

Study of Ecological Water Requirements on the Gngara and Jandakot Mounds under Section 46 of the Environmental Protection Act



Task 2: Determination of Ecological Water Requirements

Prepared for:

The Water and Rivers Commission

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INTRODUCTION

In this phase of the project water regimes (EWRs) considered necessary to support the values identified in Tasks 1a and 1b were determined. In contrast to current EWRs, the team has developed EWRs that encompass the true complexity of eco-hydrological interactions but maintain adaptability to management frameworks. Current EWRs have been most often set as minimum and/or maximum water levels based on the requirements of key species. These levels do not address other components of the water regime considered of equal importance in maintaining ecosystem values. In establishing EWRs the team has also considered the duration of required water levels and the rate of water level rise and/or decline, where possible. In all cases, limitations to scientific information and assumptions have been identified to ensure transparency in the scientific basis for EWRs.

During field visits undertaken in Task 1 a small number of wetlands and terrestrial bore sites, identified in the 1991/92, 1995 and 1997 reports were considered to have lost all or most of their ecological value related to groundwater dependence. These GDEs are listed in Table 1 with a brief description of the reason for the loss of values.

This phase of the project has been divided into three sections. The first section presents a summary of existing information on GDEs and their water requirements followed by a review of the existing WA approach and an outline of the process applied in this study.

In Section 2 general EWRs are first described for all GDEs identified in Task 1. Due to the paucity of information on the majority of 'new' GDEs, it is not possible to describe EWRs for a large number of ecosystems. Lack of quantitative data for some components of many previously described GDEs also limits EWRs to qualitative assessments. However, where the required level of information is available detailed/quantitative EWRs are described.

In Section 3 comment is made on the likely response to water level changes predicted over 2, 5 and 10 year intervals (2003-05, 2003-08 and 2003-13) modelled under PRAMS 3.0. To achieve this, a GDE's susceptibility to groundwater decline is determined using a matrix of conservation values, current ecological condition, historic water level decline and current depth to groundwater. Groundwater dependence and drawdown impacts are largely based on vegetation. Limits of acceptable change are described for each type of GDE (wetland, terrestrial vegetation etc.) and comment made on the current standing of each GDE.

Table 1: GDEs identified in the 1991/2, 1995 and 1997 reports not considered in the EWR review due to severe decline or complete loss of ecological values related to groundwater dependence.

Group	GDE	Reason for loss of values related to groundwater dependence	
Wetlands			
Gngangara	Coogee Springs	Due to changes in water quality, drying and the associated declines in ecological condition, the ecological values of the wetland have been severely degraded. The wetland no longer supports diverse aquatic macroinvertebrates nor has the potential to support waterbirds and other aquatic vertebrates. Only one species of wetland vegetation persists with little opportunity for recruitment.	
Terrestrial ecosystems			
Gngangara	JB5	The bore is within 50m of an operation market garden, which has increased in size in recent years. The majority of native vegetation in the vicinity is also heavily modified.	
	PM6	Recent investigations into soil moisture retention suggests there are 3 perched lenses in the soil profile above the water table, which is currently 12m below the ground surface. It is therefore unlikely that vegetation at this site is accessing groundwater and is relying instead on moisture in the perched layers. May be relocated or replaced.	
	PM7	Recent investigations into soil moisture retention suggests there are 2 perched lenses in the soil profile above the water table, which is currently 9.5m below the ground surface. It is therefore unlikely that vegetation at this site is accessing groundwater and is relying instead on moisture in the perched layers.	
	WM6	The bore is located between Neaves Rd and a semi-rural homesite. Although intact <i>Banksia</i> woodland occurs opposite, it is approximately 2m upslope of the bore and as a result the groundwater levels measured in the bore are unlikely to be representative of that underlying the vegetation. May be relocated or replaced.	
	MM49B	Vegetation highly degraded and not representative of high priority conservation area within Whiteman Park. May be replaced by GD10.	
	PM25	The woodland in the vicinity has been cleared for rural use.	
	Jandakot	JM24	The <i>Banksia</i> woodland in the vicinity has been significantly reduced through clearing with further clearing indicated in the near future.
		JM29	The <i>Banksia</i> woodland in the vicinity has been significantly reduced through clearing with further clearing indicated in the near future. May be relocated to Bush Forever Site 263.
		JE12C	Water levels are greater than 12m and the area is marked for future urban development.
		JM33	The area is marked for future urban development.
JE20C		<i>Banksia</i> woodland in the vicinity has been impacted by semi-rural use and is marked for future urban development.	
JE23C		The area is marked for future urban development.	
J310		The woodland in the area has been cleared for industrial development.	
JM18		The woodland in the area has been cleared for industrial development.	
JE1B		The woodland in the area has been impacted by clearing for sand-mining and semi-rural use.	
JE18C		The woodland in the area has been cleared for semi-rural use and recreation.	
JM15	The woodland in the area has been cleared for semi-rural use.		
JM27	The woodland in the area has been cleared for rural use. May be relocated to Bush Forever Site 342.		
JM5	The area has been cleared for urban development.		

