of investigation wells in the Jarrahwood area is lower than in some other areas of the Blackwood Plateau such as near the Blackwood River and its tributaries, as the key issue is the ability to model and monitor the impacts on these key risk areas. The hydraulic characteristics of the Yarragadee Formation, while spatially variable, relate largely to the geometry of the formation. This can be determined from a relatively fewer number of investigation wells than have been drilled during the investigation program. The density of wells in the area of the proposed wellfield is adequate to account for the variations in hydraulic characteristics in this area.

The modelling considered the range of alternative wellfield locations and configurations at an equal level of detail, including the proposed Jarrahwood wellfield.

4.8.7 Uncertainty and potential for irreversible impacts

A number of submissions expressed concern that there is insufficient information on the ecological effects of the predicted drawdowns. The submissions proposed that this uncertainty and the potential for irreversible impacts means that the *Precautionary Principle* should be applied and the project should not be approved. There is also a level of uncertainty on effectiveness of mitigation and contingency actions.

Sufficiency of information

Substantial scientific information has been obtained, analysed and presented in evaluating the proposal. This work included:

- extensive hydrogeological investigations and monitoring programs
- extensive hydrological monitoring programs
- development of conceptual and numeric models of the groundwater systems
- biological surveys, studies and monitoring surveys
- social impacts studies
- economic value and impact studies.

It is clearly acknowledged that complete scientific certainty is not available. It should also be recognised that full and complete information would never be available for a major groundwater development. There will always be some level of uncertainty, not least because of the uncertainty associated with future climate. In order to address this, the project is underpinned by the proposed adaptive management approach described in Volume 1 Chapter 8 Section 1.1.4 of the Sustainability Evaluation/ERMP, and set out in terms of a practical program in the revised Groundwater Abstraction Management Plan (Appendix 1). The approach is comprehensive and recognises the need for ongoing monitoring and progressively incorporating learning.

There has been some criticism of adaptive management as providing an inadequate means of addressing the potential risks to the high values within the region. The criticism is based on comments that the current level of knowledge is not delivering certainty that there will be no unacceptable impacts and is insufficient to facilitate adaptive management. The adaptive management approach is specifically aimed at dealing with some level of uncertainty. As the project proceeds and more monitoring information becomes available, the level of understanding will increase and the level of uncertainty diminish. The key issue is the development and implementation of responses to untoward or unexpected hydrological or biological impacts.

Precautionary Principle

Several submissions proposed that because of the level of uncertainty, the proposal should not be approved in accordance with the *Precautionary Principle*.

Volume 1 Chapter 8 Section 1 of the Sustainability Evaluation/ERMP deals specifically with the *Precautionary Principle* in acknowledging uncertainty while proposing that the adaptive management approach together with application of contingency actions where unforeseen events occur will preserve the key elements of the principle. The *Precautionary Principle* was one of the sustainability principles adopted for the project, for which objectives were developed and the Sustainability Evaluation/ERMP describes the expected achievement of those objectives.

It is worth commenting that many of the submissions appear to misrepresent the essential nature of the *Precautionary Principle* as being a "cautionary principle" and proposing that as there is uncertainty, the cautious approach should be applied and the proposal not approved. The emphasis of the *Precautionary Principle* as included in the *Environmental Protection Act 1986* focuses on lack of full scientific certainty not being used as a reason for postponing measures to prevent environmental degradation. The following key aspects of the principle have been applied to the proposal:

- measures to prevent environmental degradation will not be postponed, rather they will be applied pre-emptively (see revised Groundwater Abstraction Management Plan [Appendix 1])
- avoidance of serious or irreversible damage
- risk assessment.

Effectiveness of mitigation and contingency actions

Several submissions expressed concerns on the potential effectiveness of proposed mitigation and contingency actions. This issue has been addressed in Sections 4.9 and 4.14 of this report.

4.9 MITIGATION AND OFFSETS

4.9.1 Submission issues

Several concerns were raised regarding the mitigation and offsets package proposed in the Sustainability Evaluation/ERMP. The key aspects of concern were:

- mitigation plans for the social, economic and environmental impacts have not been developed
- mitigation has been poorly addressed in the Sustainability Evaluation/ERMP and the options proposed are inappropriate or unfeasible
- the proposed commitment to management of threatening processes.

4.9.2 Response to submission issues

The key elements of the mitigation and offsets package proposed in the Sustainability Evaluation/ERMP are summarised in the following sections, together with responses to the relevant submissions. The initiatives proposed as mitigations and offsets are considered to be demonstrably appropriate, and the feasibility of the more technical contingency proposals is dealt with in Section 4.14.

4.9.3 South West Sustainability Initiative

The South West Yarragadee Sustainability Initiative will be an element of the proposed adaptive management framework and involves commitment to a range of actions to obtain information to refine the existing models of the groundwater system and associated dependent ecosystems, and to achieve net benefit outcomes. The Sustainability Initiative is largely a research offset that will enhance the understanding of the ecosystems in the South West and their relationship to water. The initiative will be funded through a capital investment of $2 million with the capital and any earned interest made available to the initiative over a period of ten years.

Activities undertaken under the initiative would include:

1. A major biodiversity study of groundwater dependent ecosystems in the potentially affected areas that may include:
    - the occurrence, condition, spatial extent and groundwater dependence of floristic and vegetation communities at a local and regional scale
    - the occurrence, severity and spatial extent of forest disease
    - the occurrence and spatial extent of significant aquatic fauna
    - investigating the genetic diversity of significant aquatic fauna that use the tributaries as refugia
    - the identification and spatial extent of terrestrial fauna habitat
    - the occurrence and abundance of terrestrial vertebrate fauna, including specifically, threatened fauna as defined in the *Wildlife Conservation Act 1950* and the *Environmental Protection and Biodiversity Conservation Act 1999*, Priority fauna as defined and listed by DEC.
2. Supporting investigations into the potential for acidification from acid sulphate soils, and potential means of management.
3. Sponsoring an investigation into the magnitude and potential means of managing irrigation return water and the effects of changing land use on water demand, availability and quality.

The biodiversity study will be steered by a technical committee of:

- two independent scientific experts
- two representatives of the Water Corporation
- two representatives from DEC
- one representative from DoW.

Annual progress reports on the study will be prepared by the Water Corporation as part of the annual Sustainability Report and will be made publicly available.

Several submissions commented that adequate mitigation plans for the social, economic and environmental impacts have not been developed. This initiative addresses environmental, social and economic aspects. The biodiversity study will be fundamental to directly improving environmental management in the region, as will the proposed acid sulphate soils investigations. The acid sulphate soils, irrigation return water, and land use impact investigations will provide direct economic and consequent social benefits to the region.

The work will have a potential positive flow-on effect to Nannup Shire from potential changes to land use on Scott Coastal Plain, being the only area identified in the Sustainability Evaluation/ERMP as having potential for some negative socio-economic impact (Volume 2 Chapter 3 Section 3.2.1 Table 3.5).

Several submissions indicated that more detail was required on the scope of the studies proposed under the initiative. The scope of the studies would require substantial negotiation with the stakeholders and this negotiation would be undertaken once approval to implement the proposal is granted. This would ensure that adequate consideration is given to the scoping by all relevant stakeholders, and that it meets contemporary needs and priorities.

4.9.4 South West Public Water Supply Future Planning Study

A South West Public Water Supply Future Planning study is proposed as the means of establishing a plan and development program to meet future public water supply needs in the South West. This plan (similar to that prepared previously for the IWSS) would:

- consider all the public water supply demands in the broad region
- involve all interested and potentially affected stakeholders in a highly consultative process
- address the following:
    - future public water supply demand
    - potential sources for public water supply
    - source development program for public supply
    - assessment of quality and security of existing public water supplies
    - program for upgrading existing quality and security of public water supplies where required
    - program for new connections to the extended IWSS or other sources.

This study will be conducted jointly with the Busselton Water Board and Aqwest and will involve extensive stakeholder engagement. The study will achieve the desired outcomes of clear expectations for water supply, assessment of alternative options, costing and feasibility and an implementation timeframe. The plan would provide certainty to the South West, and would help to resolve the concerns of futures foregone, benefit and equity, and accommodating reasonable regional needs. This study is considered an important strategic offset that will provide positive social and economic benefits to the region.

4.9.5 Construction clearing offsets

Some clearing will be required for the construction of the proposal alongside existing roads and other areas. All unavoidable clearing required within State Forest will be offset through a contribution of land to the conservation estate. This will be done either through the establishment of a conservation covenant on private land or through supporting the transfer of freehold land. The clearing in State Forest will be offset with a loss/gain ratio of 1:1.5 of land with an equivalent or higher conservation value. The specifics of this were under negotiation with DEC at the time or preparation of this report.

The CALM submission noted that Volume 1 Chapter 8 Table 8.2 of the Sustainability Evaluation/ERMP stated that land offsets would be provided for impacts on Poison Gully. This statement is an error in the Sustainability Evaluation/ERMP document. Land offsets are only proposed for the clearing footprint. This statement was not included in the Sustainability Evaluation/ERMP commitments.

4.9.6 Management of threatening processes

In the Sustainability Evaluation/ERMP, the Water Corporation proposed to sponsor a program to manage threatening processes in the areas that may be affected by the proposal. The funding was proposed as being up to $1 million with the capital and any earned interest made available to the studies over a period of five years. The funding was proposed to support a five year management program to address weeds, disease, feral animals, erosion and uncontrolled public access issues that exist within the potentially affected areas. The intention of this management would be expected to significantly improve the health or condition of ecosystems in the potentially affected areas on the Blackwood Plateau and the Swan and Scott coastal plains.

Submissions commented that the proposed offset of management of threatening processes should be longer than five years and that more information should be provided on what is proposed. The program has subsequently been discussed with DEC officers and agreement on the details is developing, with control of feral pigs being acknowledged as a high priority for management, in accordance with the findings of the State of the Environment Report. The management of feral pigs is labour intensive and funding for a baiting program would be expected to provide substantial conservation benefits for the Blackwood Plateau area. The commitment to this program has consequently been modified to reflect the current extent of agreement with DEC on this aspect (see Section 8.4).

4.9.7 Other mitigation actions

Other mitigation actions outlined in the Sustainability Evaluation/ERMP include:

- wellfield relocation to minimise impacts
- wellfield to abstract water from several zones of the Yarragadee Formation
- water made available for future regional use.

4.10 CUMULATIVE IMPACTS

4.10.1 Submission issues

Several submissions commented that cumulative impacts have not been adequately taken into account in the Sustainability Evaluation/ERMP. The submissions remarked that proposal drawdowns should be considered together with the effects of regional abstraction, climate change, tree farms and changing land use.

4.10.2 Response to submission issues

The proposal has considered the cumulative drawdowns expected to result from the Water Corporation proposal together with the drawdowns from regional groundwater abstraction over the next 30 years. The primary reason for considering future regional abstraction is to satisfy the *State Water Strategy* (Government of Western Australia 2003b) requirement to ensure that, "… *all reasonable regional needs including social, recreational and projected future development will be satisfied before transfers can take place*". The *Rights in Water and Irrigation Act 1914* also requires that in considering the licence application of the proposal, regard should be given to where the proposed taking and use of water may prejudice other current and future needs for water. The drawdowns resulting from these abstractions is understood to be the key consideration in decision–making on the Water Corporation proposal.

The cumulative effects of climate change were included through adoption of recharge rates based on a 9% drier climate regime than has been observed historically and this was applied to all modelling scenarios. The expected drawdowns from further drying of climate (further progressive reductions in recharge rates of 5% and 10%) were presented separately to show the areas that might be affected by this particular stressor, and the specific extent of those effects. These results can be added to any of the other drawdown scenarios modelled to determine the cumulative impact under the range of possible scenarios. The information was presented in this form to limit the presentation to a reasonable number of scenarios (seven compared to fifteen if the results of the two climate change scenarios were added to each of the other scenarios for presentation purposes). The further reductions in recharge are considered less likely outcomes than the base modelling case of a 9% drier climate.

The effects of tree farms and changing land use were not modelled as the possible range of futures for these stressors is highly speculative and variable, both in spatial extent, form and intensity, timing and location.

4.11 CLIMATE CHANGE

4.11.1 Submission issues

A substantial number of submissions raised concerns about the impacts of climate change, suggesting that the issue had not been adequately dealt with in the Sustainability Evaluation/ERMP. The key aspects of concern to submitters were:

- need to consider declines in rainfall up to 20%
- acceptability of impacts added to climate change stress
- effects of reduced rainfall on groundwater recharge
- poor understanding of climate change.

4.11.2 Response to submission issues

Each of the above concerns is addressed in detail in the following sections. It should be noted that the discussion of predicted groundwater level changes through out this report has been focussed on the modelling results based on a 9% reduction in historical rainfall as a consequence of climate change, being considered the more likely scenario, and to keep the presentation simple. The discussions have not included further climate change responses as they are speculative at best, and the information on the additional drawdowns that may occur as a result of further drying of climate has been presented in the Sustainability Evaluation/ERMP. These additional drawdowns can be added to the results presented in this report if the reader wishes to consider the potential outcomes of drier scenarios.

4.11.3 Need to consider declines in rainfall up to 20%

The modelling work undertaken and presented in the study reflected several scenarios based on a drying climate in the south west of Western Australia.

The SWAMS V2.0 model was calibrated using rainfalls over the period 1990 to 2003 which were about 7% lower than the long–term average. The recharge used for scenario modelling was based on average rainfalls from 1971 to 2003 and reflects rainfalls 9% lower than the long–term average. This represents a drier climate that is approximately midway within the expected range of future climate change scenarios as modelled by CSIRO (2001)[3]. The implications of further climate change were addressed by presenting the watertable drawdown impacts expected from an additional progressive 5% and 10% reduction in recharge applied over the 30 year modelled period. The consequent drawdowns are considered to represent the results of a 14% and 19% reduction in average rainfall, if added to the other modelled drawdowns.

The extent to which groundwater recharge will respond to changes in rainfall is complex, and is expected to vary depending on a number of factors, of which the hydrogeology and biological transpiration responses are very important.

Net groundwater recharge can be expected to reduce in volume if rainfall over the region reduces, and this is clearly acknowledged in the Sustainability Evaluation/ERMP. The relationship between rainfall and recharge under climate change is discussed in depth in Volume 1 Chapter 7 Section 2.1.4 of the Sustainability Evaluation/ERMP. Presumptions by submitters, that groundwater recharge will diminish at a rate disproportionately greater than the rate of rainfall reduction are unfounded. Surface flows have declined disproportionately to the recent reductions in rainfall in the south west of Western Australia, however, examination of water balance data presented in the Bari *et al*. (2004) and Berti *et al.* (2004) studies showed that the disproportionately reduced surface flows in the Stirling Dam catchment have been partly offset by increases in percentage groundwater recharge rates. Given that a drier climate is likely to cause a biological response with vegetation shifting to a species with lower transpiration rates, there is no basis for assuming that evapotranspiration would increase to the extent implied by submitters, even under high air temperatures and correspondingly higher evaporation rates. As outlined in the Sustainability Evaluation/ERMP (Volume 2 Chapter 5 Section 2.6), Tick Flat on the Gnangara Mound is an example of vegetation, with predominantly wetland characteristics, gradually changing to vegetation characteristic of upland areas, and with lower dependencies on groundwater, since the 1970s. The only influence on vegetation type in this area that could have caused this change is the drier climate experienced in the region over recent decades.

[3] The CSIRO forecasts for climate change are relative to the longer–term historic rainfall.

In considering the potential impacts of a drier climate on groundwater recharge, the local hydrogeology would be an important factor. On the coastal plains, where the groundwater systems are essentially "full", a relatively large proportion of rainfall runs off as rejected recharge. It would be expected that reductions in rainfall in these areas would only result in a reduction in the volume of rejected recharge (manifesting as a reduction in streamflow). That is, net recharge volumes on the coastal plains would remain unchanged, unless the rainfall reduction was of a similar magnitude to the amount of rejected recharge. This would require a reduction in rainfall of about 300 mm/yr (33%) on the Swan Coastal Plain and 240 mm/yr (about 20%) on the Scott Coastal Plain before absolute recharge rates were affected.

On the Blackwood Plateau, the area of outcropping Yarragadee Formation would be expected to experience an immediate reduction in recharge in response to reduced rainfalls. In the short–term, the proportionate reduction in recharge may exceed the reduction in rainfall, at least until the biological response has an effect in reducing transpiration. However, recharge through the outcropping Yarragadee Formation is a relatively small component of recharge over the Southern Perth Basin (about 12% of total recharge).

The remaining area of the Blackwood Plateau is overlain by the Leederville Formation, with extensive areas of Mowen Formation, in which there are predominantly downward head gradients between the surface and the Yarragadee Formation of up to 100 m or more. It could be expected that changes in recharge rates into the upper Leederville Formation would respond in similar fashion to the outcropping Yarragadee Formation, with an immediate disproportionate reduction in recharge. This would result in lowered water levels in the upper Leederville Formation, potentially of the order of several metres. However, the changes to the downward head gradients (particularly in the areas with high gradients) would be relatively smaller, and the consequential changes in recharge rates to the Yarragadee Formation would occur at much slower rates.

The Sustainability Evaluation/ERMP discusses the expected long–term impacts of a drier climate on groundwater recharge at length, taking the lagging biological responses into account. This suggested that over time, the resulting percentage reductions in groundwater recharge would closely match any percentage reductions in rainfall and given the above assessment, is considered to be a conservative assumption.

Therefore, it is a reasonable assumption that the recharge values adopted in the climate change scenarios, of 5% and 10% progressive reductions in recharge, correspond with rainfall rates approximately 5% and 10% lower than those used in the primary modelling scenarios. If these climate change results are added to the primary scenarios as is suggested in the Sustainability Evaluation/ERMP, these would represent recharge rates of approximately 15% and 19% lower than the historical average. CSIRO studies suggest that a 20% reduction is the most extreme outcome of the various modelling studies undertaken for the South West. Given the approximate nature of both regional climate and regional groundwater modelling, it is felt that the scenario with a further 10% reduction in recharge represents a strong indication of the extent of drawdown that might be expected as the most extreme outcome (20% reduction in rainfall).

The rainfall in the first half of 2006 has been the lowest on record for much of the south west region. Rainfalls have been 50% lower than the mean based on the 1961 to 1990 average (BOM 2006). Therefore, recent conditions are extreme even in the context of climate change.

4.11.4 Acceptability of impacts added to climate change stress

The issue of acceptability of impacts that may be added to the impacts of climate change stressors is discussed in detail in Volume 1 Chapter 7 Section 2 of the Sustainability Evaluation/ERMP. The key issue is identified in this discussion is the uncertainty of the climate change prognosis, and the judgment of what may be an acceptable impact, given that the environmental systems are undergoing uncertain changes (impacts) in any event. Volume 1 Chapter 7 Section 2.1.6 of the Sustainability Evaluation/ERMP presents a suggested framework for such decision-making, specifically recognising that decisions need to be made under uncertain circumstances. The principles proposed within this framework are based on maintaining levels of ecological productivity and recognising important conservation values.

4.11.5 Effects of reduced rainfall on groundwater recharge

Several comments raised the issue of the need to consider the effects of reduced rainfalls on recharge. This issue is discussed above in this section (*Need to consider declines in rainfall up to 20%*).

4.11.6 Poor understanding of climate change

Several comments raised issues regarding the poor understanding of climate change, and the need to take a conservative approach under these circumstances. The comments relate to the more general issue of uncertainty as discussed in Section 4.8. The discussion under the heading *Need to consider declines in rainfall up to 20%* I n this section, relates directly to the specific issue of climate change uncertainty. The adaptive management approach outlined in the Sustainability Evaluation/ERMP (Volume 1 Chapter 8 Section 1.1.4) is set out in more specific detail in the revised Groundwater Abstraction Management Plan (Appendix 1).

4.12 SALTWATER INTRUSION

4.12.1 Submission issues

Numerous submissions raised concerns about saltwater intrusion as a result of the proposal. Other than general concerns over seawater intrusion, the key aspects of concern to submitters were:

- impacts on Aqwest and City of Bunbury water supply wells
- impacts on Busselton Water Board water supply wells
- impacts on domestic water wells
- impacts on coastal wetlands.

4.12.2 Response to submission issues

Each of the above concerns is addressed in detail in the following sections.

4.12.3 General concerns

Concerns raised in submissions related to acknowledgment in the Sustainability Evaluation/ERMP that there would be some level of seawater intrusion resulting from the proposal.

Seawater intrusion is a very common management issue in coastal aquifers all over the world. Good management to allow full utilisation of these groundwater resources requires appropriate location and construction of any wells near the coast.

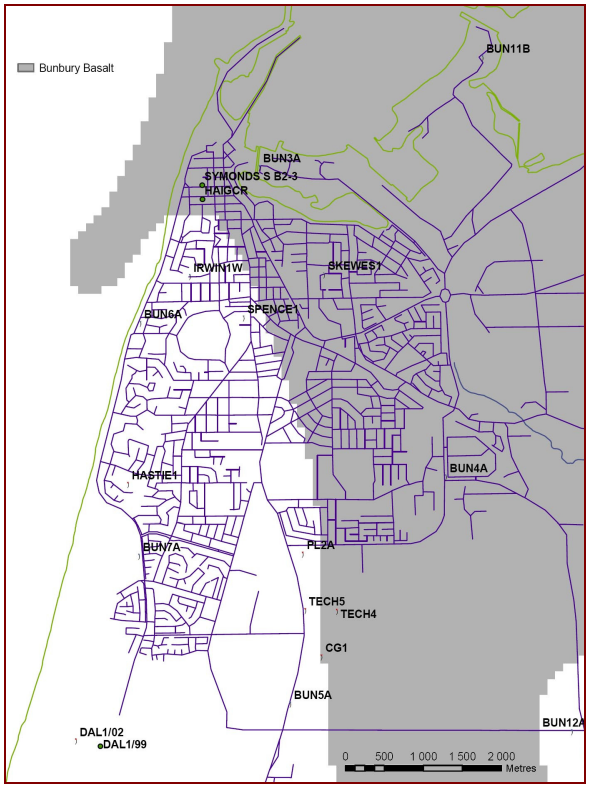
As outlined in the Sustainability Evaluation/ERMP, intrusion occurs very slowly, over many years, and progress can be readily monitored to allow planning of management responses. The Water Corporation has committed to undertake such monitoring.

4.12.4 Impacts on Aqwest and City of Bunbury water supply wells

Background

At Bunbury, where the Bunbury Basalt in not present, the Yarragadee aquifer is hydraulically connected to the ocean through overlying superficial sand and limestone, and contains an interface between the fresh groundwater and saltwater. At the top of the Yarragadee aquifer, the interface approximately corresponds with the saltwater wedge in the overlying superficial aquifer near the shoreline, and progressively becomes deeper within the aquifer inland from the coast. The inland limit of the saltwater wedge extends up to several kilometres from the coast, and is apparent between 495 and 550 m depth in PL2, situated 2.9 km from the coast (Figure 4.8). An investigation hole drilled by the Water Corporation at Dalyellup (DAL1/02), situated 6 km south of Bunbury CBD and 700 m from the coast, intersected the saltwater interface at around 400 m depth. A similar situation probably exists at Bunbury, but there are no deep monitoring holes in the area to verify this; existing monitoring wells close to the coast are less than 100 m deep, which is insufficient in most locations to reach the interface.

Figure 4.8 Bunbury area – extent of Bunbury Basalt



The Bunbury Basalt underlies the northern portion of Bunbury, providing a barrier between seawater at the surface and the Yarragadee aquifer, while the saltwater interface present below the basalt is connected to the ocean beyond the limit of basalt. The isolating properties of basalt are demonstrated in monitoring well BS3A where basalt prevents the downward intrusion of surface saltwater into the Yarragadee aquifer, which contains fresh groundwater extending to at least 100 m in depth. Saltwater in the Symonds St well, intersected from 24 m to a total depth of 52 m, is derived from seawater beyond the extent of overlying basalt.

In the Dalyellup well, a deeper zone of fresh groundwater was intersected below 540 m, and is separated from the overlying saltwater by a 4 m clay layer. It is likely that this deeper zone of fresh groundwater is a remnant from the last glacial age when sea levels were considerably lower and the coastline was over 50 km west of the current position. When sea levels rose about 6000 years ago, a saltwater wedge intruded into the Yarragadee aquifer, but the deeper section was protected in the Dalyellup area by the layer of shale. A similar occurrence of fresh groundwater below saltwater is present in PL2, where there is fresh water below 550 m depth beneath a shale bed. The shale beds separating fresh and saltwater intersected in PL2 and Dalyellup 1/02 may be part of the same layer. It is possible that the deeper zone of fresh groundwater extends some distance offshore, and may also occur at Bunbury below the shallower saltwater wedge(s).

The schematic cross-section shown in Figure 4.9 is a conceptualised representation of the saltwater interface as a series of wedges occurring within the Yarragadee aquifer in the Bunbury area.

Several production wells within the Yarragadee aquifer near the coastline at Bunbury have a history of fluctuating or increasing salinity over several decades, indicating these wells penetrate a mixing zone associated with the saltwater interface. Saltwater has intruded in the north of Bunbury townsite, where saltwater was observed in the Bunbury Water Board Haig Crescent well in 1976. This intrusion was the result of excessive pumping from a small section of the aquifer in close proximity to the saltwater interface.

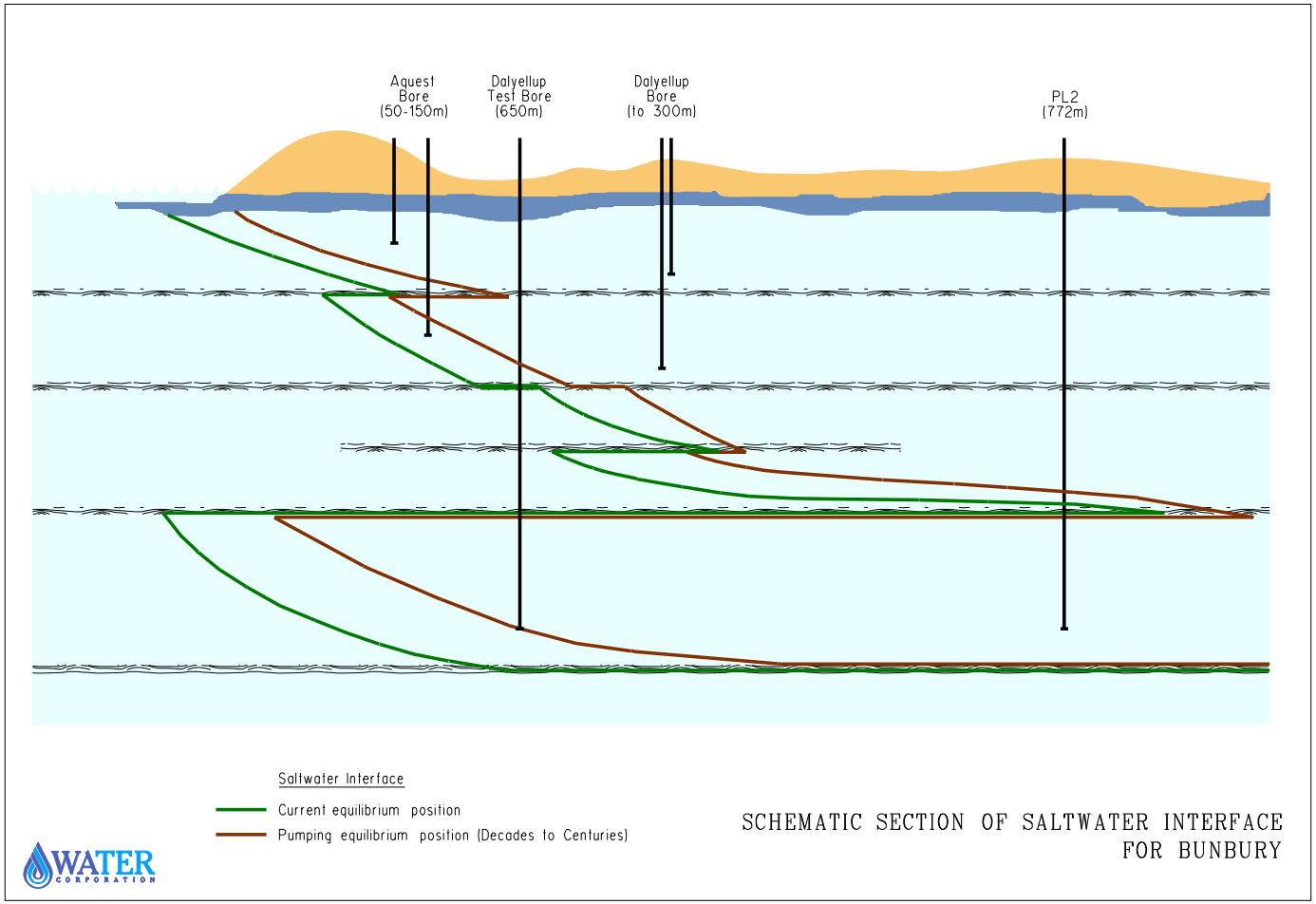
The slow rate at which saltwater intrudes is demonstrated by how production wells in close proximity to the coast at Bunbury have been able to pump large quantities of groundwater from the aquifer over decades without widespread saltwater intrusion. Those wells that have experienced saltwater intrusion were situated closest to the coast and were particularly vulnerable. The process will be very slow, occurring over decades to centuries, and can be readily monitored to allow planning of management responses.

Proposal impacts

Regional growth in groundwater use in the Bunbury area will have more significant effects on seawater intrusion than the Water Corporation proposal, as is currently being experienced with rising salinities in Aqwest wells. These impacts are the result of concentrations of local pumping within a shallow section of the Yarragadee Formation. This was recognised in the early 1980s when increases in salinity were observed in several Bunbury Water Board wells. Recommendations were made at that time, to the Bunbury Water Board and City of Bunbury, to modify the locations and screened sections of their wells to reduce these effects. These recommendations have been implemented to a limited extent.

The increasing salinity effects that are currently being observed are the direct result of local pumping and not from regional water abstraction as would occur with the South West Yarragadee proposal. The current saltwater encroachment appears to be occurring in a discrete zone of the aquifer, which is indicative of local influence - effects from more distant regional pumping would tend to spread over the full vertical section of the aquifer.

Figure 4.9 Conceptualised representation of the saltwater interface



The Water Corporation will monitor and observe the seawater interface in the Bunbury region, and in conjunction with the regulator; establish its movement over time. Given the very slow movement of the saltwater interface, this will allow time to plan any modifications that may be required to existing wells. The regional groundwater monitoring network will identify the propagation of impacts from the proposed Water Corporation wellfield and will be used to determine the extent to which Water Corporation pumping is responsible for any saltwater movements. More recently constructed Aqwest water supply wells are located away from the coastline and would not be at risk.

The Corporation will pay for any justifiable relocation of Aqwest assets providing the need could be associated with the operation of the South West Yarragadee Water Supply Development, as committed in the Sustainability Evaluation/ERMP.

Aqwest proposed that the Water Corporation wellfield should be located on the northern and southern coastlines so that "*it does not interfere with existing or future regional use and it intercepts discharge to the oceans*." This was also suggested in several individual submissions. The Water Corporation believes that the proposition is entirely contrary to good management of the resource and prevention of seawater intrusion affecting existing regional users. Locating Water Corporation abstraction in areas of current concentrations of abstraction, close to the coast, will have several significant negative effects on all users when compared with the proposed location:

- exacerbated lowering of pressures in the Yarragadee Formation in coastal areas, increasing the extent of seawater intrusion and risk to existing users as well as the Water Corporation
- increased interference drawdown with existing users
- increased drawdown of the coastal plain watertable and associated environmental impacts
- sub-optimal utilisation of the available water in the Southern Perth Basin.

4.12.5 Impacts on Busselton Water Board water supply wells

Busselton will not be affected because the salt water interface within the Yarragadee lies a considerable distance offshore and, in the Busselton area, the Yarragadee is overlain by the less transmissive Leederville aquifer – which provides a barrier between the Yarragadee and the ocean. The proposed monitoring program to measure pressure heads in the aquifers will provide an early warning system of potential seawater intrusion. Seawater intrusion will not extend inland beyond the coast unless aquifer pressures fall below sea level in these areas. The aquifer pressures in this area are several metres above sea level at the present time, consistent with the seawater interface lying well offshore.

4.12.6 Impacts on domestic water supply and other wells

The movement of the saltwater interface resulting from the proposal will occur very slowly and at depth. The only wells at risk are those in the deeper formations near the coast (in the Yarragadee Formation and in the Leederville Formation where present). No domestic wells are understood to fall into this category. Shallower watertable wells in the superficial formations would not be affected.

4.12.7 Impacts on coastal wetlands

No seawater intrusion will occur into any coastal wetlands, as any interface movement would be in aquifer formations at depths considerably lower than the base of any coastal wetlands. The coastal wetlands are all located in the superficial formations, which are not expected to experience any seawater intrusion effects.

4.13 MONITORING

4.13.1 Submission issues

Several concerns were raised on the monitoring regime proposed in the Sustainability Evaluation/ERMP. The key aspects of concern were:

- feasibility of the required monitoring intensity
- conflict of interest in the Water Corporation monitoring its own effects
- time delay of impacts
- monitoring not sufficiently defined and extensive monitoring required.

4.13.2 Response to submission issues

Each of the above concerns is addressed in detail in the following sections.

4.13.3 Feasibility

The proposed program of hydrological and biological monitoring is believed to be feasible (as set out in the revised Groundwater Abstraction Management Plan [Appendix 1]). It comprises a combination of existing hydrological monitoring carried out by the DoW as part of its ongoing water resources assessment and management role. Given that this role is expected to continue (and probably intensify), the associated monitoring is expected to continue accordingly.

The Water Corporation program complements the DoW program through substantial additional hydrological monitoring and a comprehensive biological monitoring program, both in the areas of expected impact, and in a series of control areas intended to provide information to allow differentiation of the various causes of change in the system that may occur. These causes would be:

- the proposal
- regional private and public water supply abstractions and diversions
- climatic variation
- climate change
- changes in land use affecting recharge.

The program is intensive and will be reviewed every three years in consultation with the proposed Monitoring Review Group and modifications proposed as necessary for approval by the DoW. It is expected that once the drawdown effects from the proposal are observed over a reasonable period, it would be possible to reduce the intensity of monitoring in those areas able to be demonstrated as not being affected by the proposal.

4.13.4 Conflict of interest in monitoring

The Water Corporation would not be averse to monitoring being reviewed by an independent party. The monitoring results for South West Yarragadee project will be made publicly available by the Water Corporation, and can be validated and/or audited by the DoW at any time. Because the Water Corporation and DoW monitoring programs will complement each other, discrepancies would be expected to become obvious, and could be readily checked.

It is understood that in many situations it is standard practice for large groundwater users to be required to monitor the impacts of their abstractions at their own expense and provide the results and interpretations of them to the agency for review, as a condition of their *Rights in Water and Irrigation Act 1914* licences. The Water Corporation has over 120 water allocation licences for which it undertakes monitoring.

4.13.5 Time delay of impacts

The Groundwater Abstraction Management Plan (Appendix 1) acknowledges that there will be a delay in impacts, in particular biological impacts, which may result from watertable drawdowns. The plan consequently incorporates an integrated approach to monitoring both hydrological and biological responses with a process for triggering responses if untoward changes are observed in either, with control sites to provide a basis for decision–making on the potential causes.

The monitoring program essentially has four tiers of monitoring:

1. Yarragadee pressure levels: The pumping will first change pressures in the Yarragadee aquifer. Monitoring in this layer will provide an early warning system for any changes in pressure that are different to that expected from the modelling results. Monitoring of other aquifers will also occur but the criteria bores (bores where rates of expected drawdown are defined as triggers for contingency measures) will be in the Yarragadee aquifer where pressure changes will be identified first.
2. Vertical propagation: The monitoring network includes wells into the various geological units that occur between the Yarragadee Formation and the surface. Monitoring these wells will show if and how any change in pressure in the Yarragadee is being propagated vertically.
3. Groundwater level: Monitoring of water levels in both the areas of interest and in control areas (areas not hydraulically connected to the Yarragadee aquifer) to enable any watertable impacts due to groundwater abstraction to be identified.
4. Surface: Vegetation, stream flow and aquatic fauna monitoring in both areas of interest and in control areas. This is to ensure that no unexplained changes occur in these systems.

In the Yarragadee Formation, close to the proposed wellfield and in the formation units that are screened by the production wells (Yarragadee units 1 and 3), groundwater pressure declines are expected to be immediate as the wellfield commences production, with responses at a distance being less in magnitude and more gradual. Drawdowns at key locations can be checked against the expected drawdowns, almost as soon as they occur and appropriate action taken if they differ materially. The revised Groundwater Abstraction Management Plan (Appendix 1) sets out the key monitoring wells and range of expected drawdowns, which will trigger a management response if exceeded.

Any biological response is expected to lag the hydrological response (watertable drawdown or reductions in surface water flows), and it is generally expected that the hydrological monitoring will provide the first indications of potential impact issues. However, the intensity of the biological monitoring will provide for early indications of an adverse biological response in the event that the dependency of the biological systems on the groundwater system has been under–estimated. The inclusion of a range of control sites in the monitoring program will provide information to allow differentiation on the causes of any observed adverse effects.

4.13.6 Detail of the monitoring program

It is recognised that the monitoring program needs to be comprehensive. Uncertainty associated with the proposal requires an adaptive management framework. Consequently, the monitoring program needs to be broad but also with an early-warning capacity.

CALM indicated that water quality should be measured at more than just gauging stations as these tend to be atypical sites. It is recognised that gauging stations are often atypical habitat but there is no reason that pH, conductivity, nutrients and colour would be different in gauging stations compared to upstream sites. The only parameter that may differ would be water temperature (given the position of upstream pools of some gauging stations). Water flowing over gauging stations is typically mixed by turbulent flows, and as such, reflects the ambient water quality of in-stream reaches.

CALM also commented that water quality parameters should include conductivity, pH, nutrients, temperature and colour. The first four parameters are proposed to be monitored and the Groundwater Abstraction Management Plan (Appendix 1) has been amended to include temperature. Colour has not been included as this is not considered as critical as the other parameters monitored (Davies et al. 2004).

Information regarding monitoring added to the revised Groundwater Abstraction Management Plan (Appendix 1) as a result of the submissions and other consultation includes:

- additional key monitoring sites
- defined rates of drawdown in key Yarragadee bores that will be used as triggers for contingencies
- additional information on the frequency of monitoring
- a map of each area of potential impact showing the biological, hydrological and physical monitoring sites in that area
- updated trigger for flow supplementation in Milyeannup Brook.

4.14 CONTINGENCY ACTIONS

4.14.1 Submission issues

Several concerns were raised regarding the contingency actions proposed in the Sustainability Evaluation/ERMP. The key aspects of concern were:

- feasibility and appropriateness of the proposed contingency actions
- vagueness of the contingencies and responsibilities.

4.14.2 Response to submission issues

Each of the above concerns is addressed in detail in the following sections.

4.14.3 Feasibility and appropriateness of proposed contingency actions

The proposed contingency actions are set out in the Groundwater Management Abstraction Plan within the Sustainability Evaluation/ERMP (revised version in Appendix 1). They comprise a hierarchical set of measures, ordered by response to impacts of increasing severity as follows:

1. Site specific contingencies to supplement flows in the Blackwood River, St John Brook and Milyeannup Brook if unacceptable flow reductions are recorded in any of these systems.
2. Adjustment of the abstraction regime by altering the proportion of water abstracted from the different units of the Yarragadee Formation. If major adjustment of abstraction is required, additional wells will be drilled at identified contingency well sites.
3. Contingencies developed in consultation with the Monitoring Review Group and the regulatory agencies in response to environmental monitoring suggesting unacceptable impacts may occur.
4. Temporary reduction in abstraction rates while further investigations into potentially unacceptable and unexpected occurrence are undertaken.
5. Permanent reduction in abstraction rates where determined appropriate by either the DoW or the Water Corporation.
6. Cease abstraction and investigate alternative sources.

Site specific contingencies

There are several areas where there is an identified expectation of an observable impact, and if that impact exceeds the limits of expectation, then consideration of implementing the site specific contingency actions will be triggered. The primary triggers for taking site specific contingency actions are:

- an observed groundwater response occurs at a rate greater than indicated by the modelling
- an observed biological response occurs which is inconsistent with expectations and monitoring of control sites.

Of the areas in which there is potential risk of impact, the areas of Yarragadee Formation outcrop and subcrop beneath the Blackwood River, Poison Gully and Milyeannup Brook are considered the most sensitive to abstraction effects from the proposal. St John Brook is an area of high social and environmental value where the anticipated risks are small, but would need to be offset if greater impacts than expected were to occur.

The Reedia wetlands is an important ecological area where no impacts are expected, but would need to be managed if impacts are detected. Groundwater level and environmental responses in other areas of potential impact such as the coastal plains, will be considered on their merits at the time, as these areas are expected to be impacted by local regional groundwater abstractions to a greater extent than by the proposal.

The specific triggers and contingency action for each of these potential risk areas is set out in the revised Groundwater Abstraction Management Plan (Appendix 1).

Feasibility of flow supplementation

The feasibility of the proposed contingencies has been reviewed to the extent considered reasonable at this time. Streamflow supplementation is a major site–specific contingency and URS Australia (2006b) has undertaken a desktop review of the feasibility of installation and operation of wells to provide supplementation water to the Blackwood River and tributaries, St John Brook and Milyeannup Brook. A copy of the letter report is presented in Appendix 5.

Based on an examination of potential yields, water quality (TDS, temperature, pH and dissolved oxygen) four selected sites were considered feasible for the installation of production wells for supplementation, as proposed. The sites and target source formations were selected to ensure no or minimal impact at the watertable. The target source formations at the identified sites are overlain by the aquitard beds of the Mowen Member and preliminary modelling results showed drawdown impacts would be largely contained within the Yarragadee Formation and no significant further reductions in discharges into the Blackwood River and tributaries would result. Minor treatment may be required to remove iron and manganese, and such treatment (using aeration) would ensure the required dissolved oxygen levels are met. Groundwater temperatures are appropriate without treatment.

The required flow rates are small, and erosion control associated with discharge of supplementation water into watercourses can be managed. Power would have to be arranged for each site.

The pumping rates and annual volumes for supplementation, (if required) are small, being no more than 20 L/s for about three months (155.6 ML/yr) for the Blackwood River, and 5 L/s and 2 L/s for Milyeannup Brook and St John Brook respectively, again for about three months each year. The maximum total annual abstraction, if and when required, would be about 210 ML/yr, and would add about 0.5% to the proposed 45 GL/yr abstraction proposal.

Feasibility of adjustment of the abstraction regime

Adjustment of the abstraction regime is a demonstrably feasible contingency, if deemed necessary, including the potential for temporary or permanent reductions in abstraction, if so required by DoW. The Water Corporation has a history of substantially modifying and reducing groundwater abstractions from its wellfields on the Gnangara Mound in order to contribute to offsetting the environmental impacts of falling watertables, even though the impacts have largely been the result of a drier climate and pumping by other private users.

Any adjustment of the abstraction regime would need to be tailored to mitigate the specific impacts that are observed, and at this time, it is not possible to be definitive on the details of the adjustments that might need to be made. Changing the distribution of abstraction between the two Yarragadee Units proposed for screening (Units 1 and 3) is a relatively simple process that can largely be accommodated by changing pump duties in the various wells. The selection of contingency well sites to modify the geographic location of abstraction is notional at this time, and may need to be modified if monitoring results and subsequent modelling indicate that alternative locations are necessary. This can only be determined at that time.

Clearly, the option to completely shut down the wellfield would be a last resort action if all other measures fail and is not expected to be required. However, in this event, alternative sources would be sought to provide the required water in order to protect the investment in the water transfer infrastructure. Alternative sources could involve the development of surface water sources in the region, such as the Donnelly River, subject to the required approvals being obtained.

The Water Corporation believes that the very low risk of impact and the range of offsetting and mitigation measures available would allow the option of complete wellfield shutdown to be avoided. Some reduction in abstraction could be accommodated, if necessary, through the construction of alternative compensating sources, such as a pipehead dam on St John Brook that would take water from run–of–river flow in the wintertime and at a location that would not impact on the stream ecology. The consequential reduction of freshwater flows into the Blackwood River would not be affected as the water would only be diverted during winter, when the flows in the Blackwood are saline and of a magnitude that changes in the St John Brook inflow would not result in any significant change to the Blackwood River flow regime. If proposed for implementation, such a contingency would be referred for assessment of environmental acceptability in its own right.

The Water Corporation will commence investigations into alternative sources, immediately following approval of the proposal, to enure lead times for implementation of those alternatives are minimised.

Other contingencies

Other contingencies may be able to be developed to meet unexpected impacts that emerge over time. These would be developed in consultation with the Monitoring Review Group and the regulatory agencies as necessary and practical.

4.14.4 Vagueness of the contingencies and responsibilities

As discussed in the previous section, it is not possible to be entirely definitive in setting out the full range of contingencies that may be required to cover every situation, particularly unexpected situations. Further work has been undertaken on the streamflow supplementation contingency in defining how it could be implemented if deemed necessary, as discussed above. Other contingencies such as modifying abstraction regimes, have been defined to the extent considered practically feasible at this time.

The Water Corporation will take responsibility for implementing any contingencies associated with mitigating the impacts of the proposal, where those impacts can clearly be demonstrated as having been caused by the proposal. To clarify the situation in terms of where there may be an impact that is the combined result of both Water Corporation and regional abstractions, the Water Corporation has proposed that it take full responsibility for offsetting and management in those areas where the Water Corporation is the major contributor to the drawdown effect. This effectively means the Water Corporation will be responsible for offsetting all groundwater drawdown impacts on the eastern Blackwood Plateau.

It should be recognised that, over time, there will be a range of influences other than groundwater abstractions that will affect regional watertables, both on the coastal plains and on the Blackwood Plateau. As discussed in the Sustainability Evaluation/ERMP and in this response to submissions, climate change is one such influence. Another major influence is land use, in particular the potential increase in blue gum plantations on rural properties on the coastal plains, and management of the forests on the Blackwood Plateau. These influences are beyond the control of the Water Corporation and require a coordinated response by all agencies to optimise management outcomes.

The South West Yarragadee Sustainability Initiative proposed in the Sustainability Evaluation/ERMP includes sponsorship of a research program on the effects of changing land use on water demand, availability and quality. This will provide valuable information to the agencies responsible for managing land uses, and forests in particular, to ensure impacts on water resources can be adequately accounted for.

4.15 PIPELINE ROUTE

4.15.1 Submission issues

Several submissions were raised regarding the pipeline route. The key aspects of concern were:

- insufficient information presented on the pipeline route (wetlands, flora and fauna)
- potential impacts on Ironstone Gully Falls
- acid sulphate soil risk
- impacts on landholders along the route.

4.15.2 Response to submission issues

Each of the above concerns is addressed in detail in the following sections.

4.15.3 Insufficient information

The pipeline route as presented in the Sustainability Evaluation/ERMP has been planned to avoid all environmentally sensitive areas wherever possible utilising the latest in GIS database planning tools. To avoid any areas not fully surveyed and listed, the Water Corporation has made a commitment in the Sustainability Evaluation/ERMP to undertake the following surveys along the pipeline route:

- a soil sampling program to further define the risk of exposure of acid sulphate soils
- a detailed flora and fauna habitat survey to identify species and communities of conservation significance.

The flora and fauna habitat survey will be adequate to address all requirements of the EPBC Act as raised by the Department of Environment and Heritage. The pipeline route has been designed to avoid all wetlands of conservation significance with the exception of the Preston River. An assessment will be made of the best possible method and location for all crossings and each will require approval by the DoW.

Watertable piezometers will also be established to further define the behaviour of the Swan Coastal Plain particularly the seasonally inundated areas through which the pipeline will pass.

A Wetland Management Plan (Appendix 2) and a Watercourse Crossing Management Plan (Appendix 3) have been prepared to clarify the means of minimising environmental impacts of pipeline construction with wetlands and watercourses.

4.15.4 Ironstone Gully Falls

The potential impact of the pipeline route on Ironstone Gully Falls has been identified within the route planning reports prepared for the Water Corporation.

The issue of ferrocrete, otherwise known as ironstone, is one that will be investigated thoroughly in a geotechnical investigation. Ironstone is noted to occur along the route in several locations along the Capel–Donnybrook Road (know locally as Goodwood Road), and options for construction in this material will be based on the outcomes of the geotechnical investigations.

In the area of Ironstone Gully Falls, the Water Corporation is investigating the use of the existing road bridge and engineering solutions that utilise existing structures to avoid impacting the homogenous sheet of ironstone in the Falls picnic area.

4.15.5 Acid sulphate soil risk

There is a risk of exposing acid sulphate soils during the construction of the buried pipeline. As detailed in Volume 2 Chapter 9 Section 20 of the Sustainability Evaluation/ERMP, the identification and treatment of acid sulphate soils will be managed in accordance with DoE Acid Sulphate Soils Guideline Series.

In accordance with the DoE Guidelines, an Acid Sulphate Soils Management Plan will be prepared to the satisfaction of DoE before commencement of any works on the pipeline route. The Water Corporation will carry out a sampling program to determine the location and nature of acid sulphate soils along the pipeline route, which will commence during the geotechnical investigation phase of the pipeline planning activities.

4.15.6 Impacts on landholders

The potential impacts on affected landowners are addressed in Section 6.7.

4.16 CONSULTATION PROCESS

4.16.1 Submission issues

Several submissions raised matters associated with the consultation undertaken for the project. The issues raised comprise several primary components:

- insufficient consultation with those affected by the development footprint
- insufficient advertising during the public comment period
- the Sustainability Evaluation/ERMP was difficult to read.

4.16.2 Response to submission issues

Each of the above concerns is addressed in detail in the following sections.

4.16.3 Consultation regarding development footprint

The wellfield location was finalised during the assessment process through evaluation of the detailed modelling of several different wellfield configurations. The pipeline route could not be finalised until the wellfield location was determined. Therefore, detailed consultation with potentially affected landowners was not feasible during the development of the proposal.

A meeting was held with landholders in the Jarrahwood area to discuss the details of the treatment plant location and pipeline routes. Further follow-up meetings will be held as detailed design progresses.

Consultation with landowners along the pipeline route commenced in July 2006 when the Water Corporation sent a comprehensive information pack to each potentially affected individual landowner. The information included aerial strip maps showing the location of the pipeline alignment on each lot. The Water Corporation has offered to meet all affected landowners individually to discuss the pipeline with the project team between late August and mid–September 2006. A Toll Free Number has been established to assist communication, which as at 10 August 2006, has taken calls from 30 of the 137 individual landowners.

Another letter was sent on 21 August notifying landowners of the Water Corporation's requirement for entry to land to undertake the various environmental and planning studies which are critical to the current project delivery schedule. This letter will include a further offer of individual discussions with the project team.

The proposed alignment is still subject to the Water Corporation's legislative requirements to issue a "Notice of Proposal" to each of the affected landowners. This will be undertaken after environmental approval and a government decision to proceed, and it is by this process that each affected landowner has a formal opportunity to object to the proposed infrastructure.

4.16.4 Public comment period

The consultation prior to the public release of the Sustainability Evaluation/ERMP was extensive and is described in Volume 1 Chapter 8 Section 2 of the document. During the public comment period, the Water Corporation prepared two full page advertisements that provided information on the key issues, process, commitments and provided information on the Sustainability Evaluation/ERMP and how to access copies. These information advertisements were run consecutively in the following newspapers:

- Busselton Dunsborough Mail (1/3/06, 8/3/06 and 15/3/06)
- Augusta Margaret River Mail (1/3/06, 8/3/06 and 15/3/06)
- Bunbury Mail (1/3/06, 8/3/06, and 15/3/06)
- Donnybrook Bridgetown Mail (28/2/06, 7/3/06 and 14/3/06)
- South Western Times (2/3/06, 9/3/06 and 16/3/06)
- Manjimup Bridgetown Times (1/3/06, 8/3/06 and 15/3/06)
- Harvey Leschenault Reporter (11/4/06).

In addition to this, the EPA advertised the Sustainability Evaluation/ERMP as part of their statutory advertising requirements. The advertising of the public review period was carried out in accordance with the EPA requirements. The Water Corporation made hard copies of the Executive Summary with a CD of the entire document available free of charge, which is beyond the EPA requirements.

Over 600 submissions were received on the proposal, demonstrating that there was a high level of awareness that the documents were available for comment.

4.16.5 Sustainability Evaluation/ERMP document

The Sustainability Evaluation/ERMP covered a large number of topics and was designed to meet the information requirements of:

- the EPA, assessing the project under Part IV of the *Environmental Protection Act 1986*
- the DoW, assessing the licence application for groundwater abstraction under the *Rights in Water and Irrigation Act 1914*
- the Sustainability Panel, assessing the project in accordance with the *State Sustainability Strategy*
- the general public.

The document structure was determined in consultation with the EPA Service Unit prior to public release. It was recognised that it would be difficult for any one reader to find the specific information they required from such a large document. Accordingly, the Executive Summary, document structure diagram and the contents pages were designed to make the information more readily accessible to the reader.

5. RESPONSES TO OTHER ENVIRONMENTAL ISSUES

Several issues were commonly raised in submissions and these are summarised and discussed in the following sections. The issues raised were:

- marine impacts
- subterranean fauna
- vegetation dependence on deep watertables
- energy use.

5.1 MARINE IMPACTS

5.1.1 Submission issues

Concern was raised over the potential impact of reduced groundwater discharge to the ocean as a consequence of the proposal.

5.1.2 Response to submission issues

The primary area of reduced groundwater discharge to the ocean is expected to be through the reduced off-shore Yarragadee Formation groundwater outflows. The changes in groundwater flow regimes in the shallower formations are expected to be minimal, as demonstrated by the small changes in watertable levels on the coastal plains. The shallower formations discharge into the near–shore marine environment.