SECTION 1 - ENVIRONMENTAL WATER REQUIREMENTS OF GROUNDWATER DEPENDENT ECOSYSTEMS

1.1 BACKGROUND ON ECOLOGICAL WATER REQUIREMENTS

GROUNDWATER DEPENDENT ECOSYSTEMS

Throughout Australia, the future of groundwater resources are being reviewed due to increasing pressure from consumptive uses for agriculture, mining, urban and commercial developments. The role which groundwater plays in controlling the health of major ecosystems across Australia is also being increasingly recognised. To ensure the continued health of these ecosystems, the respective needs of the principal users of groundwater, that is groundwater-dependent land uses and ecosystems, need to be formally recognised and provided for. Recognition of groundwater dependent ecosystems as a distinct group is relatively recent and may largely be attributed to work by Hatton and Evans (1998), although management of Groundwater Resources in Western Australia has recognised the importance of provision of water to the environment since 1986 (Water Authority of Western Australia, 1986). Groundwater dependent ecosystems can be defined as a complex community of organisms where groundwater is a key element required for consumptive use, biophysical processes or as habitat (Sinclair Knight Merz, 2001). At present, the importance of the role groundwater plays in controlling these ecosystems is poorly understood. If policy and management systems are to consider groundwater dependent ecosystems they require quantitative estimates of their water needs. Consideration of water requirements of groundwater dependent ecosystems has been a recent addition to water allocations decisions and therefore the allocation process is faced with little knowledge regarding the water needs of these ecosystems and the methodologies available for determining these.

ECOLOGICAL WATER REQUIREMENTS

All ecosystems require water to maintain their ecological processes and associated communities of plants and animals. Ecological water requirements (EWR) describe water regimes needed to sustain the ecological values of water dependent ecosystems at a low level of risk (ARMCANZ / ANZECC, 1996). A water regime can be defined as the prevailing pattern of water behaviour over a given time, components of which are groundwater depth, rate of groundwater level rise and duration. Estimations of the water regimes required by an ecosystem are developed through strategic scientific research or through the application of local knowledge based on many years of observation. Determining ecological water requirements for an ecosystem involves identifying those aspects of the natural water regime that are most important for maintaining key ecosystem features and processes. EWRs include elements of quantity and duration and apply both spatially and temporally and are used to inform water resource management and decision makers in the determination of environmental water provisions (EWP). The EWP is the water regime that should be met after consideration of social, economic and ecological water requirements and may involve trade-offs between these requirements. Clearly, it is desirable that the EWR and EWP are the same, however, they may not be equal due to conflicts over the use of water. In such cases the issue of whether the EWP should be equal to or less than the EWR will largely depend on the relative importance placed upon the protection of ecological values by the community concerned.

Until the early 1970's, the management of water resources in Australia was predominantly concerned with the assessment, development and harnessing of new water resources for irrigation, urban and industrial, stock and domestic water supply. However, there is now considerable and increasingly effective public and political pressure for authorities to manage water resources to meet both the traditional needs as well as providing water for the environment.