The marine discharges from the Yarragadee Formation have not been investigated. However, the discharges are expected to occur as a widely dispersed leakage to the ocean, both as upward percolation through overlying formations, or as a diffuse discharge across the extensive area of subterranean outcrop of the formation at the seabed. The discharges to the ocean would tend to be though seawater/freshwater interfaces within the aquifer, rather than as direct freshwater discharge into the ocean. The ultimate discharge to the ocean would be generally beyond the near–shore environment, extending out to the edge of the continental shelf.

Given the expected highly diffuse and dispersed nature of this discharge, and the mixing processes in the ocean, it is considered extremely unlikely that there would be any ecosystems dependent on these discharges being maintained at current levels.

The need to ensure that seawater interfaces in the freshwater aquifers are maintained at an appropriate distance from the shore (with the possible exception of some seawater intrusion occurring in the Bunbury area) will ensure that groundwater discharges to the ocean are maintained at a significant level. For example, 60% of the natural groundwater discharge to the ocean will be maintained in the Bunbury area, after accounting for the proposal and regional abstraction after 30 years.

5.2 SUBTERRANEAN FAUNA

5.2.1 Submission issues

Concern was expressed that the potential impacts of the proposal on subterranean fauna have not been adequately investigated or assessed. Volume 2 Chapter 6 Section 5.4 of the Sustainability Evaluation/ERMP sets out the justification for the extent of investigation and consideration given to such fauna. This is reiterated below.

5.2.2 Response to submission issues

Given that the proposal is not expected to cause any drawdowns in the environments (Tamala Limestone) where troglobitic fauna may exist, there is no need to consider this form of subterranean fauna. Groundwater levels in the Tamala Limestone formations on the Swan and Scott Coastal Plains are not expected to be impacted by the proposal because of the distance from the points of abstraction. Groundwater levels in the formations will be controlled by the ocean because of their proximity to the coast. Troglobitic fauna are consequently not expected to occur within the area of drawdown impact.

Stygofauna may exist within the superficial formations on the coastal plains. However, the relatively small drawdowns expected, compared to the saturated thicknesses of these formations and the range of natural variation in watertable levels provides assurance that these fauna will not be impacted. Ecological water requirements for stygofauna were not assessed by URS Australia (2004). They were considered unlikely to be critical as the drawdown criteria to be established for wetlands and vegetation would protect stygofauna.

Stygofauna sampling of a test production well indicated no stygofauna as being present in the Yarragadee Formation. However, the well construction technique may have affected this result. If stygofauna are present in the confined aquifers, there will be no impact from the proposal because water levels (and consequently available stygofauna habitat) in these aquifers will not change (only pressures will be affected).

While little scientific information is available on the susceptibility of stygofauna to groundwater level change, the fact that many exist within groundwater as Gondwanic relics, strongly suggests they have considerable tolerance to such change. Water dependent troglobitic fauna, because of their clearer dependence on the presence of a watertable, would be expected to be more susceptible to watertable change. However, as explained above, given the significant distance separating the Water Corporation wellfield from any areas of known caves, troglobitic fauna are not expected to be an issue.

5.3 WELL CONSTRUCTION AND TESTING

5.3.1 Submission issues

DoE commented that groundwater pumped to develop and test the production wells may contain high concentrations of soluble iron and may have a net acidity that may cause environmental impacts when disposed of.

5.3.2 Response to submission issues

The Construction Management Plan included in the Sustainability Evaluation/ERMP (Volume 2 Chapter 9 Section 21) includes a requirement to store and treat any wastewater to ensure compatibility with the water in the receiving environment and with aquatic biota. Diffusers will be installed to eliminate erosion effects. A contingency action to cease discharge until an appropriate management action in the event of any adverse impacts from the discharges, has been included in the plan.

5.4 VEGETATION DEPENDENCE ON DEEP WATERTABLES

5.4.1 Submission issues

Concern was expressed in several submissions that vegetation in areas with a depth to watertable greater than 10 m had not been considered to be groundwater dependent, and that such vegetation had roots that often extended to depths well beyond 10 m.

5.4.2 Response to submission issues

Vegetation in areas with high depths to groundwater (greater than 10 m) primarily relies on the high moisture holding capacity of soil profiles upon the Blackwood Plateau and reliable annual wetting of the soil profile. While tall vegetation may have roots that penetrate to close to the watertable in areas of high depth to watertable, they are not phreatophytes and not watertable dependent. The watertable tends to limit the depth of root penetration, and progressive lowering of the watertable would allow these species to progressively extend their roots to greater depth without ecological impact.

5.5 ENERGY USE

5.5.1 Submission issues

Two public submissions raised questions about the energy requirements of the project. The key issue raised was that the energy requirements of the project were not adequately addressed in the document and that pumping of the water to Perth is an inefficient use of energy.

5.5.2 Response to submission issues

The energy requirements of the proposal are described in detail in Volume 2 Chapter 8 Section 10 of the Sustainability Evaluation/ERMP under the 'Energy efficiency' factor.

The proposal will require 4.6 MW of energy per year supplied through the Western Power South West Integrated System. The generation of this energy by Western Power will result in an estimated release of 41,000 t/yr of greenhouse gas emissions (CO_2e[4]) based on an assumed indicative carbon intensity of the Western Power South West Integrated System of 1032 kg CO_2/MWhr[5]. This is indicative, as the grid carbon intensity is changing as overall configuration of power stations within the grid changes.

[4] Co_2e – carbon dioxide equivalent.

[5] Carbon intensity value for the SWIS used for the Environmental Protection Statement prepared for the Perth Metropolitan Desalination Proposal (Welker Environmental Consultancy 2002).

Implementation of this project will delay the need for future desalination plants that are significantly more energy intensive. There is no other source capable of supplying approximately 45 GL/yr within the necessary timeframe (Water Corporation 2005). Therefore, the South West Yarragadee Water Supply Development is the most energy efficient option available.

The Water Corporation has set an aspirational target of being carbon-neutral by 2030. This will be achieved through a program that considers all of the Water Corporation emissions (a portfolio approach) to reduce the Water Corporation emissions profile and gain the greatest practical energy efficiencies across the business. As part of the greenhouse gas management portfolio approach, a Greenhouse Emissions Reduction Plan will be developed to enable the Water Corporation to work towards its target of carbon neutrality.

6. RESPONSES TO KEY SOCIO-ECONOMIC ISSUES

Several key issues were commonly raised in submissions and these are summarised and discussed in the following sections. The key issues raised were:

- future regional water needs
- effects on other users
- economic impacts of the proposal
- impacts on timber production
- alternative approaches to meeting IWSS demand
- heritage impacts
- social impacts.

Each of the above issues is addressed in the following sections.

6.1 FUTURE REGIONAL WATER NEEDS

6.1.1 Submission issues

A number of submissions raised a range of issues associated with the potential impacts on future South West regional water needs. The issues can be distilled into the following:

1. Transfer of water out of the region will inhibit future industrial growth in the South West. The Yarragadee aquifer will be fully allocated in 30 years due to population growth in the South West. Therefore, no water should be exported, as it will be needed in the region.
2. As the estimated future regional use is predicted to have significant impacts in its own right, there should be no water allocated to Perth.
3. The Sustainability Evaluation/ERMP assumed 'no growth' in water use by the mining sector. This is flawed logic as it is likely that there will be growth in all sectors in the future.

6.1.2 Response to submission issues

Each of the above concerns is addressed in detail in the following sections.

6.1.3 Inhibition of future growth in the South West

In considering the issue of regional water needs, it is important to emphasise that the Water Corporation proposal is not in direct competition with regional users because of the location of the Water Corporation wellfield in an area to which private regional users do not have access. If the Water Corporation proposal does not proceed, an additional 45 GL/yr would not then become available in the areas in which regional users do have access (primarily the coastal plains). The primary limiting factor on overall water availability from the Southern Perth Basin is the constraint on drawdown impacts on key ecological systems.

Distributing abstractions across the region is the primary means of maximising overall water availability through distributing the drawdown impacts. Environmental constraints may only permit several additional GL/yr to be allocated to uses on the coastal plain if the proposal does not proceed. Unless the Water Corporation wellfield is developed, the maximum economic benefit from the resource cannot be achieved for the State, irrespective of where the water is used.

The Sustainability Evaluation/ERMP comprehensively considered and evaluated future growth in the South West region that may be likely to require water from the Southern Perth Basin. The conclusion was that there is adequate water available in the region to meet future demands for several decades, and there would not be competition with the Water Corporation proposal in the short to medium–term.

The *State Water Strategy* (Government of Western Australia 2003b) indicates that the South West Yarragadee source should be developed "*for the benefit of communities in the South West and those serviced by the Integrated Water Supply Scheme*". While the source is being investigated at this time to meet strong growth in the existing IWSS, once connected, these new assets would also be available to deliver water to high value uses in the South West.

As outlined in the Sustainability Evaluation/ERMP, the proposal will extend the existing IWSS from Harvey to the proposed treatment plant near Jarrahwood. A transfer main along the Swan Coastal Plain will pass near the growing regional centres of Bunbury, and Capel, and the Kemerton Industrial Park. Water supplied through an integrated system provides opportunity for economic benefits to both the region and the State. An enhanced water supply will support expansion of the population and a higher overall level of economic activity in the South West.

The *State Water Strategy* sets a requirement that transfer of water from the region should only be undertaken when it can be ensured that "… *all reasonable regional needs including social, recreational and projected future development will be satisfied before transfers can take place"* (Government of Western Australia 2003b). The Water Corporation "reasonable regional needs" position statement (Strategen 2005) sets out a suite of basic principles to be applied to considerations of how this issue should be addressed to ensure the objectives of the *State Water Strategy* are met.

In considering the issues and competing interests in application of the above principles, the proposal provides considerable opportunity for more water to be made available from the groundwater resources of the Southern Perth Basin than would be possible without the proposal.

The water available in the region exceeds current and near-future demand by a substantial margin. The Yarragadee aquifer system will be significantly under-utilised in the short to medium–term, at the regional scale. Based on current demand projections, any competition between the various demands is not expected to occur for several decades. This provides an opportunity to develop the resource and learn more about its behaviour under higher levels of abstraction than it is now experiencing. The information gained will be invaluable in making future management decisions about limits on use.

The Sustainability Evaluation/ERMP set out the Water Corporation preferred approach to addressing reasonable regional needs (Volume 2 Chapter 3 Section 3.1) that envisaged regional use of water from the IWSS to meet regional public water supply demand growth. By 2033, it is expected that a proportion of the 45 GL/yr provided to the extended IWSS from the Yarragadee aquifer will be used locally to meet some of the public water supply (or other high value needs) of the South West, and the remaining portion would be transferred out of the region.

If there is future competition for groundwater between the extended IWSS and other regional demands, then this competition should be addressed on the specific merits and impacts of the competing uses, under the circumstances that apply at the time and in accordance with the proposed reasonable regional needs principles. This approach will ensure that the opportunities for regional development are maximised, particularly in terms of job creation, and in a manner that is beneficial to both the State and the South West Region. The DoW has responsibility for such decision-making, and water resource management plans (if and as developed) could set out the basis for addressing future competition.

As detailed in Volume 1 Chapter 8 Section 3.2.6 of the Sustainability Evaluation/ERMP, the Water Corporation has committed to the preparation of a South West Public Water Supply Future Plan if the South West Yarragadee Water Supply Development project is approved. This plan would provide a greater level of confidence in the availability of water to meet regional needs.

6.1.4 Impacts of future regional use

Some submissions suggested that as estimated future regional use would have significant impacts in its own right, there should be no water allocated to Perth[6].

The cumulative impacts of future regional use and the Water Corporation proposal are not expected to become significant in the short–term. The extent to which they become significant in the longer–term will depend on a range of factors, not the least being the actual rate and geographic distribution of growth in regional abstractions. In those areas where regional groundwater use is expected to have its highest impacts (the coastal plains), the Water Corporation impacts are low to zero, and management of regional use would be largely independent of management of the Water Corporation abstractions.

On the eastern Blackwood Plateau (between the Busselton and Darling Faults), where Water Corporation impacts are expected to be more dominant than the impacts of the more remote regional abstractions, the Water Corporation has committed to mitigating and offsetting the cumulative impacts of all users. Given this separation of the management of regional abstraction impacts and the proposal, the Water Corporation believes there is no justification in refusing an allocation of water to the IWSS based on the impacts of regional use.

6.1.5 Mining sector growth

The Sustainability Evaluation/ERMP assumption of 'no growth' in use by the mining sector is based on an industry sector study undertaken by Economics Consulting Services (2003). The primary mining activity in the region is mineral sand mining and industry projections indicate that while there will be new mines opening, others will close, and there will be no overall increase in the level of mining. Effectively, only the mining locations will change. The comments that suggest there would be growth in mining water demand in the region have not been substantiated by any data.

Nonetheless, if mining growth does occur, contrary to the assumptions, this demand should be dealt with within the proposed "reasonable regional needs" principles (Strategen 2005, Volume 2 Chapter 3 Section 3.1 of the Sustainability Evaluation/ERMP).

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[6] Numerous submissions equate Perth as being the destination of water being delivered into the IWSS. This perception does not recognise that the IWSS services many country towns and other regional demand centres such as mining enterprises, as well as the Perth metropolitan area. The proposal is intended to meet the requirements of the overall growth in demand in the IWSS which incudes growth in centres other than Perth.

6.2 EFFECTS ON OTHER USERS

6.2.1 Submission issues

The effects of the proposal on other users was an issue of concern to a substantial number of submitters. The concerns were based on the following propositions:

1. Drawdowns resulting from the proposal will make some existing wells salty or dry.
2. Environmental impacts of the proposal would result in reductions to local groundwater allocations.
3. Other applications to draw water from the Yarragadee have been refused on the grounds that the aquifer is fully allocated. Why should the Water Corporation be an exception?
4. Compensation to local industries that may be refused future water licences because of the proposal.
5. Delays in processing other groundwater abstraction licence applications while awaiting determination of the Water Corporation application.
6. The project will reduce the capacity of Aqwest and the Busselton Water Board to supply existing and future customers. This will make these suppliers unviable and is anti-competitive.
7. Agricultural pastures and water supplies will be affected.
8. The evaluation should be based on modelling existing allocations, not estimated use.

6.2.2 Response to submission issues

Each of the above concerns is addressed in detail in the following sections.

6.2.3 Drawdown impacts on existing wells

Concerns were expressed that drawdowns resulting from the proposal will make some existing wells salty or dry. The issue of saltwater intrusion into existing wells is addressed in detail in the Sustainability Evaluation/ERMP and Section 4.12 of this report.

The potential for the proposal to cause any existing wells to become dry has been minimised through location of the wellfield on the Blackwood Plateau at a considerable distance from existing local wells (the majority of which are located on the coastal plains). As acknowledged in the Sustainability Evaluation/ERMP (Volume 2 Chapter 5 Section 4.11), there is potential for some limited interference drawdown to occur at depth with existing Yarragadee Formation wells on the coastal plains (3 m maximum on Swan Coastal Plain and generally less than 1 m on the Scott Coastal Plain after 30 years of pumping). The extent of interference with private wells in the shallower formations would be substantially less. The extent of drawdown interference resulting from the proposal is not expected to cause detrimental impacts to other groundwater users, provided those users have constructed wells to a design that recognises that other users may reasonably use the same resource.

Drawdown interference effects on existing users from other large allocation regional users would be expected to be considerably higher than the impacts induced by the Water Corporation proposal, because of the proximity of those users to each other.

6.2.4 Reductions to local groundwater allocations

There was a concern that the impacts resulting from the proposal would result in reductions to local groundwater allocations. The basis for this concern is not clear, as the Sustainability Evaluation/ERMP has considered the impacts of the Water Corporation proposal together with substantial growth in regional use of groundwater. This work has concluded that there is considerable scope for additional abstraction for regional use, provided the areas in which such growth is permitted is adequately managed (for example, growth in private abstraction in the area near the Reedia wetlands needs to be carefully managed because of impacts on the significant and unique values of that area). Such management would be necessary, irrespective of the outcome of a decision on implementation of the Water Corporation proposal.

There is no basis within the work undertaken by the Water Corporation in evaluating the proposal, to justify reducing any existing local groundwater allocations as a consequence of the proposal.

The issue of differentiation of cause and effect within the cumulative impacts of the Water Corporation proposal and future regional growth that might result in the need to modify allocations at a future time is an administrative issue for the DoW. To simplify this issue, the Water Corporation has committed to taking full responsibility for offsetting and management in those areas where the Water Corporation is the major contributor to the drawdown effect. The Corporation would take responsibility for monitoring and reporting in other areas where the proposal has only a very limited impact. This effectively means the Water Corporation will be responsible for investigating and offsetting all groundwater drawdown impacts on the eastern Blackwood Plateau. The Corporation does not propose to take responsibility for managing the drawdown impacts of regional users on the Swan and Scott coastal plains or west of the Busselton Fault on the Blackwood Plateau.

6.2.5 Other applications being refused

Several submissions raised the issue of other applications to draw water from the Yarragadee having been refused because the aquifer is fully allocated and questioning why the Water Corporation would be an exception to this.

It is understood that the majority of previous refusals of licence applications have been for abstraction from the Leederville Formation on the western Swan Coastal Plain (Jindong area), as the associated management sub-area is fully allocated. The Water Corporation abstraction is not expected to have any measurable effect in this area, as it is not underlain by the Yarragadee Formation.

The Water Corporation is not proposing to take water from an area that has been fully allocated. The modelling work indicates that significant additional groundwater should be able to be made available to regional users, provided those abstractions are adequately managed in terms of both their geographical location, and the hydrogeological formation proposed as a source. This issue is a matter for the DoW to manage, as the agency responsible for management of abstractions and administration of the associated groundwater licences.

6.2.6 Compensation to local industries for future refusals of water licences

The South West Development Commission suggested that compensation should be paid to local industries that may be refused future water licences because of the proposal.

There are no provisions within the legislation for payment of compensation for such purposes, largely because such a system would be entirely unworkable for a number of compelling reasons. Fundamentally, it would be entirely inappropriate to compensate a party for any loss of a potential future right to which they have no actual or specific claim. It would be impossible to identify bona–fide future applicants, and such a system would only encourage speculative applications. It would be even more difficult to determine which future applicants would be successful in their application, and the extent to which they might be successful in terms of limitations on any allocation they might apply for and receive. Such a proposal would need to justify why the Water Corporation would be subject to making compensation payments, and not other applicants.

6.2.7 Delays in processing other groundwater abstraction licence applications

Concerns have been expressed by a number of submitters that there have been delays in processing other groundwater abstraction licence applications while awaiting determination of the Water Corporation application. This issue has arisen through the DoW policy of considering all licence applications in chronological order of receipt. Because of the extended time required for the Water Corporation to undertake the full range of studies necessary to complete the evaluation and assessment of its proposal, a number of applications were delayed in their consideration. It is understood that the DoW subsequently modified its policy approach to account for the delays that were occurring, and put a process in place that allowed those applications to be dealt with on their own merits prior to a decision on the Water Corporation application. It is understood that this process resulted in some applications being granted and others refused.

6.2.8 Impact on capacity of Aqwest and Busselton Water Board

Some submissions have suggested that the project will reduce the capacity of Aqwest and the Busselton Water Board to supply existing and future customers and make these suppliers unviable. It is also suggested as being anti-competitive.

Capacity to supply

The Busselton Water Board is understood to currently hold a groundwater abstraction licence with an allocation of 18 GL/yr while current use is about 4 GL/yr. It is also understood that a reserve of an additional 2 GL/yr has been set aside for this licensee by the DoW. This amount of water use would not be achieved for 30 years unless there was a sustained annual growth rate in water use of 5.5%. While such a rate might be possible over the short–term, it is extremely unlikely to be sustained for 30 years, and exceeds all regional growth predictions. At the reasonably high growth rate of 3%, it would take 55 years for this level of usage to be achieved. The Department of Planning and Infrastructure[7] indicates an expected growth rate of about 3.5% between 2001 and 2011.

Aqwest has licensed allocations totalling 11.3 GL/yr (of which 1.9 GL/yr is reported by the DoE as being a "draft licence". Current use is about 6.8 GL/yr. The allocations provide for a sustained 2.3% growth rate over 30 years, which is substantially in excess of the growth rates in water use that have historically been experienced in Bunbury. The South West Development Commission[8] reports a growth rate for the City of Bunbury of 1.5% over the period 2000-2005 and 2.0% for 2004-20005.

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[7] http://www.planning.wa.gov.au/publications/development/busselton/busselton.html [1 August 2006]

[8] http://www.swdc.wa.gov.au/files/generic_sidebar/Population%20Greater%20Bunbury%20Table_Mar06.PDF [1 August 2006]

It is also understood and expected that the DoW would give priority to regional public water supplies, in accordance with the need to ensure reasonable regional needs are met before exporting water from the region, in accordance with the *State Water Strategy* (Government of Western Australia 2003b).

As a consequence of the above, the Water Corporation proposal is not expected to affect the capacity of the local public water supply agencies to meet existing and future customer needs.

Anti-competitiveness

It was suggested that the provision of a water allocation to the Water Corporation for the IWSS from the regional resources would be anti-competitive in terms of the competitiveness of the local water boards. The basis for this comment is not clear, given the legislative situation that currently exists.

The *Water Boards Act 1904* prohibits Aqwest and the Busselton Water Boards from supplying customers outside their prescribed areas, and both have licences under the *Water Services Coordination Act 1995* to supply all customers within those areas. The *Water Boards Act 1904* also prohibits the boards from constructing or operating water supply infrastructure, including sources, outside their prescribed areas. The proposed Water Corporation wellfield is located outside the prescribed water board areas and is not competing with those boards to either service their customers, or to source water for its proposal.

The South West Yarragadee Water Supply Development proposal is to service needs within the Water Corporation operating area as licensed under the *Water Services Coordination Act 1995*, and there is no prohibition on the resources that the Water Corporation may consider for development to meet the needs within that operating area. The Water Corporation operating area does not overlie the South West water board operating areas.

These legislative and administrative arrangements effectively preclude any competition between the Water Corporation and the regional water boards, independent of any decision on the Water Corporation proposal.

6.2.9 Agricultural pastures and water supplies

Concerns were expressed in several submissions that agricultural pastures and water supplies (wells, dams, and soaks) would be affected by a drop in water level. The issue of compensating effects on agriculture was also raised.

The declines in watertable level in the areas of agricultural pastures are expected to be very small when compared to the extent of natural variations in the watertable (drawdowns of generally less than 0.1 m compared to annual variations of several metres) and impacts on pastures, etc, are not expected to be discernable.

Watertables in the agricultural areas are and will be affected by a range of influences, of which the Water Corporation proposal will be a small contributor, in limited areas. The other influences that will have substantially more impact than the Water Corporation proposal are:

- groundwater abstraction by local users
- local drainage systems
- local land uses (e.g., blue gum plantations).

There are no specific legislative provisions for compensation to be paid for the effects of groundwater abstraction, and determining the extent of liability would be highly problematic, given the range of stressors that may be the cause of watertable changes resulting in loss to agriculturalists.

6.2.10 Modelling existing allocations

It has been suggested in several submissions that the evaluation should be based on modelling existing allocations, not estimated current use. The argument put to support this is that:

- there is a substantial component of licensed allocations that are not currently used
- licensees are entitled to use their full allocations at any time should they so desire
- the effects of use of those unused allocations should be modelled as they are entitled to be used in the future.

The expectation that follows from the argument is that the impact of using the unused allocations should be added to the impacts of the projected future regional use[9].

The response to this proposition is that the estimates of future regional use inherently take the potential for use of unused allocations into account. Adding unused allocations to the growth estimates would effectively be double counting. The estimates of future regional use are based on growth in the various use sectors use and do not differentiate whether the growth would be effected by an existing user or by new users. This can be exemplified by considering the unused allocations for the local public water supply boards as discussed in Section 6.2.8 (Capacity to supply). The projected growth in regional use for Bunbury and Busselton that has been modelled would clearly be taken from within the existing allocations. It would, therefore, be entirely inappropriate to add the currently unused portions of those allocations to the projected growth in use as there would not be any commensurate demand.

6.3 ECONOMIC IMPACTS

6.3.1 Submission issues

A small number of submissions raised the economic impacts of the proposal as a concern. The key economic issue was impact on the livelihoods of farmers and concerns that they will be jeopardised by the proposal through limitations on water availability. The belief is that economic future of the South West will be limited by water. There were also concerns raised that the economic modelling by CSIRO economist, Donna Brennan, showed that the Water Corporation economic modelling was inaccurate.

6.3.2 Response to submission issues

Each of the above concerns is addressed in detail in the following sections.

[9] Projected future regional use includes the continuation of current use at the same level with an additional component added to account for growth.

6.3.3 Impacts on local users

The range of issues raised by submitters related to the range of potential impacts on existing and future local groundwater users is addressed in detail in Section 6.2.

6.3.4 CSIRO economic modelling

The DoW commissioned CSIRO to undertake an economic evaluation of alternative water allocation options in the South West (Brennan 2006). This report evaluated two alternative scenarios:

1. Water availability in the region is constrained such that only an additional 45 GL/yr is available for abstraction (total availability of 112 GL/yr), and water could go to either the IWSS in accordance with the proposal or to meet growth in local regional demand.
2. Sufficient water is available to allow for a total abstraction of 160 GL/yr, which would allow for both some level of regional growth and the remaining water going to either the IWSS in accordance with the proposal or to meet additional growth in local regional demand.

Brennan (2006) concluded that there is not a clear economic case for allocating water to the Water Corporation if water availability is constrained to a total of 112 GL/yr. In this situation, the economics very much depend on the market outlook assumptions for agricultural produce. However, it also concluded that if it can be determined with a high degree of certainty that 160 GL/yr is available, there is a clear economic case for allocation of 45 GL/yr to the Water Corporation.

Given that overall water availability in the region is believed to be substantially in excess of 160 GL/yr, it can be concluded that the economic case to allocate 45 GL/yr to the Water Corporation is justified, consistent with the economic modelling studies undertaken by both Brennan (2006) and Economics Consulting Services (2003, 2005).

6.4 IMPACTS ON TIMBER PRODUCTION

6.4.1 Submission issues

The Forest Products Commission (FPC) expressed concerns that there had been no assessment of impacts on plantation or native forest (where appropriate) timber production capacity. There were several aspects of concern:

- impact on forest production capacity of future requirements to increase recharge
- restrictions on silvicultural management practices
- possibilities of plantation tree deaths
- clearing of pines and commercial commitments

6.4.2 Response to submission issues

Each of the above concerns is addressed in detail in the following sections.

6.4.3 Impact of future requirements to increase recharge

The FPC expressed concern that proactive additional management to increase recharge in the future may pose significant reductions in timber production capacity.

The evaluation was undertaken on the basis that land use in the catchment would remain largely the same as is currently the case, and that the only significant future influence on recharge would be climate change and abstraction[10]. The Water Corporation has no proposals to require future changes to management of the forest to manipulate recharge.

6.4.4 Restrictions on silvicultural management practices

The FPC expressed a strong objection to the proposal with respect to any potential future restrictions on silvicultural management such as forest thinning, reduced fertiliser and other chemical use (similar to State Forest 65 over the Gnangara Mound), and expedited pine removal.

As indicated above, the Water Corporation has no proposals regarding restrictions to silvicultural management practices, with respect to manipulation of recharge (forest thinning or expedited pine removal), with the exception of the proposal to clear plantation timber for the treatment plant site as discussed below.

With respect to chemical use, the Water Corporation does not propose to require any restrictions on the normal use of chemicals for silvicultural management as the Yarragadee Formation aquifers proposed to be developed are confined aquifers, at substantial depth. The travel times for recharge (and chemicals used on the land surface) to reach the levels from which water will be abstracted are several tens of thousands of years, during which time considerable attenuation of concentrations and chemical make–up are expected to occur.

The wells will be constructed using standard artesian well techniques that will ensure the annulus between the well casing and the drill hole (other than in the screened zones) is sealed with cement grout to prevent vertical water exchange between aquifers as a result of the well construction. It is expected that the Rights in Water and Irrigation Act 1914 licences for construction of the wells will require such construction techniques as a licence condition.

The Water Corporation proposal for a wellfield into the Yarragadee Formation on the Blackwood Plateau is entirely dissimilar to the wellfields in State Forest 65. The substantial proportion of groundwater abstraction in State Forest 65 is from the shallow superficial formations, which are unconfined and in circumstances where chemicals use on the land surface poses a significant and immediate threat to water quality in those aquifers. Restrictions on chemical use to protect water quality in public drinking water supply catchments are entirely justified in these circumstances.

[10] Increasing abstraction from the regional groundwater system will act to increase recharge through several mechanisms, including recovery of currently rejected recharge.

6.4.5 Possibility of plantation tree deaths

The FPC comments that: "*The potential impact to plantations as evidenced in the Lexia borefield by plantation tree deaths with the Gnangara Plantation has not been assessed. This is particularly surprising as the ERMP suggests potential changes in land use from irrigated agriculture to plantation timber farming with no assessment of the viability of such an option.*"

The potential impacts on vegetation in the area as a result of the proposal, and of future regional groundwater abstraction has been assessed, and it has been concluded that the potential for impacts on vegetation are minimal. The South West Yarragadee Water Supply Development abstraction will be from deep confined aquifers, which will result in considerable attenuation of drawdown impacts at the watertable. Over most of the region, particularly the Blackwood Plateau, the depth to watertable is such that vegetation is not groundwater dependent and any changes will not affect that vegetation. In addition, the expected rates of drawdown in areas where vegetation may potentially be affected will be at rates such that tree deaths will not occur. Rather, there will be a slow transition in the vegetation types in those limited areas.

The tree deaths that were experienced in the Lexia area, and other parts of the Gnangara Mound, in the early 1990s were primarily the result of several extremely (record) hot days, combined with an extended period of low rainfall. Lowered watertables from local groundwater abstraction were a further contribution, but the occurrence of extensive tree deaths in areas remote from the effects of abstraction and other human activity demonstrated that the other factors were the predominant cause (Water Authority 1992).

The Sustainability Evaluation/ERMP notes that there are changes in land use from irrigated agriculture to plantation timber farming occurring in the region. The viability of plantation timber farming is not a matter for the Water Corporation to assess. However, the proposed South West Yarragadee Sustainability Initiative includes a component to research the potential effects of future land uses in the region, in particular the effects of plantation timber farming, on the hydrology.

6.4.6 Clearing of pines and commercial commitments

With respect to the proposed clearing of about 20 ha of plantation for the treatment plant, the FPC has expressed strong opposition: "*to any erosion of State plantation resource as this undermines commitments under a number of State Agreement Acts.*"

Water Corporation recognises the commercial imposition placed on FPC as a result of the proposal to construct infrastructure within an existing pine plantation. This imposition will become evident if the early harvest of pines creates a commercial differential to that anticipated if the pines were to be harvested at full maturity. A commercial settlement based on the possible differential will be negotiated.

6.5 ALTERNATIVE APPROACHES TO THE PROPOSAL

6.5.1 Submission issues

Many submissions questioned the need for the proposal and a large number proposed consideration and use of a range of alternative approaches to meeting water demand in the IWSS. The alternative approaches included:

- alternative sources and improvements in water use efficiency
- staging abstractions
- relocation of the wellfield
- modifying risk level of total sprinkler bans.

In supporting proposals for alternative sources, a substantial number of submissions suggested that use of the South West Yarragadee in the IWSS was inappropriate use of the resource, being largely for watering of lawns and supporting lifestyles.

6.5.2 Response to submission issues

Responses to these various aspects of the specific alternative approaches to meeting demand proposed by submitters are presented in the following sections.

6.5.3 Alternative sources and water use efficiency

Many submissions questioned the need for the proposal and some proposed consideration and use of a range of alternative sources of water for the IWSS. The most "popular" alternative was recycling of Perth's wastewater. Other suggested alternatives included seawater desalination, dams, desalination of water from Wellington Reservoir. Fundamental to consideration of alternative sources, is the need to understand the need for the proposal, and constraints that apply to development of the next major IWSS source.

Need and constraints

Since 2001, Government has invested $880 million in source development, including the new 45 GL/yr climate-independent, Perth Seawater Desalination Plant and a 17 GL/yr water trade with Harvey Water Irrigators.

Despite the massive investment program in new sources, the 2006 drought has returned the IWSS to a position of supply vulnerability. In addition, demand from the IWSS is growing at just under 3% per annum, because of population growth, smaller lot sizes and commercial activity flowing from the buoyant state economy.

The continuing uncertainty in relation to future climate confirms the imperative for a major new supply. This is the highest priority in successfully meeting the latest water supply challenge brought on by the drying climate.

The outcome of not proceeding with a major new supply is an increased risk of severe watering restrictions if the current rainfall sequence continues in future years.

A total sprinkler ban would have a significant social and economic impact on the community. However, it is possible that further restrictions to in-house or commercial/industrial demand would be required, with even greater economic and social impacts. Restrictions of this nature are unprecedented in any major Australian capital city in living memory, although they are now being contemplated in south east Queensland.

The South West Yarragadee Water Supply Development is the only option ready for immediate development and capable of providing a major increase in supply capacity.

The *State Water Strategy* (Government of Western Australia 2003b) highlighted significant programs to support water conservation and reuse. These initiatives enjoyed widespread support through the public consultation on the Strategy.

The Water Corporation recognises that there is a range of water supply sources available to meet the increasing demand for water in the IWSS, and these have been included in the Water Corporation *Security Through Diversity* strategy, which is being actively pursued. As explained in the Sustainability Evaluation/ERMP, the South West Yarragadee Water Supply Development is proposed as a viable means of meeting an immediate need to add major source capacity to the IWSS, after consideration of the full range of options identified in the submissions. The evaluation of these alternative sources is presented in the IWSS Source Development Plan (Water Corporation 2005) and several were discussed in some detail in Volume 1 Chapter 1 Section 1.4 of the Sustainability Evaluation/ERMP.

Basis for the proposal

Overall, the decision to progress the South West Yarragadee Water Supply Development proposal was founded on:

- the ability of the source to provide the required amount of water at the required level of security within the required timeframe and limited ability of alternatives in this regard
- the extent of competition for the source being limited, at least in the short–term
- the expectation that environmental issues would be manageable
- the location of the source being strategically important to development of the south west of the State.

Comment is provided below on specific alternative sources proposed by submitters.

Wastewater recycling/re-use

Wastewater recycling is being actively investigated by the Water Corporation in pursuing the *State Water Strategy* (Government of Western Australia 2003b) target of reusing 20% of treated wastewater sources by 2012. The priority announced in the Strategy was for large scale scheme-based reuse options. The Water Corporation has developed a number of strategies to achieve this target and to increase community awareness and acceptance of the use of treated wastewater. The target recognises the range of issues that need to be addressed in the use of treated wastewater in any form of water supply, including cost and health issues, as well as numerous technical aspects.

The Kwinana Water Reclamation Plant was commissioned as a result and has added 6 GL/yr of recycling capacity. In addition, the reuse of water for the irrigation of green spaces has been increased, both in metropolitan and country areas.

A $30 million proposal has been developed for a 1.5 GL/yr trial over five years to investigate the feasibility of injecting reverse-osmosis treated wastewater into aquifers for reuse as public water supply. Perth is in a unique position to take advantage of this technology and source augmentation solution, due to the nature and presence of local groundwater aquifers. An important component of the proposal is a comprehensive engagement process to determine community attitudes towards indirect reuse of treated wastewater.

The Managed Aquifer Recharge and Kwinana Water Reclamation Plant expansion projects represent an opportunity to significantly increase the proportion of wastewater reused, to a level that will greatly exceed the 20% target set in the State Water Strategy. If successful, they would place Western Australia in a leadership position for reuse water, nationally and internationally.

Seawater desalination

As outlined in Volume 1 Chapter 1 Section 1.4.9 of the Sustainability Evaluation/ERMP, a 45 GL/yr seawater desalination plant is under construction and is required together with the South West Yarragadee Water Supply Development proposal to meet immediate water supply demands. Additional desalination plants are expected to provide future opportunities to add source capacity to the IWSS and the Water Corporation is continuing to evaluate this option. However, there are issues of location, cost (capital and operating), energy usage, and disposal of brine that must be addressed with any future desalination plant that do not make such sources competitive with the South West Yarragadee Water Supply Development in the timeframe required.

Dams

There are no dams closer to the IWSS than the proposed South West Yarragadee Water Supply Development with the capability of supplying 45 GL/yr at the required level of reliability, and the cost of these sources would consequently be substantially higher. It is anticipated there would be substantial environmental issues that would need to be investigated to ensure they could be managed at a low level of risk. The further development of dams in the South West would be considered in the proposed South West Public Water Supply Planning Study that has been committed to by the Water Corporation, as a condition of approval of the proposal.

An important factor in the consideration of dams as an alterative source to the proposal, is their direct dependence on rainfall to deliver yield. This creates an element of risk in terms of the certainty associated with the ability to deliver the required volumes of water at the required level of reliability in the short–term. Essentially, new dams are a longer–term option that can add to the diversity of sources that can deliver water to the IWSS.

Desalination of water from Wellington Reservoir

Wellington Dam is a large, strategic source capable of delivering 40-50 GL/yr to the IWSS in the future, if current water quality issues can be resolved and existing water entitlements reallocated to public water supply. However, this option is susceptible to climate variation and inflows to the dam over the last five winters have been significantly below the longer–term average. Harvey Water irrigators hold a 68 GL a year entitlement at Wellington Dam.

There are a number of environmental, social and economic studies that need to be undertaken, with community and stakeholder involvement, in developing a strategic development plan for Wellington Dam.

The complexity of issues at Wellington Dam requires a whole of Government cross-agency approach to the planning process. A realistic timeframe for the development of a strategic plan is two years, after which a further five years would be required for environmental approvals and construction.

Improvements in water use efficiency

Improvements in water use efficiency were proposed by submitters as viable alternatives, through a range of initiatives such as subsidisation of water tanks, compulsory water tanks in new residential areas, grey water recycling, increasing the price of water, use of native plants in gardens, etc.

The principle of water use efficiency is addressed in some detail in Volume 2 Chapter 3 Section 4.2 of the Sustainability Evaluation/ERMP. In accordance with the *State Water Strategy* (Government of Western Australia 2003b), the Government has set a target of reducing per capita water use from the current unrestricted level of 180 kL/person/yr to 155 kL/person/yr by 2012 and the Water Corporation has committed to achievement of that strategic objective. The Corporation is undertaking an extensive demand management program to support achievement of that water use target for the IWSS. The program initiatives are set out in the Sustainability Evaluation/ERMP. The 155 kL/person/yr target has been achieved since 2003, primarily due to two days per week scheme water roster.

The *State Water Strategy* also committed to setting targets for all service providers, in all parts of the state, comparable to targets set for the metropolitan area. Another major component of the water conservation measures announced in the Strategy, was the *Waterwise* rebate program. To date, more than 238,000 rebates have been approved, totalling $28.8 million.

However, while these initiatives will effectively reduce (or at least slow) the need for future water supply sources they will not deliver 45 GL/yr in the required timeframe to meet the short–term demand, future growth in demand, and the required reliability levels. Water use efficiency does not constitute a feasible alternative to the proposal, but the program to achieve more efficient use will be pursued in any event.

6.5.4 Staging abstractions

A number of submissions proposed staging abstractions from the proposed wellfield to ensure drawdown impacts are manageable. The key issue in staging abstractions is minimising the risk to the required substantial capital investment in infrastructure.

The major portion of the cost of the South West Yarragadee Water Supply Development proposal is associated with the capital cost of the water transfer infrastructure (treatment plant and pipeline) and not the wellfield. It would not be economically feasible to construct the transfer infrastructure in stages to match a staged development of the wellfield. The proposal must be developed on an expectation that 45 GL/yr would be available from an area in proximity to the proposed wellfield. This quantity may be ultimately taken from a modified wellfield if monitoring indicates that there needs to be modification to the abstraction regime to mange the impacts of pumping (in accordance with the Groundwater Abstraction Management Plan [Appendix 1]). In the event that monitoring indicates that a reduction in overall groundwater abstraction from the wellfield (or from a modified wellfield) is unavoidable, the Water Corporation would pursue alternative water supply sources in the region such as local surface water, in order to protect its investment in the transfer infrastructure. This has been clearly acknowledged in the Sustainability Evaluation/ERMP.

The Water Corporation expects to be able to progressively increase the levels of pumping from the resource such that the full abstraction rate of 45 GL/yr would not be taken until several years after pumping commences. However, the rate of progressive increases in abstraction would primarily depend on the actual water supply capacity available within the IWSS at the time. This will be highly dependent on inflows to the IWSS surface water storages in the meantime. The possibility exists that 45 GL/yr would be required at start up of the scheme.

It is important to note that in acknowledging this proposal to progressively increase abstraction rates, the Water Corporation would not accept that the progressive increases be subject to specific approvals, based on monitoring of the impacts. Rather, the Water Corporation would seek approval to pump up to 45 GL/yr, recognising that if monitoring indicates that unacceptable adverse impacts are occurring or are considered likely to occur, then the Water Corporation would respond in accordance with the processes set out in the Groundwater Abstraction Management Plan (Appendix 1).

6.5.5 Relocation of the wellfield

Aqwest and some individual submissions proposed locating the Water Corporation wellfield to the coastal margins. This proposal would exacerbate the potential for seawater intrusion into both Water Corporation and other regional wells and wellfields. The issue is discussed in detail in Section 4.12 of this response to submissions.

Other submissions generally questioned the lack of consideration of alternative wellfield configurations. Over the course of the studies that resulted in the finalisation of the Sustainability Evaluation/ERMP, a number of alternative wellfield configurations were considered, including the distribution of pumping between the various Units of the Yarragadee Formation, as well as alternative wellfield locations and layouts. The original wellfield as proposed and modelled was located entirely in the Blackwood Groundwater Area south of Mowen Road, with abstraction totally from Yarragadee Unit 3. This configuration was developed with the aim of maximising separation from existing users on the coastal plains, and minimising environmental impacts in those areas.

However, following consideration of the initial modelling results, an alternative wellfield with some wells extending into the Busselton–Capel Groundwater area north of Mowen Road was examined to determine if this would reduce the impacts on the Blackwood tributaries such as Poison Gully. It was concluded that such changes would not result in major differences in the nearby areas. It also became apparent that the environmental sensitivity of the Reedia wetlands was an important factor to consider. While the hydrogeological evidence strongly indicates that there is very limited potential for any wellfield on the Blackwood Plateau east of the Busselton Fault to affect water tales in the Reedia wetland area, the environmental consequences were considered sufficient to warrant substantial relocation of the wellfield to the proposed site near Jarrahwood. The Jarrahwood site also reduces the risk of impacts at Poison Gully, Milyeannup Brook and on the Scott Coastal Plain. Several alternative pumping distribution scenarios involving Yarragadee Units 1 and 3 were considered for this site and it was determined that the proposed arrangement of pumping from both Units presented the lowest overall risk option.

In its conclusions, the Peer Review Panel (2005) noted that use of the SWAMS V2.0 model was appropriate in evaluating risk "*… to assist in borefield location and design by relocating from the original proposed Western Borefield to the now preferred Eastern Borefield. By so doing the level of environmental risk associated with potential reduction in water flows in the Blackwood River, to the Reedia wetlands and to the formation of acid sulphate soils on the eastern Scott Coastal Plain has been reduced*".

6.5.6 Appropriateness of use of the resource

A substantial number of submissions suggested that use of the South West Yarragadee in the IWSS was inappropriate use of the resource, being largely for watering of lawns and supporting lifestyles. This comment appears to be an unsubstantiated value judgement made by submitters, and ignores the high economic value associated with the domestic use of water in any urban centre, including urban centres in the South West. This issue is discussed at length in Volume 2 Chapter 3 Section 2 of the Sustainability Evaluation/ERMP, particularly the comparative socio-economic public benefit that results from use of the water in public water supply systems. Given that the proposal would result in extension of the IWSS further into the South West, the benefits would be extended to this region at the same time.

It is reiterated here, that if the Water Corporation proposal is not permitted to proceed, this will not result in an equivalent amount of water being available for other uses in the region as access to the wellfield area is not available to private users. Rejection of the proposal is likely to result in only several additional GL/yr being made available to other uses on the coastal plains if the same constraints on drawdown effects on groundwater dependent ecosystems are applied to all users.

6.5.7 Modifying risk level of total sprinkler bans

The Conservation Commission proposed that consideration be given to using a 1% risk level of a total sprinkler ban, compared to 0.5% as adopted by the Water Corporation. The justification for the Conservation Commission proposal is that 1% would be a similar risk level as applied to flood risks to buildings, and would allow time for consideration of a broader range of options.

The adopted risk level of 0.5% has been negotiated and agreed with Government. In theory, adopting a lower level of supply reliability could potentially defer the need for the South West Yarragadee project by up to two years. However, the extremely poor 2006 winter and resultant low storage position for the Integrated Water Supply Scheme means that the scheme will continue to rely on high groundwater abstraction from the Gnangara and Jandakot Mounds to reduce the chance of more severe restrictions until the South West Yarragadee project is delivered in October 2009. The probability of a sprinkler ban in 2007/2008 is currently estimated to be between 1 year in 6 and 1 year in 10. Proceeding with the South West Yarragadee project is the only option of ensuring a significant improvement to supply reliability in the near future.

6.6 HERITAGE

6.6.1 Submission issues

Several submissions raised concerns with the issue of Aboriginal Heritage. The key aspects of concern were:

1. The impact of the proposal on Aboriginal Heritage values has not been adequately studied.
2. The project is a threat to the environmental and spiritual values of the Blackwood and other areas.
3. The processes for disturbance of Aboriginal heritage areas set out in the *Aboriginal Heritage Act 1972* have not been followed.

6.6.2 Response to submission issues

Each of the above concerns is addressed in detail in the following sections.

6.6.3 Heritage assessment

A Water Corporation objective for the South West Yarragadee Water Supply Development is to protect and avoid disturbance of Aboriginal Heritage sites. As such, infrastructure planning has avoided all heritage sites on the current Department of Indigenous Affairs register, except in the case of linear features such as listed rivers. It is recognised that further work is required and the Water Corporation has committed to:

1. Conduct a detailed Aboriginal heritage survey of the proposed infrastructure footprint before construction of proposal infrastructure in consultation with the local Indigenous community and in accordance with the requirements of the Department of Indigenous Affairs.
2. Seek approval for any disturbance of identified heritage sites under s18 of the *Aboriginal Heritage Act 1972*.

Further consultation will establish the protocols for the future field surveys to identify any sites not currently on the register.

The commitments and level of information provided were appropriate at the time the Sustainability Evaluation/ERMP was released, as modifications to the infrastructure routes were still possible. Proposal modifications may be required as a result of issues raised in the submissions or as a result of the consultation with landholders along the pipeline route. This process is still underway and the final pipeline route is yet to be finalised.

6.6.4 Potential environmental threats

Aboriginal heritage values are closely associated with the environment and adverse impacts on the environment will also affect heritage values where they exist. Goode & Irvine (2006) conducted a study to define the social water requirements for the traditional owners of water bodies on the Blackwood Plateau and Scott Coastal Plain. The overall result of this survey is that Nyungah people believe that water sources, particularly ground water, are at the centre of both their belief system and its association with the health of the environment. Places of importance identified in the study included the Blackwood River Summer Pools, Milyeannup Brook, Barrabup Pool, Lake Jasper, Gingilup Swamps and the Hardy Inlet.

The Blackwood River (in its entirety, including its banks and immediate surrounds) was identified as having high historic and current cultural value because of its use for hunting, fishing, marroning and camping. These uses rely on water levels and flows of the Blackwood River, especially in the deep, permanent pools. The impact on the low summer flows of the Blackwood River is estimated to be well within the limits of the environmental water requirements (maximum reduction of 6% in the lowest summer flow that would occur in the driest year). Such a change would not measurably affect the values associated with those flows. Water levels in permanent pools along the Blackwood River and in lower St John Brook will not be affected by groundwater drawdowns, as artesian heads will be maintained in the Yarragadee Formation in these areas, ensuring continuation of an upward discharge to maintain these features. As there is expected to be no significant adverse impact on the environmental values of the Blackwood River, the heritage, fishing, marroning and camping values of the Blackwood River will also be retained.

Barrabup Pool is in the lower reaches of St John Brook, where high artesian heads will effectively buffer any drawdown effects and no change in water levels in the pool is expected.

Some hydrological changes are expected to occur in Milyeannup Brook and minimum flows could reduce by up to 30% in summer. If the permanent flow length of the Brook contracts to within 1500 m of the Blackwood River (in the dry autumn of 2006, the Brook was 2000 m from the river), flow supplementation will be triggered to protect the aquatic fauna of the creek. There is expected to be very little impact on the groundwater dependent ecosystems in Milyeannup Brook as the creek line is steeply incised and the watertable is flat; therefore, vegetation outside of the main channel is unlikely to have high groundwater dependence.

Lake Jasper is another area of considerable heritage significance in the region. The water levels and groundwater levels in and around Lake Jasper will not be affected by the proposal as indicated by the interpreted modelling results presented in the Sustainability Evaluation/ERMP and more recently confirmed by local scale modelling (Aquaterra 2006). Therefore, there will be no impact on the lake or its heritage values.

Gingilup Swamp is south of the Scott River and outside of the potential area of groundwater drawdown from the Water Corporation proposal.

The predicted changes in flow quality and quantity in the Blackwood River are expected to be small. The Hardy Inlet is an estuarine system adapted to highly variable conditions and will not be noticeably affected by the small expected changes in the Blackwood River.

6.6.5 Aboriginal Heritage Act 1972

The Water Corporation has not yet commenced applying for s18 consents to disturb Aboriginal Heritage areas under the *Aboriginal Heritage Act 1972*. The Water Corporation is aware of its legislative responsibility and will apply for the required consents. It is usual for proponents to go through this process after receiving environmental approval rather than before.

6.7 SOCIAL IMPACTS

6.7.1 Submission issues

Several submissions raised matters associated with the social impacts of the project.

This issue comprises two components:

- social impacts inadequately addressed (recreation, tourism, sense of place and education)
- social impacts of environmental degradation, particularly tourism on the Blackwood River
- impacts of the pipeline route.

6.7.2 Response to submission issues

Each of the above concerns is addressed in detail in the following sections.

6.7.3 Social impact assessment

The following studies were conducted for the social impact assessment of the proposal:

1. Survey of social values (ARCWIS 2003). The social value survey focused on the values and views of residents of the South West and Perth on the proposal to export water to the IWSS, and explored circumstances in which attitudes to the proposal may change.
2. Issues scoping study (Water and Rivers Commission 2003). The Water and Rivers Commission prepared an issues scoping paper that described hydrological, ecological, social, allocation planning and communication issues that arose from consultation with a broad range of stakeholders through public and individual meetings, and from ongoing liaison with groups and individuals with an interest in the development.
3. Economic value study (Economics Consulting Services 2003).
4. Aboriginal cultural values survey (Goode 2003).
5. Synnott Mulholland Management Services (2005) conducted a three-phase social impact assessment which included community scoping and profiling, and identification of social variables of interest. The second phase involved the scoping of impacts and projection of estimated effects and thirdly, recommendations for mitigation, remediation and enhancement, and monitoring.

The social impact assessment addressed the following factors under the sustainability principle of 'Community well-being and heritage':

- lifestyle, amenity and recreational use
- sense of place
- indigenous communities
- development footprint.

The submitters did not clarify the specific inadequacies of the social impact assessment, and given the extensive range of studies that were carried out, the Water Corporation believes that these issues were adequately assessed and that further work is not justified based on concerns expressed in the submissions.

6.7.4 Social impacts of environmental degradation

The South West environment has aesthetic, recreation, amenity, lifestyle and sense of place values that are important to the community at a local, regional and state scale. These social values have varying levels of dependency on the environmental values of the South West. If the environmental impacts were minimal and could be acceptably managed, the consultation undertaken through the social impact assessment studies indicated that this would allay many concerns about adverse social impacts.

The Blackwood River emerged as the focus of concerns about the potential loss of social values in both consultation and recent submissions. The impact assessment found that the Blackwood River will not be significantly affected by the proposal and contingency actions have been developed in the unlikely event that unexpected impacts do eventuate. Other than canoeing, much of the recreational use of the Blackwood River centres on the large permanent pools both in the main channel and in St John Brook. The levels of these pools are not expected to change as a result of the project (Volume 2 Chapter 5 of the Sustainability Evaluation/ERMP). The winter flow rates will not be measurably affected by the proposal, as these are dependent on rainfall across the large catchment.

The impact on the low summer flows is estimated to be well within the limits of the environmental water requirements (maximum reduction of 6% in the lowest summer flow that would occur in the driest year).

The consultation indicated that there was support for local community involvement in monitoring. The proposed Monitoring Review Group will involve local community members and membership has been designed to satisfy this requirement.

6.7.5 Pipeline route

The final pipeline alignment is still subject to consultation with the affected landholders and DEC. However, the general route is expected to cross approximately 200 lots (including government land).

The pipeline route has been designed to avoid environmentally sensitive areas, mineral ore bodies on the Swan Coastal Plain, remnant vegetation, heritage areas and, where possible, sensitive land uses. Consideration was also given to having the most direct alignment possible as bends increase the overall length of the infrastructure corridor, the cost and the loss of hydraulic heads.

Consultation with CALM highlighted the need to avoid creating new linear clearing paths through existing native vegetation. This is particularly relevant in the first section of the pipeline from the Water Treatment Plant. To avoid clearing new linear corridors through the State Forest, the proposed pipeline utilises the existing routes along the ridge on Goodwood Road (otherwise known as Jarrahwood Road), and then following the road reserve through the Capel River valley.