The Council of Australian Governments endorsed reforms in 1994 to achieve a sustainable water industry that included allocations for the environment and greater environmental accountability of water resource developments. The *National Principles for the Provision of Water for Ecosystems* (1996) produced by the Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) and the Australia and New Zealand Environment and Conservation Council (ANZECC) provide the basis for considering EWRs as part of water allocation decisions by water resource managers. In Western Australia, the Water and Rivers Commission is the lead agency in water

resource management. In 2000, after considerable consultation with the community, the Commission released its Environmental Water Provisions Policy. The Policy sets out the principles and processes for determining EWPs in WA.

The goal for providing water for the environment is to sustain and where necessary restore ecological processes and biodiversity of water dependent ecosystems. Therefore, before EWRs for an ecosystem can be stated, and water provisions set, identification of environmental values need to be considered and criteria developed to protect these values if necessary. Issues considered in identifying environmental values of groundwater dependent ecosystems include the abundance and diversity of flora and fauna, the degree of disturbance and the uniqueness of these characteristics.

The groundwater dependency of many ecosystems within Australia is directly linked to the large areas that experience low surface water inputs due to a semi-arid to arid climate or to seasonal droughts experienced across much of the continent. In a report prepared for LWRRDC, Hatton and Evans (1998) identified a number of GDEs in Australia. As a starting point in the identification process they suggested it was unlikely for any ecosystem to evolve in the presence of groundwater without having some reliance on it. They further suggested that if the availability of groundwater was reduced or its quality altered, these ecosystems would respond in a negative manner regardless of their degree of dependence. The magnitude of dependence was in turn, used to assess and rank the significance of different GDEs.

IDENTIFICATION OF GDES

The GDE identification process can be as straightforward as simple association. For example, an ecosystem associated with a groundwater fed wetland or fauna found in permanent cave-streams. However, the reliance of other ecosystems on groundwater may be much less obvious. For example, the groundwater dependence of terrestrial vegetation ecosystems can be demonstrated using the stable isotope technique. This method is based on the naturally occurring stable isotopes concentrations, which demonstrate differences in hydrogen isotope ratios between potential plant water sources, for example, soil water and groundwater (Ehrlinger & Dawson, 1992; Hatton & Evans, 1998; Walker & Richardson, 1991). Due to the complexities of surface and groundwater interactions, it is often difficult to determine the extent to which an ecosystem depends on one water source or the other. Stable isotope techniques can also be useful in stream and river flow systems in which groundwater often maintains surface water levels long after rainfall has stopped (Roberts, Young, & Marston, 2000).

Leaf area index (LAI) or the biomass of vegetation in a given area, is generally regarded as a simpler yet effective means to identify GDEs (Roberts et al., 2000). LAI works on the assumption that vegetation which has access to groundwater in dry regions would be expected to have greater leaf area than vegetation that was entirely rain dependent. Hatton and Evans (1998) also described the strong relationship between water availability and 'greenness' and concluded that LAI is therefore a good indicator of GDEs in semi-arid to arid environments.

Another method relates to observed or measured changes in the composition and/or structure of vegetation and animal communities in response to changes in groundwater availability or quality (Froend, Farrell, Wilkins, Wilson, & McComb, 1993; Research Group on Groundwater Management, 1989; Roberts et al., 2000). Measurable changes in the vigour of wetland vegetation, associated with reduced water availability, are the precursor to changes in distribution and composition. As water requirements are not being met, the vigour of individuals within a population will decline (water stress, branch die-back, reduced growth, leaf shed, chlorosis), leading to loss of individuals at drier areas of the water availability gradient (altered distribution), or total loss of the local (within wetland) population (altered wetland composition). Any such changes provide an indication that the ecosystem under consideration is potentially groundwater dependent.

Following the methodologies outlined above and an extensive literature review, Hatton and Evans (1998p.1) identified four major types of GDEs covering up to 6% of the Australian land-surface:

- Terrestrial vegetation – vegetation communities with seasonal or occasional dependence on groundwater (phreatophytic)
- Wetlands – aquatic communities and fringing vegetation dependent on groundwater fed lakes and wetlands

- Aquifer and cave ecosystems – aquatic ecosystems that exist in karstic, cave, porous and fissured aquifers.
- River base flow systems – riparian or aquatic ecosystems found along rivers or streams in which groundwater flow is a component of the base flow or mean annual flow (These systems are, strictly speaking, a hydrogeological concept not a class of ecosystem).

Further work by Evans and Hatton (Sinclair Knight Merz, 2001) resulted in two new categories of GDEs being added:

- Terrestrial fauna – native species that use groundwater directly for purposes other than habitat.
- Estuarine and near-shore marine ecosystems – plant and animal communities reliant to some degree on the discharge of groundwater.

GROUNDWATER ATTRIBUTES RELATED TO DEPENDENCY

Environmental Water Requirements can be described in terms of basic groundwater features. Evans and Hatton (Sinclair Knight Merz, 2001) identified four groundwater attributes on which the dependency of GDEs is based:

- Flow or flux – the rate and volume of groundwater required to sustain an ecosystem.
- Level – for unconfined aquifers, the depth below the ground surface of the water table.
- Pressure – for confined aquifers, the potentiometric head of the aquifer and its expression in groundwater discharge areas.
- Quality – the chemical quality of groundwater.

Determination of EWRs requires an understanding of the relationship between these attributes and the dependent elements of an ecosystem and of the nature of any temporal variations. While GDEs will respond to changes in any of these attributes, the degree of change will vary. Some GDEs may show a threshold response, whereby exceeding an attribute value will result in ecosystem collapse. Others may only show a gradual change in structure, composition or health (Sinclair Knight Merz, 2001).

LEVELS OF ECOSYSTEM DEPENDENCY ON GROUNDWATER

Part of the GDE identification process is the determination of the degree of dependence of an ecosystem on groundwater sources. This is an important step in describing the potential impacts of altered water levels on dependent ecosystems. In their assessment, Hatton and Evans (1998 p.1) considered that the "...degree of dependence on groundwater was proportional to the fraction of the annual water budget that the ecosystem derived from groundwater." They described five levels of groundwater dependence:

- Ecosystems entirely dependent on groundwater – ecosystems that would be lost in response to any change in groundwater. Examples of these ecosystems in Western Australia include karstic groundwater systems in Yanchep and Cape Range.
- Ecosystems highly dependent on groundwater – ecosystems that would demonstrate substantial decreases in health or changes in structure or composition in response to moderate changes in groundwater discharge or water tables. Near shore stromatolite systems of coastal Western Australia have been identified as having this level of dependence.
- Ecosystems with proportional dependence on groundwater – ecosystems that would show a less than proportional change in health, composition or structure in response to a change in groundwater. Examples from Western Australia include damplands and sumplands of the Swan Coastal Plain and base-flow dependent systems of the south-west.
- Ecosystems which may only use groundwater opportunistically or to a very limited extent – long-term changes in groundwater may have a negative impact on ecosystems which rely on groundwater only during drought periods or at the end of a dry season. Short-term reductions in water levels may show little impact. The jarrah forest and *Banksia* woodlands of south-west Western Australia provide an example of this level of dependence.

- Ecosystems with no apparent dependency on groundwater – wetland ecosystems which seem to rely solely on surface water. Ecosystems thought to belong to this category include episodic and intermittent arid zone wetlands.

It follows that the greater the level of dependence on groundwater the greater the potential impacts that may arise from altered water levels or changes in water quality.

Evans and Hatton (Sinclair Knight Merz, 2001) identified that an understanding of four key factors was required prior to the establishment of policy and management systems for GDEs

- The nature of the groundwater dependency of an ecosystem.
- The water requirements of the ecosystem.
- The groundwater regime required to meet the water requirements.
- The impacts of an altered water regime on the ecosystem.