Active consultation with specific interest groups such as Shires, farmers groups, conservation groups and the general public through local and state wide newspapers has been underway for many months. The aim of these activities is to raise the level of community awareness for the proposal.

Consultation with the potentially affected landholders has now commenced. Landholders have been provided plans of the proposed pipeline location within their lot, an overall site / locality plan and an invitation for individual site discussions with Water Corporation representatives. The site meetings are aimed at understanding landowner issues and including these in the final pipeline design process.

7. SUBMISSIONS AND ISSUES

The full list of submitters and the issues raised by each are set out in Table 7.1 through Table 7.3.

Table 7.1 lists the Government Departments, Statutory Authorities and Members of Parliament that made submissions. Table 7.2 lists the non-governmental organisations (i.e. community and environmental groups) and Table 7.3 collectively lists the issues raised in submissions made by individual members of the public, and the number of submissions referring to that issue.

References to the section of this report containing the response to each issue are indicated, or a short comment is made where no detailed response has been prepared.

Table 7.1 Government Departments, Statutory Authorities and Members of Parliament and issues

Submitter	Issues
Bunbury Water Board – Aqwest	• No major concerns (noted) • Separation of regulation from service delivery and process issues (not addressed – this is a matter for Government to consider) • Modelling and climate change (Section 4.11) • Modelling of impacts on groundwater flow and separation of impacts into northward vs southward groundwater throughflow (impacts relate to drawdowns rather than impacts on throughflow) • Need to test new wellfield location (Section 5.3) • Peer review had restrictive brief to not include comment on results (final peer review brief included review and comment on results) • Peer review to comment to EPA & DoW and make comments public (Peer review report was included in SE/ERMP appendices) • Saltwater intrusion constitutes a significant risk – Water Corporation wellfield located on coast (Section 4.12) • Local ownership, decision making and management (Monitoring Review Group Section 4.14) • Need to be more definitive on management trigger actions (Section 4.14) • Interference drawdown (Section 4.12)
Busselton Water Board	• Supportive of evaluation (noted) • Saltwater intrusion not expected at Busselton – monitoring required (Section 4.12)
City of Bunbury	• Impacts on Bunbury wetlands (Section 4.6) • Impacts on other regional wetlands (Section 4.6 and 4.7 • Feasibility of supplementation (Section 4.14) • Uncertainty over impacts (Section 4.8) • Regional needs not adequately assessed (including impact of blue gums) (Section 6.1) • Social and economic impacts not adequately addressed (impacts on recreation, education and tourism; interference drawdown; future increase on 45 GL/yr; investment for South West if problems arise) (Section 6.1, Section 6.3 and Section 6.7) • Saltwater intrusion (Section 4.12)

Submitter	Issues
Conservation Commission of Western Australia	• Baseline monitoring (Section 4.13) • Local area models (Section 4.8) • Longer–term pump tests (Section 4.8) • Phased production (Section 6.4.5) • 1% risk of severe restrictions (Section 6.4.5) • Impact on deep rooted vegetation (Section 5.4) • Conflicting role of Vasse Member (Section 4.3) • Impacts on duration of inundation (Section 4.6 • Impacts presented by DoW – May 2006 (noted) • Adaptive management responses and criteria inadequate (Sections 4.13 and 4.14) • Offsets do not address loss of ecosystem function in extensive range of areas – studies should be for life of pumping (Section 4.9)

Submitter	Issues
Department of Conservation and Land Management	• Certainty and comfort of proposal to meet sustainability principles and objectives, including acceptability of impacts on GDEs – further study required (Sections 4.1 and 4.8) • Greater specificity of actions to achieve an acceptable biodiversity impact outcome (no net loss) required. No net loss is a more appropriate principle than a "net increase in biodiversity and ecological function" (Section 4.1) • Better identification of trigger actions and commitments to implement adaptive management, with demonstrated capability of success in remediation of biodiversity losses and offsetting of any losses (Section 4.13 and 4.14) • Need to be able to differentiate causes of impact (Section 4.13) • Development of specific and pre-identified offsets rated to contingency actions - currently proposed offsets are inadequate in scope and scale, including magnitude of financial contribution (define scope not cost) (Section 4.9 and Section 4.14) • Mitigation of threatening processes resulting from the proposal are not appropriate as offsets (Section 4.9) • Proposes that any environmental impact that reaches a "trigger" value be fully restored and an additional offset put in place (Section 4.14) • Uncertainty on drawdowns, lag in biological response, consequent environmental impacts, and mitigation and management strategies – further study required before commissioning (including Sustainability Initiative) (Section 4.8) • Studies should be for life of proposal (Section 4.9) • Proposes trial abstraction with impact monitoring and response framework in modified Groundwater Management Plan - reluctance to modify abstraction because of impacts on Perth community water supplies (Section 4.13) • Total abstraction greater than recharge to Yarragadee Formation (Section 4.8) • Climate change (Section 4.11) • Separation of responsibility for impacts (Section 4.9) • Inadequate consideration of alternative wellfield development concepts (Section 6.4.5) • Demonstration of success of proposed mitigating actions (Section 4.9 and 4.14) • Impact on seasonal inundation of wetlands (Section 4.6) • Areas of conservation significance on private land (Section 4.15) • Uncertainty in watertable depth dataset (Section 4.8) • Conflicting role of Vasse Member (Section 4.3) • Rejected recharge, assumptions and role in environmental systems (Section 4.6) • Loss of TECs etc., to small changes in drawdown (Section 4.6) • Regional model vs local model accuracy (Section 4.8) • Justification of conservative nature of modelling (Section 4.8) • Flora and fauna studies are insufficient to assess conservation values or risks (Section 4.1) • DoW studies on water resource and allocation plan should be part of decision-making (noted) • Drawdown in peat areas creating fire risk (Section 4.1) • Groundwater discharge to the ocean (especially in proximity to Black Point Marine Park and other locations) (Section 5.1) • Impact on Donnelly River flows and flows to Hardy Inlet (Section 4.6 and Section 4.4) • Stygofauna (Section 5.2) • Terrestrial fauna impacts associated with Blackwood River (Section 4.4) and tributaries (Section 4.5)

Submitter	Issues
Department of Conservation and Land Management (cont'd)	• More detail required on management of Milyeannup Brook (Section 4.14) • Unknown changes to riffles (Section 4.5) • Importance of "very wet banks" is unknown (Section 4.5) • Impact on flow patterns of ephemeral streams (Section 4.5) • Under-sampling of St John Brook (Section 4.5) • Impacts on St John Brook not quantified (Section 4.5) • Monitoring of ground water near Reedia Swamps is required (Section 4.13) • Biodiversity - change in 1120 ha of vegetation composition (Section 4.1) • Assessment of cumulative impacts across the Blackwood River and its tributaries (Section 4.10) • 2 m drawdown on Scott Coastal Plain would require 400 mm of rejected recharge to balance (Section 4.6) • Hydrologic regime of seasonal wetlands (Section 4.6) • Impacts on Scott River wetlands – water levels and quality (Section 4.6) • Impacts on ironstone communities on Western Scott Coastal Plain (Section 4.6) • Impacts of drawdown on wetland vegetation communities (Section 4.6) and loss of biodiversity (Section 4.1) • Biology of Scott Coastal Plain not studied (Section 4.6) • Similar issues on Swan Coastal Plain (Section 4.6) • Environmental options analysis for infrastructure siting prior to construction (Section 4.15) • HDD crossing of rivers recommended (Section 4.15) • South West Yarragadee Monitoring Group membership and purpose not well defined (Section 4.13) • Groundwater Management Plan and other plans be finalised in consultation with relevant agencies (Section 4.14) • Model should only predict for 12-15 years (Section 4.8) • Groundwater responses near key GDEs need to be confirmed over wider area - show raw results over entire domain (raw results near key GDEs have been shown in SE/ERMP as the means of identifying all potential GDEs – maps of unfiltered raw results are available) • Local scale models for key GDEs (Section 4.8) • Modelling criticisms – boundaries, drains, rivers, saltwater intrusion (Section 4.12) • Over–estimates of recharge (Section 4.3) • Validation against 2 years historical data (Section 4.8) • Calibration hydrographs (Section 4.8) • Residual conservatism not adequately demonstrated (Section 4.8) • Irrigation return water (Section 4.6) • Scenario of current use plus proposal not modelled (Section 4.8.3 Modelling analysis, Scenarios) • Modelling of entitlements not use (Section 6.2.10) • Future use represents lowest forecast scenario (Section 6.1) • New equilibriums (Water Corporation abstraction will reach equilibrium within 30 years, regional abstractions are continually being added and equilibrium period would be beyond modelled period) • Blackwood River alluvium as a hydraulic barrier (Section 4.4) • Reference and commitment to CALM water removal permits (SE/ERMP notes need to obtain CALM Act water removal permits) • Buffering capacity of groundwater storage (buffering capacity of large storage is important in that aquifer head gradients are substantial and recharge travel times such that short term variations in input will be attenuated over time) • Recognition of importance of biodiversity values of the south west of Western Australia (Section 4.1)

Submitter	Issues
Department of Environment	• Limited baseline studies (Section 4.8) • No relevant trigger or mitigation performance values (Section 4.14) • Interpretation on impacts on Lake Quitjup is optimistic and not substantiated (Section 4.6) • ASS (Section 4.6) • Detailed contingency measures (Section 4.14) • Disposal of development and pump test water (CMP) (Section 5.3)
Department of the Environment and Heritage	• Flora and fauna surveys required along pipeline (EPBC listed species) (Section 4.15 and Appendix 8) • Impacts on Vasse-Wonnerup and Peel-Yalgorup Ramsar Wetland systems need to be documented in detail, with drawdown maps (Appendix 8) • Occurrence of EPBC listed species in watertable drawdown areas (Appendix 8) • Specific section to refer to EPBC issues (Appendix 8) • Maps showing locations of Ramsar wetlands, and distribution of nationally threatened flora and fauna (Appendix 8) • Maps of infrastructure in relation to vegetation communities (Appendix 8)
Forest Products Commission Western Australia	• Impact on forest production capacity – recharge, use of fertiliser (Section 6.4) • Impact on tree deaths (Section 6.4) • Clearing of pines (Section 6.4)

Submitter	Issues
NRM and Salinity Division	• Inadequate addressing of impacts on wetlands (Section 4.6) • Impacts on Scott Coastal Plain wetlands (Section 4.6) • Impact on southern Blackwood Plateau wetlands (not within potential area of impact – addressed in the SE/ERMP) • Location and values of wetlands over entire study not documented (Section 4.6) • Environmental significance of rejected recharge (Section 4.6) • Biodiversity study not considered an offset (Section 4.9) • No commitment to modifying or reducing abstraction if impacts are identified (Section 4.14) • ERMP structure is poor (Section 4.16) • Unidentified wetlands along pipeline route (Section 4.15) • Achievement of wetland sustainability objectives not demonstrated (Section 4.6) • Alternatives to the proposal should be fully investigated (Section 6.4.5) • $1m funding for threatening processes is inadequate (Section 4.9) • Wetland survey of pipeline route (Section 4.15) • No direct or indirect disturbance of environmentally sensitive wetlands (Section 4.6 and Section 4.7) • Effects of abstraction for supplementation (Section 4.14 • St John Brook inclusion as a wetland (Section 4.5) • Impacts on vegetation of seasonal wetlands (Section 4.6) • Scientific uncertainty of drawdowns (Section 4.8), susceptibility of GDEs (Section 4.1), climate change impact (Section 4.11) • Groundwater baseflow to wetlands not included in water balance estimations (Section 4.6) • Application of interim EWR criteria (Table 5.9) to other than sumplands and damplands needs clarification, and terminology (Section 4.6) • Rejected recharge on Scott Coastal Plain (Section 4.6) • Wetlands in study area not categorised and not identified as potential critical assets (Section 4.6) • Buffers on wetlands (Section 4.6) • Wetland management plan for construction phase (Section 4.6 and Appendices 2 and 3)
Paul Llewellyn MLC, South West Region	• Need to compare alternatives (Section 6.4.5) • Basis for evaluating sustainability choices (discussed at length in SE/ERMP – proposal is not a proposal for the selection of the next major source, it is an evaluation as to whether the proposal can be developed as the next major source) • Unacceptable drawdown impacts (repeat of Nannup Shire comments) (Section 4.1) • ASS (Section 4.6) • Reasonable regional needs – comparison of Yarragadee recharge and overall demand (Section 6.1) • No regional advantage in extending IWSS into the region (Section 6.1)

Submitter	Issues
Shire of Augusta-Margaret River	• Regional needs not satisfactorily considered (Section 6.1) • Current management of Yarragadee aquifer is inadequate (not a matter for the Water Corporation to comment on as proponent) • Not sustainable or economically sound (Section 6.3) • Water conservation measures to accompany use in IWSS (Section 6.4.5) • Water pricing to represent true worth (Section 6.4.5) • Impacts on environment not acceptable (Section 4.1) • Salt and nutrient concentrations in Blackwood River (Section 4.4) • Responsibility for mitigation of impacts (Section 4.9) • Mitigation measures not sufficiently detailed (Section 4.9) • Alternative water supply measures (Section 6.4.5) • Supply to supplement Margaret River TWS (may be a possibility – proposed South West Public Water Supply Planning Study would address this) • Monitoring and immediate reductions in abstraction (Section 4.13) • Statutory body to oversee taking of water and make sure promises are adhered to (not addressed – matter for government)
Shire of Boyup Brook	• Need for infill sewerage in Shire of Boyup Brook as sewage will be drawn into Blackwood River (Boyup Brook is on the Yilgarn Block and proposal will not affect the fate of sewage in the shire)) • Water recycling (Section 6.4.5) • Lifting of water restrictions (Section 6.4.5) • Regional use of system (Section 6.1) • Waterwise program and water conservation targets (Section 6.4.5)
Shire of Busselton	• Impact on Leederville Formation artesian wells in Busselton – need submersibles (Section 4.12)
Shire of Capel	• ASS: pipeline impacts on Ironstone Gully Falls; Goodwood Road (Section 4.15) • Drawdown and ASS impacts on wetlands (Muddy Lakes) (Section 4.6)
Shire of Nannup	• Unacceptable environmental impacts (Section 4.1) • Reasonable regional needs (Section 6.1) • Wellfield site selection (Section 6.4.5) • ASS (Section 4.6) • Independent technical assessment (Section 4.13) • Unknown considerations (Section 4.8) • Agricultural impacts (Section 6.2) • Water Corporation marketing strategy (Section 4.16)

Submitter	Issues
South West Catchments Council	• Uncertainty – insufficient data for assessment, all appendices outline the limitations of their reports as insufficient to confidently characterise the area, insufficient understanding of EWRs, the stratigraphy of the region is not sufficiently understood to form a good basis for the numerical model, 3m error in model, interpretation of the results was qualitative and an unacceptable basis of the ecological impact assessment (Section 4.8) • Threat to biodiversity, flora and fauna, groundwater dependent ecosystems (Section 4.1) • Blackwood River and tributaries – severe impacts (Section 4.4 and 4.5) • Contingencies – monitoring and contingency actions not sufficiently defined in the report, a more comprehensive adaptive management and monitoring regime should be required, support for the Monitoring Review Group, (Section 4.13 and Section 4.14) • Alternative sources – water recycling, North West Yarragadee aquifer (current unused allocation), wheatbelt desalination project, drain harvesting in Harvey (Section 6.4.5) • Alternatives – if the project proceeds, it should be staged (Section 6.4.5) • Improve efficiency of water use – pricing, fit for use water supply, native gardens (Section 6.4.5) • Scott Coastal Plain – the well network has data gaps and is insufficient to prepare hydrogeological interpretations, DoE modelling shows impacts on the Scott Coastal Plain are likely to be much reduced to those originally predicted. (Section 4.6) • Climate change – not adequately addressed (Section 4.11) • Salt water intrusion – only addressed qualitatively in the report not quantified (Section 4.12) • ASS (Section 4.6) • Other areas – further investigation required at Busselton, Lake Jasper, Bunbury and Margaret River. (Section 4.7)
South West Development Commission	• South west future water supply – support for extension of the IWSS into the South West with future access to the SW Yarragadee water, compensation should be provided to local industries that will miss out on future water licences due to the project (Section 6.1) • Monitoring – support for Monitoring Review Group and the Sustainability Initiative, recommend licence condition for Water Corporation to fund and install remote telemetry monitoring systems on all commercial size bores into the Yarragadee aquifer (Section 4.13) • Climate change (Section 4.11) • Offsets – not supported, impacts are too serious to offset (Section 4.9) • ASS – serious risk (Section 4.6) • Blackwood River and tributaries – need to have the infrastructure in place to initiate supplementation of flows within 12 hours as a contingency (Section 4.14) • Biodiversity, flora and fauna, groundwater dependent ecosystems – serious threat (Section 4.1) • Alternatives sources – water recycling (Section 6.4.5) • Cumulative impacts (Section 4.10)

Submitter	Issues
South West Zone of the WA Local Government Association	• Significance of region as biodiversity hotspot (Section 4.1) • Growth in demand greater than Yarragadee aquifer recharge (Section 6.1) • Alternative water supply measures (Section 6.4.5) • Limits on regional growth (Section 6.1) • No evaluation of proposal and regional growth (Section 4.8.3 Recharge estimates) • No flora and fauna surveys near wellfield (Section 4.1) • Saltwater intrusion (Section 4.12) • Heavy metals associated with basalt • Interference drawdown in superficial aquifers (Section 6.2) • Interference drawdown in Yarragadee and Leederville aquifers (Section 6.2) • Impacts on perennial pastures (Section 6.2) • Impacts on Milyeannup Brook and Poison Gully (Section 4.5) • Impacts on Lakes Quitjup and Jasper (Section 4.6) • Impacts on Blackwood River flows (Section 4.4) • ASS (Section 4.6) • Increase in blue gum plantations if water not available for irrigated agriculture (Section 6.2) • Climate change (Section 4.11) • Relationship between wetlands and deeper aquifers (Section 4.6) • Errors in assessment of regional needs (Section 6.1) • Delays in processing other licence applications (Section 6.2) • Independence of evaluation (SE/ERMP was prepared by the Water Corporation but will be assessed by the relevant decision making agencies and government)

Table 7.2 Non-governmental submitters and issues

Submitter	Issues
Augusta Community Development Association Inc.	• Improve efficiency of water use – pricing (Section 6.4.5) • Alternative sources – recycling waste water (Section 6.4.5) • Blackwood River – drop in flow and level, increase salinity, damage to ecology (Section 4.4) • Acid sulphate soils – uncertainty (Section 4.6) • Uncertainty (Section 4.8) • Social impacts of environmental degradation – tourism on the Blackwood (Section 6.7) • Biodiversity – threat to groundwater dependent (Section 4.1) • Consultation – lay person cannot interpret modelling (Section 4.16) • South west future water supply – compromised by project (Section 6.1) • Alternative project – alternative pumping rates based on season, IWSS dam water levels (Section 6.4.5) • Monitoring – extensive monitoring and reporting required (Section 4.13)

Submitter	Issues
Australian Drilling Industry Association Ltd	• Salt water intrusion (Section 4.12) • Groundwater dependent ecosystems (Section 4.1) • South west future water supply – for agriculture (Section 6.2) • Alternative sources – water trading with Harvey Water, Wellington Dam (Section 6.4.5) • Alternative project – project staging with abstraction increasing over time if acceptable (Section 6.4.5) • Acid sulphate soils (Section 4.6) • Effects on existing water users (Section 6.2)
Blackwood Basin Group	• Precautionary principle (Section 4.8) • Blackwood River – serious impacts on fish, salinity (undo Landcare works) (Section 4.4) • Biodiversity, flora and fauna, groundwater dependent ecosystems – unacceptable threat (Section 4.1) • Blackwood River tributaries – Milyeannup Brook is pristine and should not be affected (Section 4.5) • Acid sulphate soils (Section 4.6) • Coastal Plains – potential threat to the Scott River and The National Park (Section 4.6) • Uncertainty – insufficient information on ecological effects of groundwater drawdown, model error of +/-3 m (Section 4.8) • Cumulative impacts – climate change, tree farms, local water abstraction (Section 4.10) • Improve water use efficiency (Section 6.4.5) • Offsets and contingencies – inappropriate and unfeasible (Section 4.9)
Bridgetown Greenbushes Friends of the Forest	• Improve water use efficiency (Section 6.4.5) • Cumulative impacts (Section 4.10) – climate change (Section 4.11) • Blackwood River – increased salinity and species loss (Section 4.4) • Biodiversity – decline of tuarts (Section 4.1) • South west future water supply – less water for agriculture (Section 6.2) • Precautionary principle (Section 4.8)
Bunbury Wellington Economic Alliance	• Project support (noted) • Climate change – taken into account (Section 4.11) • Salt water intrusion – further research (Section 4.12) • Monitoring – support for the Monitoring Review Group concept (Section 4.13) • Adaptive management strategies are appropriate (Section 4.13 and 4.14) • South west future water supply – not threatened by the proposal (Section 6.1) • Economic and social benefits (Section 6.7) • Coastal plains – low level of impact (Section 4.6) • Uncertainty – after peer review, DoW studies etc is acceptable (Section 4.8)
Busselton Naturalists Club	• Wetlands – huge areas at risk from the project (Section 4.6) • Acid sulphate soils – high risk (Section 4.6) • Salt water intrusion (Section 4.12) • South west future water supply – in 30 years the aquifer will be fully allocated anyway (Section 6.1) • Contingencies – full plans need to be provided now not later (Section 4.14) • Biodiversity – being traded off to supply Perth's water (Section 4.1)

Submitter	Issues
Busselton Naturalists Club Inc.	• South west future water supply – underestimated future use, aquifer will be fully allocated (Section 6.1) • Salt water intrusion (Section 4.12) • Acid sulphate soils (Section 4.6) • Improve efficiency of water use (Section 6.4.5) • Alternative sources – waste water recycling (Section 6.4.5) • Cumulative impacts – local abstraction (Section 4.10) • Other areas not studied – marine impacts (Section 5.1) • Mitigation - unacceptable (Section 4.9)
Busselton-Dunsborough Environment Centre	• Uncertainty – no supporting information on the effects of the project now that it has been moved to Jarrahwood (Section 4.8) • Assessment – should be postponed until after the DoW groundwater management plan for the area is completed (DoW will provide advice via a draft plan to the EPA to assist its assessment) • Biodiversity – project represents a threat to a large area of groundwater dependent ecosystems and associated rare and endangered fauna, and conservation areas (Section 4.1) • Uncertainty – insufficient scientific knowledge (Section 4.8) • Alternative sources – should be used instead, aquifer recharge, water recycling (Section 6.4.5) • Improve efficiency of water use – pricing, restrictions (Section 6.4.5) • Blackwood River tributaries – supplementation of flow is inappropriate, there is no historical data to enable mimicking on flows (Section 4.5) • Blackwood River – threats to aquatic fauna (Section 4.4) • Coastal Plains – high risk to Ramsar east Busselton wetlands and Capel wetlands, high risk to Tutunup ironstone TEC (Section 4.6) • South west future water supply – would compete with the project (Section 6.1) • Aboriginal heritage – threat to the environmental and spiritual values of the Blackwood and other areas (Section 6.6) • Cumulative impacts – need to take into account climate change (Section 4.11), tree farms and local abstraction (Section 4.10) • Acid sulphate soils – significant risk (Section 4.6) • Salt water intrusion (Section 4.12)
Capel Land Conservation District Committee	• Precautionary principle, uncertainty (Section 4.8) • Biodiversity (Section 4.1) • Climate change (Section 4.11) • Cumulative impacts – growing populations, urbanisation (Section 4.10) • Other areas – impacts not known on the Capel River (Section 4.7) • Acid sulphate soils (Section 4.6) • Monitoring – should be daily and read remotely to allow quick response times (Section 4.13) • Contingency actions – identify trigger points and management actions (Section 4.14) • Blackwood tributaries – unacceptable to dispose of well construction water to streams (Section 5.3) • Alternative sources – water recycling, etc. (Section 6.4.5) • Improve efficiency of water use (Section 6.4.5) • Pipeline route – should not be through Ironstone Gully Falls (Section 4.15)

Submitter	Issues
Conservation Council of Western Australia Inc.	• Improve efficiency of water use – pricing (Section 6.4.5) • Biodiversity, flora and fauna, groundwater dependent ecosystems – direct and indirect (fire, weeds etc) of groundwater (Section 4.1) • Consultation – document was difficult to read (Section 4.16) • Social impacts – project will alter region's sense of place (Section 6.7) • South west future water supply – curb the potential of future sustainable growth, inappropriate to allude to potential expansion of the IWSS into the region when it is not part of the proposal. Population forecasts are based on outdated data (Section 6.1) • Uncertainty – 3 m error too much, modelling based on Yarragadee abstraction but half the bores appear to be within the Leederville Formation area, interpretation of raw modelling data is subjective, peer review expressed caution and called for local scale modelling therefore more work needs to be done before approval is given (Section 4.8) • Acid sulphate soils – inadequately addressed (Section 4.6) • Coastal plains – Water Corporation should be responsible for the combined drawdowns on the coastal plains (Section 4.6) • Precautionary principle (Section 4.8) • Wetlands (Section 4.6) • Blackwood River – unacceptable impacts on salinity and flows in the river (Section 4.4) • Blackwood River tributaries – predicted reduction in flows and water levels are significant, a 1-2m drop in the level of Barrabup Pool would unacceptably change the "sense of place" at this area of Aboriginal significance (Section 4.5) • Pipeline route – insufficiently described, acid sulphate soil risk, impacts on wetlands (Section 4.15) • Infrastructure – insufficient information on well sites, clearing required, traffic associated with the treatment plant, spill management (Section 4.15 and Section 5.3) • Aboriginal Heritage (Section 6.6) • Commitments – General support for the General Commitments, however these should be made legal conditions under Part IV of the EP Act. (Section 8.4) • Offsets – a 5 year program to assist the management of threatening processes is too short (Section 4.9) • Scott Coastal Plain – insufficient hydrogeological data on the eastern Scott Coastal Plain and the area is to significant to "best guess" impacts (Section 4.6) • Salt water intrusion (Section 4.12)
East Augusta Citizens Association Inc.	• Drawdown and acidity on Scott Coastal Plain, Scott River and Scott National Park (Section 4.6) • Additional impacts of supplementation water (Section 4.14) • Water Corporation responsibility for impacts on the coastal plains (Section 4.6) • Impacts on Western Scott Coastal Plain through Scott River (Section 4.6) • Impact on Beenyup minesite rehabilitation (no drawdown impact from proposal in this area) • Incremental abstraction (Section 6.4.5)
East Augusta Citizens' Association	• Acid sulphate soils – increased acidity of the Scott River (Section 4.6) • Coastal plains – already experiencing impacts due to groundwater drawdowns (Section 4.6) • Cumulative impacts – blue gums, climate change, irrigation (Section 4.10) • South west future water supply – licence applications already being knocked back (Section 6.1) • Contingencies – lag time in reaction means damage could be done even after pumps are turned off (Section 4.14) • Social impacts of environmental degradation – tourism etc (Section 6.7) • Blackwood River – salinity and acidity risk (Section 4.4) • Groundwater dependent ecosystems – unacceptable risk to the South West (Section 4.1)

Submitter	Issues

Freshwater Fish Group	• Precautionary principle ignored (Section 4.8)
	• Further studies required
	  o Summer fresh flows provide refuges for fish in dry tributaries (Section 4.5)
	  o DoW predicts 32% reduction in Blackwood discharge (cf 13%) (Section 4.4)
	  o Flow reductions in Milyeannup Brook affects Balston's pygmy perch with loss of species in Blackwood River catchment (Section 4.5)
	  o No historical flow data from Milyeannup Brook affects accuracy of mimicking flow regime (Section 4.5)
	  o Unsubstantiated hydrological predictions (Section 4.8)
	  o Impacts on Eastern Scott Coastal Plain (Section 4.6)

Friends of the Earth Australia	• Climate change – cumulative impacts (Section 4.11) • Blackwood River (Section 4.4) • Biodiversity (Section 4.1) • Precautionary principle (Section 4.8) • Salt water intrusion (Section 4.12) • Acid sulphate soils (Section 4.6) • Blackwood River tributaries – unacceptable impacts (Section 4.5) • Uncertainty (Section 4.8) • Alternative sources – water trading, recycling (Section 6.4.5) • Improved efficiency of water resources (Section 6.4.5)
Geographe Catchment Council	• Uncertainty – insufficient information, delay decision, uncertainty in state water allocation planning, relocation of wellfield has not been studied, regional data not appropriate for local scale assessment (Section 4.8) • Biodiversity, flora and fauna, groundwater dependent ecosystems – unacceptable threat (Section 4.1) • Other areas – need investigation into effects on Capel River, Vasse River and Bussell Hwy Swamps (Section 4.7) • Coastal Plains – high risk to ironstone vegetation communities, risk to Vasse Wonnerup wetlands (Section 4.6) • Monitoring – should be extensive (Section 4.13)
Leeuwin Environment	• Impact on biodiversity of Australia's only recognised "Biodiversity Hotspot" (Section 4.1) • Impacts on GDEs and need for hydrologic certainty (eg Margaret river pools) (Section 4.1 and 4.7) • Inadequacy of model to assess environmental impacts (Section 4.1) • Impact on fauna in Blackwood River (Section 4.4) and tributaries (Section 4.5) • Climate change and EWRs (Section 4.11) • Acid sulphate soils (Section 4.6) • Selective use of peer review comments • Ecological impact of rejected recharge (Section 4.6) • Differentiation on cause of impacts (Section 4.13) • Mitigation of impacts may take a long time (Section 4.9) • Impossible to stop extraction because of investment (Section 4.14) • Local use cut (Section 6.1)

Submitter	Issues
Leschenault Catchment Council	• Uncertainty – discrepancies in information, decision should be deferred until Government Water Management Plans are in place (Section 4.8) • Ecosystem integrity – severe impacts on biodiversity, threatened species and communities (Section 4.1) • Wetlands – threat to wetlands near Bunbury, coastal plains (Section 4.6) • Acid sulphate soils – threat to wetlands (Section 4.6) • South west future water supply – project will curb regional productivity and development (Section 6.1) • Climate change – Precautionary Principle should be applied (Section 4.11) • Swan Coastal Plain – increase salinity at the base of the Scarp (Section 4.6) • Improve water use efficiency – pricing, reuse, fit for use supply, native gardens (Section 6.4.5)
Lower Blackwood Landcare Centre	• Acid sulphate soils (Section 4.6) • Drawdown effects on agriculture (including acid sulphate soils) (Section 6.2) • Blackwood River and tributaries – reduced flows, salinity (Section 4.4 and 4.5) • Contingencies – supplementing flows is not sustainable (Section 4.14) • Offsets – inappropriate and infeasible (Section 4.9) • Biodiversity, flora and fauna, groundwater dependent ecosystems – unacceptable threat (Section 4.1) • Scott Coastal Plain – unacceptable threat to a diverse and highly endemic ecosystem (Section 4.6) • Improve water use efficiency (Section 6.4.5)
Margaret River Wine Industry Association Inc.	• South west future water supply – reduce availability for agriculture (Section 6.2), Yarragadee will be fully allocated soon with just regional use (Section 6.1) • Uncertainty (Section 4.8) • Existing water users – modelling should be based on allocations not estimated use (Section 6.2) • Contingencies – Water Corporation should take responsibility for all Yarragadee water use (Section 4.14)
Pastoralists and Graziers Association of Western Australia	• Uncertainty – further research and a management framework for all users is required, current discrepancies between the Water Corporation and DoW reports, groundwater dependent ecosystems not sufficiently understood (Section 4.8) • Alternative sources – water trading from existing unused allocations (Section 6.4.5)
South West Environment Centre (Inc.)	• Blackwood River and tributaries (Section 4.4 and 4.5) • Coastal plains (Section 4.6) • Uncertainty (Section 4.8) • Acid sulphate soils (Section 4.6) • Biodiversity, flora and fauna, groundwater dependent ecosystems (Section 4.1) • Social impacts of environmental changes (Section 6.7) • Contingency actions – adaptive management is not sufficient guarantee (Section 4.14) • Monitoring – support for the Monitoring Review Group concept (Section 4.13) • Offsets – insufficient (Section 4.9) • Alternative sources – water recycling (Section 6.4.5) • Improve efficiency of water use (Section 6.4.5) • Salt water intrusion (Section 4.12)

Submitter	Issues
Southern Forests Landcare - Warren Catchments Council	• Alternative sources – North West Yarragadee, desalination using alternative energy, (Section 6.4.5) • Alternatives – project implementation should be staged (Section 6.4.5) • Improve water use efficiency – pricing, education, gardening, fit for use water supply strategy (Section 6.4.5) • Uncertainty – insufficient data for assessment, not enough known about EWRs, uncertainty in the modelling due to the use of average data and inaccurate conceptualisation of the river-aquifer interface, recommend research into the geological structure of the region (Section 4.8) • Biodiversity – impacts on regionally high value vegetation, not enough known (Section 4.1) • Contingencies – lack of information on contingencies and adaptive management, contingency actions should be able to be implemented immediately, need binding trigger levels (Section 4.14) • Monitoring – establish monitoring network prior to abstraction, insufficient monitoring frequency proposed, monitoring should be real time, support for the independent Monitoring Review Group (Section 4.13) • Climate change – increases uncertainty (Section 4.11) • Precautionary principles – should be applied (Section 4.8) • Wetlands – project puts the Gingilup-Jasper Wetland System at risk, not enough information to determine what will be impacted (Section 4.6) • Acid sulphate soils – serious threat, Mineral Sands example, need to survey the area at risk in detail (Section 4.6) • Scott Coastal Plain – serious risk to the eastern Scott Coastal Plain (Section 4.6) • Other areas – more information required on Donnelly River, Busselton, Lake Jasper, Bunbury and Margaret River (Section 4.7)
South-West Forests Defence Foundation Inc.	• Biodiversity, flora and fauna, groundwater dependent ecosystems – unacceptable threat) (Section 4.1) • Acid sulphate soils – effects on Scott River and Hardy inlet (Section 4.6) • Uncertainty – inadequate research on effects of groundwater drawdowns (Section 4.8) • Cumulative impacts – climate change, tree farming, clearing, burning and disease (Section 4.10) • Blackwood River – salinity, flows (Section 4.4) • Improve efficiency of water use (Section 6.4.5)
Toby Inlet Catchment Group Inc.	• Biodiversity, flora and fauna, groundwater dependent ecosystems – unacceptable threat (Section 4.1) • Blackwood River (Section 4.4) and tributaries – salinity, flows, freshwater fish and crayfish (Section 4.5) • Acid sulphate soils – coastal plains (Section 4.6) • Improve efficiency of water use (Section 6.4.5) • Alternative sources – recycle waste water (Section 6.4.5) • Wetlands – potential for acidification and salinity (Section 4.6) • Uncertainty – ecological effects of groundwater drawdown (Section 4.1), no research done near St John Brook where the wellfield will be located (Section 4.8) • Cumulative impacts – regional abstraction and climate change (Section 4.10) • South west future water supply – will have an impact, therefore not enough water for regional transfer (Section 6.1) • Scott Coastal Plain – effects on the Scott River and National Park not studied (Section 4.6) • Aboriginal heritage (Section 6.6)

Submitter	Issues
Urban Bushland Council WA Inc.	• Uncertainty – insufficient understanding of groundwater dependent ecosystems (Section 4.1) • Contingencies – Water Corporation won't turn it off (Section 4.14) • Acid sulphate soils – Beenup mine example, studies required before assessment (Section 4.6) • Blackwood River tributaries (Section 4.5) • Uncertainty – conflicting figures of recharge (151 GL/yr and 373 GL/yr), insufficient hydrogeological understanding, insufficient understanding of ecosystem impact (Section 4.8) • Climate change – not adequately incorporated (Section 4.11) • Biodiversity, flora and fauna, groundwater dependent ecosystems – no benign effects of groundwater drawdown (Section 4.1) • Improve efficiency of water use (Section 6.4.5)
Waterbirds Conservation Group	• Improve water use efficiency – native gardens (Section 6.4.5) • Biodiversity - project is a threat to the environmental values and biodiversity of the South West, likely to have drastic effects on TECs (Section 4.1) • Acid sulphate soils – likely to be widespread, Beenup example (Section 4.6) • Blackwood River and tributaries – likely to extinguish aquatic fauna, salinity threat (Section 4.4 and 4.5) • Climate change – defer any drawdown of the aquifer until climate change is understood, not adequately addressed in the document, (Section 4.11) • Alternative sources – recycling (Section 6.4.5) • Wetlands – important wetlands threatened, not enough information on the Swan Coastal Plain, ecological values will be seriously affected (Section 4.6) • South west future water supply – the project is stealing water from the region which has its own needs (Section 6.1) • Economic impacts – tourism losses, need to cost environmental impacts (Section 6.3) • Consultation – the Sustainability Evaluation/ERMP is difficult to read and incomplete (Section 4.16) • Salt water intrusion (Section 4.12) • Aboriginal heritage (Section 6.6) • Cumulative impacts – have not been adequately addressed, blue gums (Section 4.10) • Infrastructure – clearing will result in a net decrease in ecological function and biological diversity, clearing in the conservation estate and river crossings is unacceptable (Section 4.15) • Monitoring – need more research into baseline data, support for the Monitoring Review Group but need more information on who the group would consist of, time lag in response would mean that adaptive management may happen too late (Section 4.13) • Contingencies – no guarantee that supplementation of flows would work (Section 4.14) • Other areas – need information on the effect of reduced freshwater discharge (Section 4.7) • Uncertainty – abstraction may reduce the quality of the water resource, studies were undertaken during 2002 to 2005 and this is too short for a full understanding of the system (Section 4.8) • Coastal Plains – threat to the endemic aquatic fauna in the area (Section 4.6) • Offsets – not appropriate, the predicted impacts can't be offset (Section 4.9)

Submitter	Issues
Western Australian Farmers Federation (Inc.)	• Precautionary principle, uncertainty (Section 4.8) • Drawdown effects on agriculture (Section 6.2) • Water supply – for agriculture (Section 6.2) • Social impacts (Section 6.7) • Consultation process – not well implemented (Section 4.16) • Salt water intrusion (Section 4.12) • Threat to biodiversity (Section 4.1) • Wetlands (Section 4.6) • Alternative sources – desalination, water recycling, catchment thinning, Wellington Dam (Section 6.4.5) • Improve efficiency of water use (Section 6.4.5)
Western Australian Forest Alliance	• Biodiversity, groundwater dependent ecosystems, flora and fauna – significant impact from lower groundwater (Section 4.1) • Climate change (Section 4.11) • Acid sulphate soils – unacceptable risk (Section 4.6) • Uncertainty – inadequate research on potential impacts of drawdown on ecosystems (Section 4.1) • Blackwood River – increased salinity unacceptable (Section 4.4) • Offsets and contingencies – Water Corporation should be responsible for its impacts, support for "switch off" contingency (Section 4.9 Section 4.14) • Monitoring – support for independent review group (Section 4.13) • Improved efficiency of use (Section 6.4.5) • Alternative sources – recycling (Section 6.4.5)
Western Australian Fruit Growers Association	• Water supply – for agriculture (Section 6.2) • Alternative sources – reuse of treated wastewater (Section 6.4.5) • Improve efficiency of water use (Section 6.4.5)
Wetlands Conservation Society (Inc.)	• Wetlands – likely significant impacts (Section 4.6) • Biodiversity, flora and fauna, groundwater dependent ecosystems – unacceptable threat, Gnangara example (Section 4.1) • Uncertainty – hydrogeology not well understood (Section 4.8) • Improve water use efficiency (Section 6.4.5) • Alternative sources – recycled waste water, Wellington Dam (Section 6.4.5) • Accountability – Water Corporation has a poor record of environmental performance (unsubstantiated opinion)
Wetlands Research Associations Inc.	• Impacts on conservation significant Reedia wetlands (Section 4.2) • Errors in stratigraphy and structural geology (direct connection of surface of Mowen Member to underlying drawdowns, faults act as conduits, etc) will result in wetlands on plateau being drawn down (Section 4.3) • Radiocarbon dating is flawed (Section 4.3) • Partitioning of the water balance (Section 4.3) • Threats of irreversible damage (Section 4.1) • Lack of full scientific certainty and Precautionary Principle (Section 4.8)

Submitter	Issues
Wildflower Society of Western Australia	• Threat to biodiversity and groundwater dependent ecosystems (Section 4.1) • Uncertainty, Precautionary Principle (Section 4.8) • Climate change (Section 4.11) • Contingencies – may be too late (Section 4.13) • Acid sulphate soils (Section 4.6) • Blackwood River tributaries (Section 4.5) • Accountability – previous performance (Water Corporation will be legally accountable through the Se/ERMP commitments, including monitoring, reporting and responding to monitoring as required) • Alternative sources – water recycling (Section 6.4.5) • Improve efficiency of water use (Section 6.4.5)

Table 7.3 Submission issues raised by individuals

Issues	No of submissions	Refer to
Project support	2 individual	Section 1
Biodiversity, flora and fauna, groundwater dependent ecosystems – general threat to the environment of the South West	101 individual plus proformas	Section 4.1
Cumulative impacts	20 individual plus proformas	Section 4.10
Climate change	36 individual plus proformas	Section 4.11
Saltwater intrusion	19 individual	Section 4.12
Monitoring regime	6 individual plus proformas	Section 4.13
Contingency actions	20 individual plus proformas	Section 4.14
Pipeline route	5 individual	Section 4.15
Consultation process	4 individual	Section 4.16
Threatened or rare flora, fauna or ecological communities	29 individual plus proformas	Section 4.2
Blackwood River	45 individual plus proformas	Section 4.4
Blackwood River tributaries	25 individual	Section 4.5
Acid sulphate soils	50 individual plus proformas	Section 4.6
Coastal Plains	25 individual	Section 4.6
Wetlands	27 individual	Section 4.6
Other areas	8 individual plus proformas	Section 4.7
Precautionary principle	14 individual	Section 4.8
Uncertainty	46 individual plus proformas	Section 4.8
Mitigation and offsets	5 individual plus proformas	Section 4.9
Energy use	2 individual	Section 5.5
South west future water supply	18 individual plus proformas	Section 6.1
Drawdown effects on agriculture	12 individual	Section 6.2
Effects on other users	20 individual plus proformas	Section 6.2
Economic impacts	9 individual plus proformas	Section 6.3
Alternatives sources / locations	62 individual plus proformas	Section 6.4.5
Inappropriate use of water, improve efficiency	79 individual plus proformas	Section 6.4.5
Heritage	7 individual	Section 6.6
Social impacts	8 individual plus proformas	Section 6.7

8. CHANGES TO PROPOSAL

8.1 KEY CHARACTERISTICS

The key characteristics of the proposal are presented in Table 8.1 and Figure 8.1. The key project characteristics have not changed from those presented in the Sustainability Evaluation/ERMP. Minor pipeline route changes have been (and will continue to be) negotiated with landowners prior to final design. The wellfield collector main length has been increased from 7.5 km to 20 km.

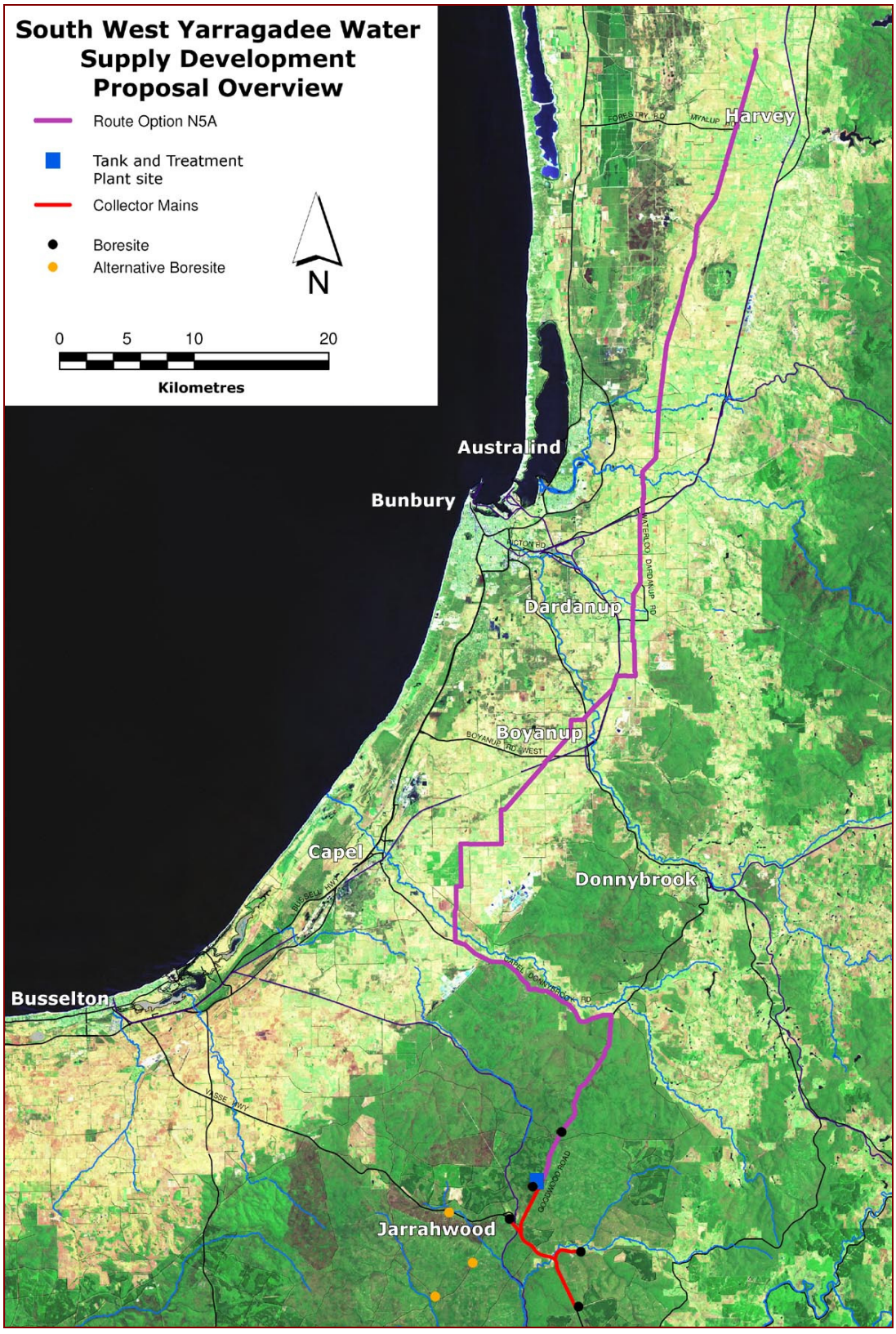
The proposal includes a water treatment plant to be located in a pine plantation to the north of the source works and transfer main to take water from the treatment plant to the existing IWSS Stirling Trunk Main at Harvey mostly along roadsides and through cleared land.

Table 8.1 Key characteristics table

Element	Description
Wellfield	
Source	South West Yarragadee aquifer
Rate of abstraction	45 GL/yr
Location of wells	5 sites and 3 contingency sites as indicated in Figure 8.1
Well type	Conventional up to 20 ML/day capacity
No. of wells	2 at each site, one each at approximately 400m depth (Yarragadee Unit 1) and approximately 700m depth (Yarragadee Unit 3)
Pipeline	
Water transfer mains	Approximately 105 km as indicated in Figure 8.1. The final alignment is subject to detailed environmental and engineering investigations, and landholder consultation.
Diameter	1400 mm
Wellfield collector main	Approximately 20 km total for the 5 well sites. Approximately 13 km total for the 3 contingency sites, if required.
Length	20 km
Diameter	1400 mm
Water treatment plant	
Location	Goodwood Road on the Whicher Scarp near Jarrahwood
Facilities	Filtration, chlorination, pH adjustment, sludge drying beds
Capacity	135 ML/day on average
Storage tank	25 ML
Clearing	
Clearing	Approximately 50 hectares total, within agricultural land, road reserves and State Forest.
Energy use	
Wells	600 kW each (35 GWhr/yr)
Treatment plant	600 kW each (5 GWhr/yr)
Pump stations	None*

* A proposed pump station at Ravenswood is not specific to the South West Yarragadee Water Supply Development project.

Figure 8.1 Locality plan of the South West Yarragadee Water Supply Development



Construction of the project infrastructure will take two years and is planned to commence in late 2007 with commissioning in late 2009. Construction of the pipeline will be carried out during two summer periods (2007/08 and 2008/09) to minimise impacts when the watertable is close to or at the ground surface.

8.2 CHANGES TO GROUNDWATER ABSTRACTION MANAGEMENT PLAN

In response to the submissions received, several changes were made to the Groundwater Abstraction Management Plan presented in the Sustainability Evaluation/ERMP. The key areas of change are:

- modifications to the monitoring program, in particular the specification of criteria monitoring sites and associated drawdown regimes that would trigger management responses
- identification of vegetation monitoring sites, including control sites
- inclusion of a more detailed contingency triggering process.

The revised Groundwater Abstraction Management Plan is presented at Appendix 1.

8.3 ADDITION OF WETLAND MANAGEMENT PLAN

A Wetland Management Plan has been prepared in response to comments and is presented at Appendix 2.

8.4 CHANGES TO COMMITMENTS

In response to the issues raised in the public submissions and in consultation with the EPA, the Water Corporation has made a number of changes to the proposal commitments. The commitments have also been reviewed and refined to make them clearer and more readily auditable. Some refinement has related to confining the scope of the environmental commitments to environmental issues and some timings have been modified to reflect more appropriate times (eg publishing of the annual Sustainability Report to commence following completion of construction, rather than prior to construction). The commitments have also been re-ordered. The key changes are as follows:

1. Commitment 6 (Table 8.2) has been modified to reflect the current state of discussions with DEC officers regarding sponsorship of a threatening process program. This has resulted in an increase in the proposed level of funding, with a $1.5M (compared to $1M in original commitment).
2. Commitment 4 in the Sustainability Evaluation/ERMP has been removed as it is not measurable or achievable. DEC as the advisory agency for the EMPs (New commitment 2.1 and 3.1) will be able to provide comments on the actions for management of the issues. The EMPs will address all environmental matters previously listed in the commitment. In addition, the inclusion of matters currently addressed under other legislation represents an unacceptable legal risk to the proponent in the previous wording (e.g., breach of noise regulations has a maximum penalty of $25K for bodies corporate, however, inclusion as a condition of a Ministerial Statement increases the maximum penalty to $250K.
3. Commitment 6 in the Sustainability Evaluation/ERMP has been removed as quarterly intervals for third party audits are not appropriate. Audits may take a month to complete at each time, and first and second party audits will also be undertaken. The audit schedule will be included in the EMP required by new Commitment 3.1 (Table 8.2).

4. Inclusion of a new commitment (Commitment 10 Table 8.2) to develop a local scale model to enable more refined consideration of potential drawdown impacts on the groundwater dependent ecosystems of the Blackwood River and tributaries.
5. The SE/ERMP commitments referred to advice from CALM (Department of Conservation and Land Management) and DoE (Department of Environment). The recent amalgamation of these agencies into the Department of Environment and Conservation (DEC) is acknowledged in the revised commitments.

The revised commitments are set out in full in Sections 8.4.1 and 8.4.2.

8.4.1 General Commitments

This section outlines commitments made by the Water Corporation that are not likely to be conditions of approval issued under Part IV of the *Environmental Protection Act 1986* and are not necessarily requirements under other legislation. These commitments will be publicly reported on and independently audited by an accredited Environmental Auditor every five years.

1. Work with the DoW and DEC to arrange declaration of a public water supply catchment area over the relevant portions of the Yarragadee aquifer recharge zones.
2. Establish a South West Yarragadee Interpretive Centre in the South West to provide information to the community and visitors about development of the aquifer.
3. If existing Aqwest (formerly Bunbury Water Board) or Busselton Water Board public water supply wells are affected by saltwater intrusion (to the extent that they no longer meet the water quality criteria for potable use) caused by the Water Corporation groundwater abstraction from the Yarragadee aquifer, the Water Corporation will provide alternative means for accessing an equivalent amount of potable water at an equivalent cost, through either:
   3.1. provision of funding to install new wells into the Yarragadee aquifer further inland
   3.2. direct supply of water to the relevant company by the Water Corporation.
4. Develop and implement a landowner engagement program to finalise the pipeline alignment, management of pipeline construction and ongoing maintenance procedures.
5. Act within the provisions of the *Land Administration Act 1997* for the pipeline easement interest, but wherever possible, agree on compensation for the interest in land, for loss or for compensation through negotiation.
6. The water from the proposal will be available to any consumer prepared to enter the standard access arrangements (user pays cost of connection or as otherwise supported by the Government) and the uniform tariff pricing policy that applies to other IWSS water users in the State.
7. If the groundwater abstraction is reduced by the Water Corporation in accordance with the adaptive management program, or the Department of Water reduces the licence allocation in the future, the Water Corporation commits to develop alternative strategies to address any shortfall in IWSS supply to IWSS consumers including those in the South West[11].

[11] It is understood that the development of alternative sources to meet supply shortfalls would be subject to the usual approvals, and no approval of contingencies would be implied by approval of this proposal.

8. Undertake a South West Public Water Supply Future Planning Study to provide a plan for meeting the future public water supply needs in the South West. This plan would be undertaken in conjunction with Aqwest and Busselton Water Board and involve extensive consultation and market surveys of community satisfaction with the water planning and management. The plan would investigate and address the following:

   8.1. future public water supply demand

   8.2. potential sources for public water supply

   8.3. source development program for public supply

   8.4. assessment of quality and security of existing public water supplies

   8.5. program for upgrading existing quality and security of public water supplies where required

   8.6. program for new connections to the extended IWSS or other sources.