1.2 ECOLOGICAL WATER REQUIREMENTS OF DIFFERENT FORMS OF GROUNDWATER DEPENDENT ECOSYSTEMS

TERRESTRIAL VEGETATION

The largest body of literature on phreatophytic terrestrial vegetation water requirements comes from western North America from research carried out on native riparian vegetation (Friedman, Scott, & Auble, 1997; Scott, Shatfroth, & Auble, 1999; Stromberg & Patten, 1990; Stromberg, Tress, Wilkins, & Clark, 1992). These systems have been massively altered over the last century by water development and land use practices. Because of its close dependence on streamflow, riparian vegetation is very sensitive to changes associated with water development and near channel groundwater alterations.

The rapid decline of these valuable ecosystems has made riparian conservation a focal issue for many federal, state and private organisations. Most of the research directed in this area is focused at understanding the context of natural variation in plant response to aid in understanding the effects of past and current water management. Research has been conducted from species to a regional level using interdisciplinary approaches to evaluating natural and human-induced changes in the native vegetation. Scott & Eggleston (1999) and Shafroth, Stromberg & Pattern (2000) quantified the relationship between the patterns of response and mortality in dominant riparian species to groundwater depletion due to in-channel sand mining and other anthropogenic mechanisms. Information on the extent and timing of vegetation response (changes in morphology, growth and mortality) was matched with quantitative data on the rate, depth and duration of water table declines and enabled identification of stress or mortality thresholds.

These studies have aided efforts to promote survival of desirable riparian species and management of activities likely to stress this vegetation. Although the outcomes of this research provide means by which terrestrial vegetation water requirements can be conceptualised, the quantitative information is very specific to shallow depth to groundwater systems in mild, temperate climates.

In South Africa recently adopted water policy and legislation (National Water Act) has major implications for a more integrated sustainable management of both ground and surface waters (DWAF, 1997). In the past, excessive utilisation of groundwater has impacted the baseflow and impacted on the vegetation of numerous perennial rivers and springs (Bate & Walker, 1993; Le Maitre & Scott, 1999). The requirements of vegetation that depend on groundwater in these ecosystems are poorly understood and is an issue that will have to be addressed to meet the obligations of the new South African Water Act. These requirements will place new demands on water resource managers to ensure that utilisation does not lead to damage to the environment, including ecosystems which depend on groundwater. Therefore a greater understanding of the groundwater requirements of plants will be required to enable the determination of water reserves for ecological purposes before water-use licenses may be granted or renewed.

Traditionally, in South Africa, research on the interaction of plants and water sources has been in the domain of the hydrological sciences and divided between disciplines of surface and groundwater

hydrology. This division has been addressed during the water law review process recognising that surface and groundwater system are indivisible (DWAF, 1995, 1996). As a result, vegetation-groundwater interactions are the focus of renewed interest towards a holistic approach and integrated management of natural resources in South Africa. This growing interest is likely to generate new information on determining vegetation water requirements in the near future.

In Australia, riparian vegetation has received the most attention when estimating the quantitative groundwater needs of vegetation. Although consideration of riparian vegetation has been a recent addition to environmental water requirement methodologies, approaches have already been described by Roberts *et al.* (2000) for floodplain vegetation. In addition, research has been conducted in the Murray River basin in South Australia to determine the importance of alluvial groundwater in supplying water to the riparian eucalypt forest. Results indicate that groundwater plays a significant role, with this vegetation drawing a substantial proportion of its water requirements from shallow alluvial aquifers of the Murray River basin (Bacon & Stone, 1993; Thorburn, Walker, & Brunel, 1993).

More recently a descriptive desktop methodology for identifying potential groundwater requirements of native vegetation was developed for the Nature Conservation Council of New South Wales (PPK Environment & Infrastructure Pty Ltd., 2001). The aim of the method is to enable classification of potential groundwater dependency of vegetation without conducting field studies by prompting the user to define and assess characteristics of the vegetation and the study area.