9. Undertake a South West Yarragadee Sustainability Initiative that includes:

   9.1. the biodiversity and acid sulphate soils studies in Environmental Commitment 2

   9.2. sponsor a research program up to the value of $0.5M on:

      9.2.1. the magnitude and potential means of management of irrigation return water

      9.2.2. the effects of changing land use on water demand, availability and quality.

10. Provide opportunities for Indigenous People to be employed in undertaking monitoring programs.

11. The Water Corporation will establish and maintain a South West Yarragadee Monitoring Review Group to review and provide advice to the Water Corporation on:

   11.1 environmental monitoring actions

   11.2 environmental monitoring results

   11.3 adaptive management measures for groundwater abstraction.

   The Water Corporation will consider representation on the South West Yarragadee Monitoring Review Group as described in the Environmental Review and Management Programme (Strategen, February 2006, Volume 1 Chapter 8 Section 3.2.3).

8.4.2 Environmental commitments

Table 8.2 Consolidated environmental commitments

Commitment No.	Commitment	Timing	Seek advice from
1 Environmental Surveys	The Water Corporation will survey the infrastructure alignment to determine: • the presence and depth of acid sulphate soils. • flora, fauna and forest diseases.	Prior to construction.	-
2.1 Environmental Management Plan - Construction	The Water Corporation will refine the Construction Environmental Management Plan contained in the Sustainability Evaluation/Environmental Review and Management Programme (Strategen, February 2006, Volume 2 Chapter 9) addressing the management of: • Terrestrial Flora and Fauna. • Weeds and Forest Diseases. • Fire. • Noise and Vibration. • Acid Sulphate Soils and Dewatering. • Dust. • Incidents, spills and wastes. • Borefield Construction. • Rehabilitation. • Environmental and Compliance Auditing.	Prior to construction.	DEC
2.2 Environmental Management Plan - Construction	The Water Corporation will implement the Construction Environmental Management Plan required by Commitment 2.1.	Construction and post-construction as stipulated in the plan.	DEC
3. South West Yarragadee Water Supply Sustainability Report	The Water Corporation will prepare and publish a South West Yarragadee Water Supply Sustainability Report on: • compliance with conditions of the Statement. • assessment of environmental performance and implementation of environmental management plans. • summary of environmental monitoring results and investigations. • stakeholder engagement. • advice from the South West Yarragadee Monitoring Review Group to the Water Corporation, and the response by the Water Corporation to that advice.	At the completion of construction and then annually for the first five years of operation. The frequency of reporting will then be reviewed and determined by the Water Corporation on advice of the South West Yarragadee Monitoring Review Group.	

Commitment No.	Commitment	Timing	Seek advice from
4. Offset - Environmental Protection.	The Water Corporation will provide the DEC with a sponsorship grant of $300 000 per year for 5 years for the management of feral pigs and/or foxes in the following areas: • Blackwood River; • Poison Gully and Milyeannup Brook valleys; • proposed Blackwood National Park; • proposed St John Brook Conservation Park; • Western Scott Coastal Plain; • Eastern Scott Coastal Plain; and/or • Swan Coastal Plain southwards from the northern border of the Shire of Harvey. Notations: 1. The management of feral pigs and/or foxes will be implemented by the DEC. 2. The value is not subject to interest or CPI increases over time.	Construction and Operation.	-
5. Offset – Environmental Investigations	The Water Corporation will develop and implement a $1.5M biodiversity and acid sulphate soils study in the following areas: • Blackwood River; • Poison Gully and Milyeannup Brook valleys; • proposed Blackwood National Park; • proposed St John Brook Conservation Park; • Western Scott Coastal Plain; • Eastern Scott Coastal Plain; and/or • Swan Coastal Plain southwards from the northern border of the Shire of Harvey. The biodiversity component of the study may include but is not be limited to the investigation of: • the spatial extent, condition, and groundwater dependence of vegetation communities at local and regional scale; • the spatial extent, condition, and groundwater dependence of TECs; • the spatial extent and abundance of aquatic fauna that use watercourse tributaries as refugia. • The acid sulphate soils component of the study may include but is not be limited to the investigation of: • the spatial extent and depth of acid sulphate soils.	To be completed within 5 years after the commencement of operation.	The study scope will be developed with DEC and DOW. The results will be provided to the South West Yarragadee Monitoring Review Group, DEC and DoW.
6. Offset – Land	The Water Corporation will offset native vegetation cleared. The area of offset land will be calculated using a clearing loss/gain area ratio of 1:1.5 and will be of comparable conservation value, or alternatively as agreed with the Director General of the DEC. The offset land will be incorporated into the conservation estate by (a) the freehold transfer of Water Corporation owned the land to the Director General of DEC, (b) the transfer of land(s) vested with the Water Corporation to be vested with the Director General of DEC or (c) establishing conservation covenants on land(s) owned by or vested with the Water Corporation, as determined by the Water Corporation.	Within 2 years after the commencement of operation.	DEC

Commitment No.	Commitment	Timing	Seek advice from
7. Poison Gully Artificial Supplementation – Investigation.	The Water Corporation will investigate the artificial supplementation of Poison Gully with groundwater sourced from the South West Yarragadee Groundwater Aquifer. The investigation will include: • A survey of fauna (terrestrial and aquatic) that is dependent on the surface water contained in Poison Gully. • An assessment of values of the flora (as previously surveyed) and fauna identified in comparison to the known distribution of the flora and fauna within SW State Forest. • An assessment of the options available for supplementation of Poison Gully. The assessment will include identification of the volume of groundwater required for supplementation to offset surface water level reductions from operation of the South West Yarragadee Water Supply Proposal (excludes impacts from climate change). • An assessment of the feasibility of installing the required infrastructure for artificial supplementation (including provision of power, environmental impacts from construction, installation and operational costs).	Prior to operation.	DEC

9. CONCLUSIONS

All issues raised in the submissions have been addressed in this report by either:

- further explanation of technical aspects of the proposal to address the issue or concern
- provision of more detail on the proposal regarding the issue of concern
- modifications to several commitments
- modification to the Groundwater Management Abstraction Plan and inclusion of a Wetland Management Plan.

Based on the extensive impact assessment presented in the Sustainability Evaluation/ERMP and evaluation of the response to issues raised in the public submissions, the Water Corporation is confident that the proposal will not result in significant adverse impacts to environmental values in the region. Key aspects that provide this confidence are:

1. The highly developed understanding of the conceptual hydrogeology/hydrology of the region based on extensive drilling, testing and monitoring programs undertaken over several decades. This understanding has been adopted into a best practice three-dimensional model of the groundwater system to evaluate regional scale responses to the various scenarios of future abstraction and changes to recharge because of further future climate change. While limited to providing a regional scale evaluation of drawdown impacts, the model is conservatively based in respect of several key parameters. These include the extensive volumes of water held in storage in clayey horizons that would be released by drawdowns in the Yarragadee Formation and recovery of "rejected recharge" on the coastal plains (acknowledged by the Peer Review Panel).
2. The development of a local scale model for the Eastern Scott Coastal Plain and the detailed examination of the hydrogeology and hydrostratigraphy of the Blackwood River and tributaries and the Swan Coastal Plain has confirmed the regional scale modelling results as being conservative.
3. The physical magnitude of the resource includes an extensive storage that that provides considerable buffering against the effects of changes in the system stressors such as recharge and abstraction. The recharge estimates are considerably higher than expected future abstraction levels, and have been conservatively derived.
4. The Water Corporation wellfield is located in an area remote from any existing and expected future abstractions by other parties, such that the Water Corporation proposal is effectively not competing with existing and future regional users. On the coastal plains, where the majority of existing and future abstractions are located, the Water Corporation drawdowns are expected to be minor compared to the effects of local abstraction.
5. The proposed adaptive management approach within a comprehensive hydrological/biological monitoring and response framework with identified triggers and availability of demonstrably feasible contingency actions provides assurance that unexpected impacts can be detected and managed.

During the scoping phase of this project, a list of sustainability objectives was established in consultation with the community and stakeholders. The results of the impact assessment, sustainability evaluation and this response to submissions indicate that all of these objectives are expected to be met by the Water Corporation proposal. A summary of the objectives, impacts and expected outcomes are provided in Table 9.1 to briefly outline how each objective is met.

Table 9.1 Summary of relevant sustainability factors, proposed management and expected outcomes

Factor & objectives	Potentially affected area	Existing environment	Potential impact (+ve/-ve)	Proposed management	Expected outcomes
ENVIRONMENTAL PRINCIPLE – Biodiversity and ecological integrity					
Flora and fauna The Water Corporation will seek to achieve a net increase in flora and fauna in the region As a minimum, the proposal will have no adverse impact on flora and fauna in the region **Rare and Priority Flora** (groundwater dependent) The Water Corporation will seek to achieve a net increase in priority and rare flora in the region. As a minimum, the proposal will have no adverse impact on rare and priority flora in the region	Blackwood River	The Blackwood River discharges 940 GL/yr of water to the Hardy Inlet and is extensively used for recreation. The river is affected by salinity with around 30-40 GL/yr of fresh groundwater baseflow that lowers the salinity of the river during summer. Other issues in the river are nutrient levels, erosion, turbidity, pool aggradation and pool anoxia. Five species of freshwater fish (salt tolerant) exist in the River. Riparian vegetation is dominated by Flooded Gums, Peppermints and Paperbarks. Human disturbance has led to high numbers of understorey weeds in some sections.	No significant impact is expected on the terrestrial or riparian environment along the Blackwood River. The predicted drawdown from the Water Corporation proposal only is expected to result in a 6% reduction in the summer baseflow of the Blackwood River in the driest years with an associated less than 10% increase in salinity during January-February These hydrological changes are not expected to have a significant impact on aquatic fauna.	Proposed mitigation includes a commitment to the supplementation of summer flows in the Blackwood River if unexpected and unacceptable impacts are likely to occur.	The predicted change in salinity is not expected to have a significant impact on the ecological values of the already altered Blackwood River. All ecological water requirements will be met even with the predicted change in flows from both the proposal and estimated future regional use. No loss of species is expected from either the aquatic or terrestrial ecosystems. The commitment to support reduction in threatening processes within the area will enhance ecological values currently affected or under threat and improve biodiversity in the area.

Factor & objectives	Potentially affected area	Existing environment	Potential impact (+ve/-ve)	Proposed management	Expected outcomes
Threatened Fauna The Water Corporation will seek to achieve a net increase in the viability of threatened fauna populations in the region As a minimum, the proposal will have no adverse impact on the distribution and viability of threatened fauna populations in the region **Threatened ecological communities (groundwater dependent)** The Water Corporation will seek to achieve a net increase in the viability of threatened ecological communities in the region As a minimum, the proposal will have no adverse impact on the distribution and viability of threatened ecological communities in the region	Poison Gully and Milyeannup Brook	Poison Gully and Milyeannup Brook are permanent tributaries of the Blackwood River that contribute approximately 0.1 GL/month of Yarragadee Formation discharge to the Blackwood River. Milyeannup Brook is a narrow tributary with Jarrah, She-Oak, Marri with Peppermints and dense undergrowth. Poison Gully is more diverse with a greater range of soil and moisture conditions. Five species of endemic freshwater fish were recorded in Milyeannup Brook and four in Poison Gully. Two of these, the mud minnow and Balston's pygmy perch are Priority 4 species. Both species were recorded in Milyeannup Brook and only the mud minnow was recorded in Poison Gully.	The predicted watertable drawdown resulting from the proposal is up to 1-2 m in Poison Gully and up to 2-3 m in Milyeannup Brook after 30 years of pumping. The total predicted watertable drawdown resulting from the proposal together with estimated future regional use in both valleys after 30 years is up to 3-5 m. There are approximately 177 ha of vegetation in Poison Gully and 52 ha of vegetation in Milyeannup Brook that has a depth to watertable of <10m and may be affected by groundwater drawdowns. Within this area, there may be a shift in some vegetation types in the lower slopes of the valleys; however, the full range of vegetation types will still exist; only their extents may change. The current spring in Poison Gully may migrate several hundred metres downstream from its current position 3.5 km upstream from the Blackwood River and the permanent stream length of Milyeannup Brook flow may contract from 2.5 km to 1 km from the proposal and estimated future regional use. There is expected to be an approximate 30% reduction in summer baseflow.	An extensive monitoring program will be undertaken in Poison Gully and Milyeannup Brook. If unexpected and unacceptable impacts are likely to occur, contingencies will be implemented. A specific contingency is proposed to supplement flows in Milyeannup Brook if hydrological changes are likely to significantly reduce the habitat available for the Balston's pygmy perch in Milyeannup Brook. If supplementation is required, the rates of flow will be designed to mimic natural flows and water quality conditions.	Watertable drawdowns in Poison Gully are expected within a localised area. Some local changes in vegetation composition are expected. This change in vegetation composition will not significantly affect any significant flora or fauna species or local or regional occurrence of any vegetation complex or site-vegetation types. The composition of some site types may change in a small section of Milyeannup Brook and Poison Gully but there will be no significant loss of keystone species, ecosystem function (including fauna habitat) or resilience. The tributaries are important refugia for significant freshwater fish species but all defined ecological water requirements are predicted to be met and instream ecology is not expected to be significantly affected. Proposed mitigation includes a commitment to the supplementation of summer flows in Milyeannup Brook if the Balston's pygmy perch habitat is substantially affected. Commitments to reduce threatening processes within the area will enhance ecological values currently affected or under threat and improve biodiversity in the area.

Factor & objectives	Potentially affected area	Existing environment	Potential impact (+ve/-ve)	Proposed management	Expected outcomes
Blackwood River and its tributaries The Water Corporation will seek to increase the ecological integrity of the Blackwood River and its tributaries. As a minimum, the proposal will have no significant adverse impact on the Blackwood River and its tributaries	Rosa Brook	Rosa Brook is not perennial and generally flows for six months from early winter to late spring. Localised pools persist in the brook throughout the year The valley is entirely within State Forest and has similar vegetation to Milyeannup Brook; forests and woodlands of Jarrah, Marri and Peppermints with dense undergrowth. No DRF species but three Priority 3 species were recorded in Rosa Brook. Four species of freshwater crayfish and five species of freshwater fish occur including the Priority 4 mud minnow.	The predicted drawdown likely to occur after 30 years as a result of the proposal is between 0.1 m and 0.25 m with small areas of drawdown in the 0.25 – 0.5 m range near Crouch Road. This drawdown over 30 years is not expected to have a measurable effect on vegetation or habitat values. The total predicted watertable drawdown resulting from the proposal together with estimated future regional use in Rosa Brook after 30 years is up to 0.5 m (with a few very small areas with a drawdown in the 0.5 – 1 m range). The Yarragadee Formation does not outcrop at the surface in Rosa Brook and the stream is not permanent so the proposal will have no discernible impact on the hydrology of the stream.	No measurable changes in Rosa Brook are expected. The groundwater levels will be monitored to ensure that the system responds as expected. If unexpected water level changes occur, contingency measures will be developed depending on the extent of impact.	The predicted groundwater drawdowns in Rosa Brook are small and the proposal is likely to result in a "low – no measurable change" impact through most of the potentially affected area within the valley. Any vegetation change that occurs will not affect the conservation status of any significant flora or fauna species or the local or regional occurrence of any vegetation complex. Small changes may occur in some site-vegetation types but regional occurrence will not be significantly affected. Rosa Brook flows will not be affected by the proposal.

Factor & objectives	Potentially affected area	Existing environment	Potential impact (+ve/-ve)	Proposed management	Expected outcomes
Wetlands The Water Corporation will seek to increase the ecological integrity of wetlands in the region. As a minimum, the proposal will have no significant adverse impact on wetlands **Other Groundwater Dependent Ecosystems (GDEs)** The Water Corporation will seek to increase the ecological integrity of other groundwater dependent ecosystems in the region. As a minimum, the proposal will have no significant adverse impact on other groundwater dependent ecosystems	St John Brook	St John Brook is the largest tributary of the Blackwood River and has a number of large permanent pools including Barrabup Pool and Workmans Pool. The brook has a small summer baseflow from the Leederville Formation of approximately 0.3 GL/yr (10 L/s), which is approximately 0.6% of the mean annual flow in the brook. Most of the St John valley is included within proposed conservation reserves and 16% of the St John Brook catchment has been cleared. The vegetation of St John Brook is dominated by open forest with an overstorey of Marri and Jarrah in the valleys and jarrah on the lateritic slopes. Three species of freshwater crayfish and four species of freshwater fish occur in St John Brook including the Priority 4 mud minnow.	The total predicted watertable drawdown resulting from the proposal together with estimated future regional use upstream of Barrabup Pool after 30 years is 1-2 m with most of this drawdown attributable to the proposal. There are approximately 700 ha of vegetation in St John Brook within the general area that may be affected by groundwater drawdowns. Within this area, the lower slopes are most likely to show change, with a small down-slope shift in the vegetation types. The scale of the model and the accuracy of the depth to groundwater contours is not sufficient to refine the area of actual expected impact further, however St John Brook is highly dissected and the lower slopes that may show some change would make up only a small proportion of the 700 ha. Drawdown above (not including) Barrabup Pool is expected to cause a small reduction in summer water levels in permanent pools and reduce summer streamflow. As the summer flows are already very low, there is potential that the groundwater discharge will cease in the upper section of the brook.	An extensive monitoring program will be undertaken in St John Brook. If unexpected and unacceptable impacts are likely to occur, contingency measures will be developed depending on the type and extent of impact. One proposed specific contingency is to supplement flows in St John Brook if hydrological monitoring indicates that the permanence of the stream is at risk. If supplementation is required, the rates of flow will be designed to mimic natural flows and water quality conditions.	The proposal has the potential to cause some groundwater drawdown within a general 700 ha area along St John Brook. There may be an effect on some vegetation on the lower slopes of the valley within this broad area. This will not significantly affect the conservation status of any significant flora or fauna species or the occurrence of any vegetation complex, but may affect the local occurrence of some site-vegetation types in a small section of the brook. Reduction in artesian pressures in the Yarragadee Formation below some sections of the brook also has the potential to reduce summer baseflow from groundwater discharge and pool levels above Barrabup Pool. Barrabup Pool itself and other pools below it are not expected to be affected. A contingency to supplement flows is proposed to ensure that this does not result in an unacceptable impact on the brook.

Factor & objectives	Potentially affected area	Existing environment	Potential impact (+ve/-ve)	Proposed management	Expected outcomes
	Reedia Wetlands	The Reedia wetlands occur both north and south of the Blackwood River between Hut Pool and Adelaide Brook within the State forest. The wetlands consist of narrow channels of creek-line flow and small permanent pools that are maintained by groundwater flows from the Leederville Formation supported by artesian heads from the underlying Lesueur Sandstone. The Reedia wetlands are named after the Priority 4 Reedia spathacea species that is found within the wetlands. The significant components of the Reedia wetlands are the valley floors with small permanent pools that support a proposed threatened ecological community and a habitat for a critical frog species.	The investigations undertaken by the Water Corporation have shown that groundwater abstraction from the Yarragadee aquifer will not transfer across the Busselton Fault and affect water table levels in the Reedia wetlands. Therefore, the Water Corporation proposal is expected to have no impact on the Reedia Wetlands.	Monitoring will be undertaken to ensure that no unexpected impacts occur on the Reedia Wetlands.	No impact from the Water Corporation proposal is expected on the Reedia Wetlands. Groundwater monitoring will be carried out to ensure that no unexpected changes in water levels occur as a result of the project. This will provide an early warning system if the aquifers do not perform as predicted. The investigations to date and the proposed ongoing hydrological monitoring of the Reedia wetlands will provide increased knowledge of other threats to the wetlands that will help inform management decisions that reduce the risk to the environment and may contribute to a net improvement.

Factor & objectives	Potentially affected area	Existing environment	Potential impact (+ve/-ve)	Proposed management	Expected outcomes
	Scott Coastal Plain	The Scott Coastal Plain occurs south of the Blackwood Plateau and north of the coastal dunes system. The eastern Scott Coastal Plain is internally draining and characterised by swamps and lakes. The surface geology comprises largely sandy deposits. The D'Entrecasteaux National Park includes a large area of the south eastern Scott Coastal Plain and includes Lake Jasper, Lake Quitjup and the lower parts of Barlee Brook and the Donnelly River. The Scott Coastal Plain is partially cleared for agriculture with large areas of remnant native vegetation. The flora and vegetation on the plain are highly diverse and specialised, and many species have a restricted range. The "Scott River Ironstone Association" vegetation community is listed as Endangered by CALM but the community has not yet been formally listed by the State Minister for Environment and is not listed as a TEC under the EPBC Act.	The watertable drawdowns (based on a 9% reduction in long term rainfall) from the proposal on the eastern Scott Coastal Plain are expected to be mostly less than 0.25 m in the summer minimum after 30 years, with up to 1m drawdowns in small areas in the northern part of the coastal plain. Drawdowns from the proposal combined with future regional use abstractions are expected to be more widespread with drawdowns of up to 1 – 2 m. Drawdowns on the western Scott Coastal Plain are expected to be minor (less than 0.25 m) from the proposal and up to 1 m from the combined abstractions. Drawdowns will occur very gradually over the 30 year period providing the opportunity for groundwater dependent ecosystems to adapt. Lake Jasper and Lake Quitjup are not expected to be affected by drawdowns from the proposal. Most other wetlands on the Scott Coastal Plains are seasonal and will not be affected by a drop in summer minima of water levels. There are 7150 ha of vegetation within the eastern Scott Coastal Plain and 110 ha on the western Scott Coastal Plain where the watertable is likely to be within 10 m of the surface and may potentially be affected by drawdowns from the proposal. No drawdown is expected under the Scott Coastal Plain Ironstone Association. The estimated drawdown in the majority (about 90%) of this area is expected to be 0.25 m or less resulting in a "low – no measurable change" potential impact on groundwater dependent ecosystems. Some small areas (north eastern part of the plain) where drawdown may be as much as 1 m, there may possibly be a "moderate" to "high" potential impact on groundwater ecosystems. Any adverse impact on these systems is likely to be mitigated by soil conditions and the recovery of the watertable during winter where inundation of the landscape occurs. There is not expected to be a measurable change in vegetation (except in small areas where there is potential for changes in site vegetation types in the north eastern part of the plain) given the anticipated full recovery in the watertable each year, soil characteristics and that drawdowns are much smaller than the observed seasonal watertable variation. Similarly, the effect of drawdowns on acid sulphate soils (acid generation) is expected to be minor.	The Water Corporation will develop and implement an extensive biological, hydrological and physical monitoring program for the region including the Scott Coastal Plain to assist in the adaptive management of the proposal. If unexpected and unacceptable impacts are likely to occur, appropriate responses will be developed and submitted to the Monitoring Review Group and the Department of Water for assessment. The Water Corporation is also committed to undertaking a comprehensive biodiversity study (within the proposed Sustainability Initiative) which will include the Scott Coastal Plain and investigate the relationship between ecosystems and groundwater. This study is proposed as a research offset and to assist with the adaptive management of the proposal. The Water Corporation will contribute to a program for the management of threatening processes (weeds, feral animals, etc) in area of conservation significance and areas of potential impact.	Over the majority of the area of potential impact (areas where the watertable is within 10 m and a drawdown is expected) no detectable changes in groundwater dependent ecosystems are anticipated for the Water Corporation proposal. In the northern part of the eastern Scott Coastal Plain, there may be gradual local changes to some site-vegetation types but this will not adversely affect fauna habitat or the conservation status of any significant flora or fauna species or occurrence of vegetation complexes. The Scott River Ironstone Association is not expected to be adversely affected. Given the expected small predicted drawdowns and recovery of watertables each year, the effects of acid sulphate soils are expected to be minimal on the Scott Coastal Plain. Similarly, no significant adverse impact on wetland functions is expected. Proposed mitigation commitments to reduce threatening processes within potential areas of impact will help protect and restore ecological values currently affected or under threat and enhance biodiversity in the area. The knowledge and data obtained from the proposed biodiversity study (within the proposed Sustainability Initiative) and comprehensive monitoring program will improve the natural understanding of the area and provide for adaptive management to ensure the area is cautiously managed into the future, particularly in the context of climate change. The proposal combined with estimated future regional abstraction is expected to result in a much greater area and amount of drawdown.

Factor & objectives	Potentially affected area	Existing environment	Potential impact (+ve/-ve)	Proposed management	Expected outcomes
	Swan Coastal Plain	The portion of the Swan Coastal Plain considered in this report is from Busselton to Bunbury. The plain is relatively flat with shallow, highly seasonal watertables and the plain is prone to seasonal flooding and waterlogging. Much of this area has been cleared and drained for agriculture. Remnant vegetation in this area is highly significant and contains several listed TECs. The Vasse–Wonnerup Wetland system (Ramsar wetland) occurs in a linear system along much of this coastline.	The predicted drawdowns in summer watertable minimums from the proposal alone after 30 years are all less than 0.5 m south of Bunbury and less than 0.25 m east of Busselton. Combined drawdowns are mostly less than 1 m with small areas of drawdown in the 1 – 2 m range. A total of 2270 ha of remnant vegetation on the Swan Coastal Plain is within areas of potential drawdown from the proposal where the watertable is within 10 m of the surface. Predicted proposal drawdowns of 0.25 m in this area may possibly result in "low" potential impact where there is likely to be "no measurable change" in ecological processes and species composition and abundance. Therefore, the proposal is not expected to have any significant impact on the vegetation of the Swan Coastal Plain in these areas. "Moderate – small change" in groundwater dependent ecosystems may possibly occur in small areas where drawdown may be up to 0.5 m after 30 years (south of Bunbury). Given the full recovery of the watertable each winter, the natural seasonal variation is greater than predicted drawdowns; no significant adverse impact on vegetation is anticipated. Three TECs occur in areas where the predicted drawdown from the proposal is less than 0.25 m after 30 years. There is not expected to be a measurable or significant adverse impact at any of these sites given the full recovery of the watertable in winter, presence of clay pans and ironstones and moisture holding capacity of soils in these areas. The potential for drawdown to adversely affect acid sulphate soil (acid generation) are expected to be minimal as the drawdowns are small and full recovery of water level is expected each year.	As for the Scott Coastal Plain.	The proposal alone is not expected to have any significant impact on the vegetation or TECs of the Swan Coastal Plain. The risk of effects of drawdown on acid sulphate soils (acid generation) is expected to be minimal. No impact is expected on the Vasse–Wonnerup Wetland system from groundwater abstraction as the water levels are connected to the ocean. The proposal will result in no significant impact on the seasonal wetlands of the Swan Coastal Plain, as surface water levels will recover fully each winter. Knowledge and data obtained from the proposed South West Yarragadee Sustainability Initiative biodiversity study and comprehensive monitoring program will improve the understanding of the area and provide for adaptive management to ensure cautious management into the future, particularly in the context of climate change.

Factor	Objective	Existing environment	Potential impact (+ve/-ve)	Proposed management	Expected outcomes
ENVIRONMENTAL PRINCIPLE – Biodiversity and ecological integrity					
Development footprint	The construction of the proposal will cause minimal permanent disturbance	The development footprint for this proposal includes the wellfield, treatment plant, storage tank and the pipeline to join with the Stirling Trunk Main at Harvey. The pipeline route crosses the Capel, Ferguson, Preston, Collie and Brunswick Rivers.	Clearing of 50 ha of native vegetation. Clearing of pine plantation for the treatment plant. Five river crossings that are Aboriginal heritage sites. Dewatering may be required in some areas for installation of the buried pipeline. This introduces the risk of temporary exposure of acid sulphate soils.	A flora and fauna survey will be undertaken of all areas to be cleared. The method of installing the pipeline across the rivers will be determined through the heritage survey. All crossings will be stabilised and rehabilitated to minimise erosion and water quality impacts. The Water Corporation proposes to provide an offset for clearing through the contribution of land to the conservation estate using a loss/gain ratio of 1:1.5 and the principle of "like for like or better".	The impacts of the proposal infrastructure have been minimised through avoiding areas of environmental significance as far as possible. The 50 ha of vegetation clearing required will be offset through land contribution to the conservation estate. Therefore, the proposal is expected to meet this objective.
ENVIRONMENTAL PRINCIPLE – Energy efficiency					
Greenhouse gas emissions	The proposal will be designed and operated according to Australia best practice regarding greenhouse gas emissions	Groundwater will be extracted from each well and pumped to a treatment plant and holding tank for treatment. The treated water will then be gravity fed from the holding tank to Harvey and on to Perth for use. Power will be required for each well and at the treatment plant, and will be sourced from the South West Interconnected System.	Energy consumption for pumping and operation of the treatment plant will amount to approximately 4.6 MW. The increase in emissions is estimated to be 41 000 t/yr CO_2e based on an assumed indicative carbon intensity of the Western Power South West Integrated System of 1032 kg CO_2/MWhr.	The Corporation has set an aspirational target of being carbon-neutral by 2030. As part of the GHG management portfolio approach, a Greenhouse Emissions Reduction Plan will be developed to manage GHG emissions consistent with the Water Corporation purpose of "sustainable management of water services to make Western Australia a great place to live".	Implementation of the proposal will indirectly contribute to increased energy use in Western Australia. The Corporation will utilise best practice in the design and operation of the infrastructure to minimise energy use and will pursue its carbon neutral policy with the expected longer-term outcome of no increase in greenhouse gas emissions. Therefore, the proposal is expected to meet this objective.

Factor	Objective	Existing environment	Potential impact (+ve/-ve)	Proposed management	Expected outcomes
SOCIO-ECONOMIC PRINCIPLE – Long-term economic health					
Economic growth	The proposal will facilitate economic growth in the IWSS and South West regions.	Communities with a diversity of economic enterprises tend to be more stable and less subject to economic cycles. They offer a wider range of employment opportunities leading to a more diverse business culture and richer society. This diversity maintains population levels and reduces outward migration. It may even attract inward migration. Approximately 36 GL/yr is currently drawn from this aquifer to service many of the town supplies as well as self-supplied enterprises, including agriculture.	Development of the proposed wellfield and allocation of 45 GL/yr to the Water Corporation does not preclude future use by the local water boards and other private users. The transfer pipeline brings a substantial source into the system and transports it across the region. This will facilitate local access rather than inhibit it for anyone seeking a public water supply of good quality water. Improved access to water will encourage business development, economic growth and economic diversity.	The Water Corporation has a responsibility to supply water to all customers on terms agreed by the Government. The Water Corporation commits to making water available from the new infrastructure to any consumer prepared to enter into the standard access arrangements that apply to water users in the State. New customers in the region will be eligible to apply for access to the proposed pipeline on the standard terms.	The proposal will contribute to the maximisation of economic output for the State. The proposal will enhance economic diversity and provide opportunities for economic growth through increased business activity in the South West region and areas served by the IWSS. Therefore, the proposal is expected to meet this objective.
Economic diversity	The proposal will enhance economic diversity in the IWSS and South West	As above	As above	As above	As above
Business and industry development	The proposal will provide opportunities for increased business activity	As above	As above	As above	As above
Economic efficiency	The proposal will provide the most cost-effective water supply source for the State.	Economic (allocative) efficiency relates to maximising the economic output by selection of the most efficient water supply option.	The South West Yarragadee water development is the most cost effective approach to meet the forecast need of 45 GL/yr within a practically achievable timeframe. Public water supply is one of the highest value water uses, which maximises the economic output from the resource.	As above	The proposal will provide cost-effective water supplies to those communities serviced by the IWSS. Therefore, the proposal is expected to meet this objective.

Factor	Objective	Existing environment	Potential impact (+ve/-ve)	Proposed management	Expected outcomes
SOCIO-ECONOMIC PRINCIPLE – Public water supply					
Water use efficiency	The Water Corporation will encourage the efficient usage of water.	The State Water Strategy requires efficiency targets as a condition of water allocation licences. The Water Corporation has implemented several measures to encourage the efficient use of water including: • Rebate Scheme for water efficient items and practices • Higher prices for high water consumers • Education program.	The proposal will meet increasing demand in the IWSS that is due to expansion of the system and population growth. The proposal will not affect the Water Corporation commitment to reducing per capita water use.	The Government has set a target of reducing per capita water use from the current unrestricted level of 180 kL/person/yr to 155 kL/person/yr by 2012. The Water Corporation has committed to the achievement of that strategic objective.	Increasing efficiency in water use in the IWSS through progressive implementation of a demand management program. Therefore, this objective is expected to be met through Water Corporation's commitment to reduce per capita water use.
Existing and future needs	The proposal will contribute to meeting the existing and forecasted demand for public water supply in the IWSS and the South West under a range of possible future climate scenarios. Water will be available to meet reasonable regional public water supply needs.	The Water Corporation supplies water to most South West towns with the exception of Busselton and Bunbury, which are supplied by separate independent statutory water boards. Harvey, Waroona, Binningup, Myalup and Hamel are already connected to and supplied from the IWSS.	As a result of the internal sustainability evaluation process, the proposal to abstract water from the South West Yarragadee aquifer for the IWSS has developed into a plan to extend the IWSS into the South West region. The proposal will contribute directly to achievement of the public water supply sustainability objective of meeting existing and forecasted demand for public water supply in the IWSS through extension of the IWSS into the region.	The proposed South West Public Water Supply Future Planning study will develop a plan for future public water supply needs in the South West and how they will be met. The plan would provide certainty to the South West, and would help to resolve some of the concerns associated with futures foregone, benefit and equity, and accommodating reasonable regional needs.	The proposal will: • provide a major increase in the supply capability and reliability of the IWSS • provide major infrastructure to support the development of high value economic development in the region through the provision of an integrated public water supply system • result in a comprehensive plan to provide for the future development of regional public water supplies. Therefore, the proposal is expected to meet this objective.
South West town supplies	This proposal will increase supply security for South West towns	As above	As above	As above	As above

Factor	Objective	Existing environment	Potential impact (+ve/-ve)	Proposed management	Expected outcomes
Quality of supply	To supply high quality water to consumers	Through its Customer Charter, the Water Corporation has committed to provide the community with water that is safe to drink and that complies with directions on drinking water quality made by the Minister for Health.	The South West Yarragadee aquifer is of a quality highly suited for public drinking water supplies. The water is well within guideline values for all constituents, with the exception of iron, which will need to be treated for removal. The Yarragadee aquifer occurs at depth and is confined over most of its area by overlying formations. Land use over the majority of the recharge zone is State forest. This results in a water source with a high degree of protection against potentially contaminating activities that may be carried out on the land surface.	The proposal for development of the South West Yarragadee aquifer includes a filtration based treatment plant. The water will also be chlorinated to remove any pathogens that may enter the water after pumping from the aquifer, and fluoridated in accordance with Government policy. The Water Corporation commits to working with the relevant agencies to arrange declaration of a public water supply catchment area over the relevant portions of the Yarragadee aquifer recharge zones.	The outcome of use of the Yarragadee aquifer as proposed is expected to be a high quality water supply suitable for use as a public water supply with minimal treatment. The administration of catchment protection under the *Country Areas Water Supply Act 1947* will assist in ensuring the quality of water is maintained for the future. Therefore, the proposal is expected to meet this objective.
Drinking water source protection	The Water Corporation will work with the Water and Rivers Commission, Conservation Commission and CALM to protect recharge areas.	As above	As above	As above	As above
SOCIO-ECONOMIC PRINCIPLE – Regional needs					
Regional needs for private water supplies	The proposal will be developed such that reasonable regional needs for water, including social, recreational and projected future development needs are not compromised by the proposal.	The State Water Strategy requires that all reasonable regional needs for water, including social, recreational, projected future development and environmental water provisions will be satisfied before transfers can take place. The State Water Strategy also indicates that the South West Yarragadee source should be developed "for the benefit of communities in the South West and those serviced by the Integrated Water Supply Scheme".	While the source is being investigated at this time to meet strong growth in the existing IWSS, once connected these new assets would also be available to deliver water to high value uses in the South West. Based on current information, it is not anticipated that competition between the proposal and regional needs will occur in the near future and may be up to several decades away. However, it is apparent that expansion of usage in localised areas of the Scott and Swan Coastal Plains may be limited by environmental constraints, even in the absence of the IWSS abstraction.	The Water Corporation proposes to monitor the trends in water usage from the Yarragadee aquifer and potential future reasonable regional needs for water from this aquifer and report to Government.	The proposal is not anticipated to significantly constrain water availability from the Yarragadee aquifer to meet reasonable regional needs. The proposal has the potential to enhance overall water availability from the aquifer. Therefore, the proposal is expected to meet this objective.

Factor	Objective	Existing environment	Potential impact (+ve/-ve)	Proposed management	Expected outcomes
Impact on current key water users	The Water Corporation will seek to understand and articulate the impact of the proposal on current key water users, to ensure that existing water users are recognised and protected from unreasonable impact.	The requirements of the RWI Act are that existing water users are recognised and protected from unreasonable impact.	The Water Corporation proposal has been deliberately located in the State forest area of the Blackwood Plateau to minimise impact on water availability to other users, and to maximise overall water availability from the resource. The proposal will not result in any reduction in water availability to existing users in the region, in terms of existing water allocations and levels of use. However, there is some potential for drawdown interference or seawater intrusion.	The freshwater/saltwater interface will be monitored to ensure that appropriate planning can be in place if saltwater intrusion is likely to occur. The Water Corporation has committed to directly make good any impacts of seawater intrusion on public water supply wells (unless such impacts can be clearly attributable to abstraction by a third party).	The proposal will not result in any reduction in water availability to existing users in the region, in terms of existing water allocations and levels of use. Any impact due to seawater intrusion will be mitigated. Therefore, the proposal is expected to meet this objective.
SOCIO-ECONOMIC PRINCIPLE – Community well being and heritage					
Lifestyle, amenity and recreational use and access	The Water Corporation will determine, through community consultation, whether community members anticipate changes to lifestyle, amenity, or recreational use and access as a result of the proposal, to ensure that negative impacts do not occur from this project and to explore potential positive outcomes.	The dominant social values of the Blackwood Plateau and its surrounds are: • Aboriginal sites of cultural significance (dealt with under Indigenous issues factor) • historic features and cultural sites of early settlement (dealt with under Sense of place factor) • tourism and recreation values • areas of high scenic quality. Collectively these contribute to a strong “sense of place”, and the latter two particularly relate to lifestyle, amenity, and recreational use and access.	All communities included in the scoping phase of the social impact assessment study were concerned about potential changes to their enjoyment of the area as a result of the proposal. Concerns related to potential changes to the environment, especially the Blackwood River. No significant impact is expected on the environment of the Blackwood Plateau. There will be a small reduction in summer baseflow of the Blackwood River. This change is minor and is not expected to affect the social values of enjoyment or amenity in the river.	The Water Corporation proposes to establish a South West Yarragadee Monitoring Review Group composed of people from the South West to participate in the assessment of monitoring programs.	No changes to amenity, lifestyle and recreational use in the area will occur. The benefit will come from increased community involvement in monitoring and reporting of results, leading to better safeguards of community amenity. Therefore, the proposal is expected to meet this objective.

Factor	Objective	Existing environment	Potential impact (+ve/-ve)	Proposed management	Expected outcomes
Direct and indirect job creation	The proposal will create employment opportunities	The project would create employment directly in the building and maintenance of the infrastructure. Reliable water supply would also stimulate economic growth and industry with indirect benefits for employment.	Job creation both in the South West and the IWSS regions	Local employment preferences in construction contracts in accordance with Water Corporation contract and employment policy and practice. Employment of Indigenous people in monitoring programs in accordance with the Water Corporation Involvement and Indigenous Employment Opportunities Policy	Some employment opportunities through direct involvement in the project construction and operation. Increased regional job creation potential through provision of integrated water supply to support high value economic development with associated employment opportunities. Therefore, the proposal is expected to meet this objective.
Sense of place	The Water Corporation will determine, through community consultation, whether community members with strong attachments to places and heritage values anticipate changes to those places and values as a result of the proposal, to ensure that negative impacts do not occur from this project and to explore potential positive outcomes.	Landscapes, people, and cultural or environmental 'icons' (such as the Blackwood River or a National Park) can contribute to 'sense of place'.	The South West communities expressed concerns related to potential changes to the environment. Sense of place in the South West is strongly linked to the Blackwood River. As the changes expected in the Blackwood River are minor, they are not expected to have a significant impact on sense of place.	The Water Corporation proposes to establish a South West Yarragadee Monitoring Review Group composed of people from the South West to participate in the assessment of monitoring programs. This will allow the community to be involved in decision making about the project and its impact on sense of place.	No change in the sense of place values of the South West is expected to occur. Therefore, the proposal is expected to meet this objective.
Indigenous communities	The Water Corporation will undertake to protect and avoid disturbance of Aboriginal heritage sites. The Corporation will explore potential positive outcomes for and with the Indigenous communities.	The Blackwood River retains significant heritage and cultural value for the Aboriginal community. There are numerous sites near the Blackwood River on the Department of Indigenous Affairs (DIA) Register of Aboriginal Sites. This includes sites such as the Hardy Inlet (archaeological deposit, camp), Blackwood River Ochre Deposit, Sues Bridge (meeting place, camp, hunting place), Blackwood Riverbank (mythological), and Barrabup Pool (mythological)), as well as the Blackwood River itself.	Some heritage sites may be affected by the proposal. The implications of these effects need to be discussed with the Indigenous communities, and will be the subject of a separate extensive consultation process that will be reported separately. The Water Corporation will discuss opportunities for employment of Aboriginal people on aspects of the project with representative groups.	Monitoring, management and reporting of impacts on heritage sites will be undertaken within the requirements of the AH Act.	The Water Corporation has undertaken the preliminary infrastructure design to minimise any disturbance to Aboriginal heritage sites, which includes avoiding all sites on the current Department of Indigenous Affairs register, except in the case of linear features such as listed rivers. Further consultation will establish the protocols for further field surveys to identify any sites not currently on the register. Where possible, opportunities will be provided for Aboriginal people to be employed on aspects of the project. Therefore, the proposal is expected to meet this objective.

Factor	Objective	Existing environment	Potential impact (+ve/-ve)	Proposed management	Expected outcomes
Development footprint	The construction and maintenance of infrastructure will cause minimal permanent disturbance to the community	The final pipeline alignment through agricultural land is yet to be determined. A notional route has been identified but an intensive engagement process with potentially affected landholders will need to be undertaken.	The wellfield and treatment plant are not near residences and are unlikely to cause an impact. Impacts on individual landholders whose land is on the pipeline route. Impacts include disturbance to summer cropping, access, dust, noise, increased traffic on site, and the effects of a work team of up to 20 people on site.	Access to private land and appropriate compensation will be negotiated with each landholder before commencement of construction.	The outcome will be positive overall, but may be negative in the short term for farmers whose properties are along the pipeline route. The potential benefits of employment and economic activity will be enhanced through the Corporation "buy local" policy.
STRATEGIC PRINCIPLE – Government policy					
Equitable access to water	The Water Corporation will ensure fair and equitable access to water for domestic use for all Water Corporation customers.	Water is a shared resource that should be available to all through equitable distribution. To ensure this, the cost of reasonable domestic water requirements should be affordable to all.	The Government uniform pricing policy will ensure that there is equity in the water supply costs. The Water Corporation commitment to prepare a South West Public Water Supply Future Plan would facilitate connection of centres to the IWSS or directly to the Yarragadee aquifer.	Through the South West Public Water Supply Future Planning Study, the Water Corporation will determine the future public water demand in those towns and centres in the South West that may be able to connect to the IWSS or be directly supplied from other sources.	Equitable access to public water supply schemes will be maintained through continued implementation of both Government Policy on uniform tariff policy and Water Corporation Customer Charter. Equitable access will be enhanced through the preparation and implementation of the South West Public Water Supply Future Plan. Therefore, the proposal is expected to meet this objective.
Government plans	The proposal will be consistent with the following Government agency plans and policies where they are appropriate and congruent: • Environmental protection • Regional development • Forest management • Regional planning • Allocation planning and licensing	The State Water Strategy makes specific reference to development of the South West Yarragadee resource "for the benefit of communities in the South West and those served by the Integrated Water Supply Scheme". The State Sustainability Strategy (Government of Western Australia 2003) indicated that the next new major source for meeting future water supply needs for Perth should be subject to a sustainability assessment. The South West Yarragadee project is being subjected to such an assessment, in compliance with the strategy.	The development of this proposal has identified a range of gaps in Government policies and proposed ways of addressing those gaps.	Two key policies that the proposal draws from are the State Water Strategy and the State Sustainability Strategy. The project specific sustainability principles developed for this proposal are based on the State Sustainability Strategy. The proposal is consistent with both the foundation and process principles of the strategy, and is an example of how these principles have been applied in a major public project	The proposal will comply with relevant Government plans and policies. Proposals to address policy gaps will enhance the development of Government policy to facilitate the consideration of this proposal and proposals for groundwater abstraction in other areas of the State. Therefore, the proposal is expected to meet this objective.
Regional development	The proposal will provide opportunities for regional development	As for *Regional needs* factor and *Business development* factor.	-	-	-

Factor	Objective	Existing environment	Potential impact (+ve/-ve)	Proposed management	Expected outcomes
STRATEGIC PRINCIPLE – Climate change					
Climate change	Determine the impact of likely climate change scenarios on the sustainability of the proposal.	Winter rainfall in the South-West of Western Australia has decreased substantially since the mid-20th century, with a series of years of lower than average rainfall since the mid-1970s. The decrease in rainfall appears to be partly the result of changes in large-scale global atmospheric circulation associated with an enhanced greenhouse effect.	Climate change will have an impact on recharge to the Yarragadee aquifer, which may result in changes to the watertable in areas where there are groundwater dependent ecosystems. The change in the watertable may, in time, induce changes within that system. Under the scenario where climate in the south-west of Western Australia will become drier, the proposal may cause a further lowering of the watertable in areas where the drawdowns in the Yarragadee aquifer are transmitted to the watertable.	The issue of climate change has been recognised throughout the proposal development and a 9% reduction in the long-term rainfall average has been included in the base modelling scenario. The Water Corporation will conduct a major biodiversity study of the groundwater dependent ecosystems of the Scott and Swan Coastal plains and the Blackwood River area that will potentially be affected by the proposal, and other selected areas not affected, to establish a baseline against which climate-and proposal-induced changes may be assessed. The acceptability of the development impacts in the context of climate change will be judged against a set of defined principles.	The proposed key principles for determining the acceptability of change induced by the proposal in the context of climate change, and the proposed adaptive management framework, will ensure that the effects of climate will be comprehensively considered in the environmental management of the proposal. Therefore, the proposal is expected to meet this objective.

Factor	Objective	Existing environment	Potential impact (+ve/-ve)	Proposed management	Expected outcomes
STRATEGIC PRINCIPLE – International and national competitiveness of water users					
Cost of water	The proposal will facilitate the competitiveness of local and regional industries in the national and international context.	The cost of the various source options is an important consideration in progressively developing the water sources that form the basis of the IWSS as it expands to meet growing demand, and to provide higher levels of security. Overall, the IWSS has been built up within a program primarily based on developing the viable and environmentally acceptable sources in order of cost.	The South West Yarragadee aquifer is the most economical large scale source of water available to the IWSS in the required timeframe. Preferentially developing lower cost water sources for the IWSS maintains the lowest possible water pricing to customers. This in turn supports the national and international competitiveness of water users taking water from the system.	The Water Corporation will continue to execute all components of its Security Through Diversity strategy and update its source development plan based on the latest information available. The Water Corporation will undertake a review of public water supply planning in the South West that examines expected growth in the need for public water supplies and the potential options for meeting those demands.	A rational planning base for the future development of public water supplies that will support the development of high-value regional enterprises and, consequently, the competitive contribution of the region to the State and national economies. Therefore, the proposal is expected to meet this objective.
STRATEGIC PRINCIPLE – Improved knowledge and skills					
Environmental risk	Reduce environmental risk by Improving the scientific certainty of the South West Yarragadee characteristics and the ecosystems that it interacts with.	As for the *Precautionary principle.*	–	–	–
Supply security	Increase supply security by improving the scientific basis for decision making and planning regarding the use of the South West Yarragadee as a water source.	The groundwater investigation program undertaken to support this proposal is one of the largest such programs undertaken in Western Australia. Approximately $12 million has been expended since 2002 in improving our knowledge of the groundwater resources of the region and their relationships with environmental and social values.	The increased knowledge from the proposal will assist in maximising water availability from the Southern Perth Basin. The model developed has been made available to the Department of Water for use in the management of water resources in the region. This should reduce the amount of information required to be supplied by applicants for water licences.	The Water Corporation is proposing to implement a South West Yarragadee Sustainability Initiative, intended to enhance the information base to provide for maximisation of water availability in the region. This initiative will provide information on key social and ecological aspects, and risk areas, to complement the information already made available through the proposal and monitoring programs.	Information on the groundwater resource, its hydrogeology, environmental dependencies and social values will assist in maximising water availability from the Southern Perth Basin. This information will be enhanced through the proposed Sustainability Initiative. Therefore, the proposal is expected to meet this objective.

Factor	Objective	Existing environment	Potential impact (+ve/-ve)	Proposed management	Expected outcomes
PROCESS PRINCIPLE – Precautionary principle					
Precautionary approach	Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In the application of the Precautionary principle, decisions should be guided by: • a careful evaluation to avoid, where practicable, serious or irreversible damage to the environment; and • an assessment of the risk-weighted consequences of the options. This definition is taken directly from the EP Act.	The nature of groundwater is such that there is always an element of uncertainty when making decisions about water availability, and predicting the drawdown impacts of particular developments. Under these circumstances the options are: to make conservative decisions that limit the stress and allow a knowledge base to be developed as the stress is progressively allowed to increase under monitored conditions or, where the potential benefits of the proposal might be high, to adopt an approach that addresses risk and uncertainty through adaptive management and contingencies.	The Precautionary principle has been applied in this proposal through improving the knowledge of the resource, risk assessment, design and implementation of the proposal to minimise risk, mitigation, adaptive management and contingencies.	The project will be managed through an adaptive management process that consists of: • management objectives and performance measures • management response choices • monitoring and evaluation of outcomes • feedback of new information into the decision making process • stakeholder engagement, specifically through the Monitoring Review Group. The South West Yarragadee Sustainability Initiative is a key element of the proposed adaptive management framework for improving the knowledge of water availability in the region for all users.	The application of an approach of adaptive management and ongoing risk assessment will ensure a precautionary approach will be applied in implementation of the proposal. This approach will substantially reduce the risk of serious or irreversible impacts on social and environmental values dependent on the Yarragadee aquifer. Therefore, the proposal is expected to meet this objective.

Factor	Objective	Existing environment	Potential impact (+ve/-ve)	Proposed management	Expected outcomes
PROCESS PRINCIPLE – Stakeholder Engagement					
Comprehensive and regular communication	Water Corporation will maintain a comprehensive and regular information flow to the community about the project and the process throughout the sustainability assessment process.	Stakeholder engagement provided the foundation for community input to the design and implementation framework for the proposal. Stakeholder engagement was strongly focused on local communities in the South West Region including Nannup, Augusta, Margaret River, Busselton, Capel, Bunbury, and farmers on the Scott Coastal Plain. Water consumers in the Perth region also formed a key stakeholder group that was consulted in the evaluation process.	Stakeholder engagement through the development of the proposal has consisted of: • Community Reference Group from the SW that met regularly to provide input into the proposal • two sets of public information sessions and "walk-ins" • market research • focus group in the Perth region • technical information progressively made publicly available • public review of the draft Scoping report • interviews with stakeholders for the social impact assessment.	The stakeholder engagement phases yet to be completed are: – the public review of the Sustainability Evaluation /ERMP – the continued involvement of stakeholders in the adaptive management of the resource through the South West Yarragadee Monitoring Review Group.	The stakeholder engagement process has resulted in changes to the design and intent of the South West Yarragadee Water Supply Development. This process has also: • identified issues of concern • influenced the mitigation measures and enhancements of the proposal • influenced the extent and content of formal sustainability commitments • enhanced community awareness of the proposal and its potential consequences. • provided a social baseline for the implementation of the development. Therefore, the Water Corporation is considered to have met and continues to meet this objective.
Relevant, balanced and inclusive consultation	The Water Corporation will engage with key stakeholders and the broader community to discuss issues, and potential impacts and benefits of the project.	As above	As above	As above	As above
Openness and transparency	The Water Corporation will conduct investigations and proposal development processes in an open and transparent manner	As above	As above	As above	As above

Factor	Objective	Existing environment	Potential impact (+ve/-ve)	Proposed management	Expected outcomes
Closed loop process	The Water Corporation will respond to issues and queries raised by the community and will provide feedback about how those issues have been dealt with and how they have influenced the process.	As above	As above	As above	As above
PROCESS PRINCIPLE – Accountability					
Define performance targets	The Water Corporation will define economic, social and environmental performance targets that reflect achievement of the objectives set out herein	The Water Corporation has implemented a comprehensive stakeholder engagement program and social impact assessment during the preparation of this Sustainability Evaluation. This engagement has led to changes to the proposal and the development of the accountability framework.	Key stakeholders, including the community will be involved in the setting of management objectives, performance measures and targets for the development. The Water Corporation will be held accountable for achievement of these objectives and performance measures through an open and transparent process.	A South West Yarragadee Monitoring Review Group will be formed to assist implementation of the adaptive management framework	The proposed accountability framework and Water Corporation commitments for an open, transparent and accountable process during the implementation of the proposal will continue to promote and enhance stakeholder engagement. This engagement will enhance the empowerment of stakeholders in the implementation and management of the proposal. Therefore, the proposal is expected to meet this objective.
Reporting performance on achievement of targets	The Water Corporation will report regularly and publicly on performance of sustainability measures	As above	Public reporting of results will provide an informed and independent review of the monitoring results and performance.	An annual Sustainability Report will be published to describe monitoring results, any environmental incidents and changes in management. The advice of the Monitoring Review Group and the Water Corporation response will also be made publicly available.	As above

10. REFERENCES

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