In Western Australia the majority of work undertaken on the water requirements of terrestrial vegetation has focussed on the coastal region of the south-west coast. Of the two large unconfined aquifers that underlie this region, the GDEs of the northern aquifer, the Gngangara Mound, are amongst the most studied and best understood systems in the country.

Large areas of woodland, predominantly *Banksia*, occur across the Gngangara Mound. Many of the tree and deep rooted shrub species associated with these communities are phreatophytic, that is, capable of obtaining groundwater from the zone of saturation either directly or through the overlying capillary fringe (Meizner, 1923). The groundwater dependency (phreatophytic nature) of these ecosystems has been acknowledged since the early 1970s when groundwater abstraction first commenced in the area (Arrowsmith, 1996). However, studies have often merely inferred phreatophytic behaviour from observations of deep root systems, response to groundwater declines and water balance studies.

Root system excavations of *Banksia* woodland species identified deep rooting patterns and an associated ability to reach depths close to or penetrating the underlying water table (Dodd, Heddle, Pate, & Dixon, 1984; Farrington, Greenwood, Bartle, Beresford, & Watson, 1989; Matzke & Associates, 1991; Nicoski, Groom, & Froend, 1997). The inference drawn from these observations was that as deep rooted woodland species access groundwater they are also capable of using it.

Vegetation mortalities have occurred across the Gngangara Mound in areas of groundwater abstraction in response to altered groundwater regimes. Results of an investigation into these deaths indicated that trees found growing in areas where the depth to groundwater was shallow, between 3 and 5 metres, were most susceptible to changes in water level where declines had been too rapid to provide adequate time for root systems to respond. (Water Authority of Western Australia, 1992). A subsequent study by Groom, Froend, Mattiske & Koch (2000) demonstrated the differences in responses between deep-rooted phreatophytes and shallow-rooted non-phreatophytes in *Banksia* woodlands. These studies provided further observational evidence of the association between groundwater dependence and terrestrial vegetation (Zencich & Froend, 2001).

Dodd and Bell (1993) were the first to demonstrate an association between plant water relations and proximity to the groundwater table. They measured seasonal and diurnal water relations in two terrestrial *Banksia* species. Their results indicated that both species had high rates of water usage throughout the year including the dry summer months, and must therefore be utilizing groundwater in the absence of soil moisture. Other studies of the same species (Grieve, 1955; Grieve & Hellmuth, 1968, 1970), however, showed low water usage in summer. Dodd and Bell (1993) concluded that these species were probably phreatophytes, relying on groundwater only where it was available.

Dawson and Pate (1996) used stable isotope techniques to demonstrate phreatophytic behaviour in *Banksia* species experimentally. Using stable isotopes as tracers, this study demonstrated seasonal

variations in water source usage by illustrating preferences for soil moisture uptake in winter and groundwater uptake in summer. Further studies (Zencich, Froend, Turner, & Gailitis, 2002) supported the finding that temporal variations exist in water source usage and indicated that spatial variations also occur. Intraspecific variations have been demonstrated between individuals from different positions in the landscape, while interspecific variations occur primarily as a function of rooting morphology (S. Zencich, pers. comm).

Zencich *et al.*, (2002) determined seasonal water sources for species growing on a coastal dune system that overlies the Gnangara Mound. The plants studied grew over groundwater that ranged in depth from 2.5 to 30 m. The naturally occurring stable isotope of hydrogen (deuterium, $\delta^2\text{H}$) was used to distinguish among potential water sources. Isotopic ratios from vascular water of the dominant species of the study area (*Banksia ilicifolia* and *Banksia attenuata*) were compared with those of potential sources of precipitation, soil moisture and groundwater. A relatively shallow-rooted perennial shrub, *Hibbertia hypericoides*, was also included as an isotopic reference.

Research undertaken by ECU (Zencich *et al.*, 2002) to determine the water requirements of phreatophytic *Banksia* woodland vegetation identified classes of phreatophytic dependency based on the influence of groundwater depth (Froend & Zencich, 2001).

Three phreatophytic categories were identified. The greater the depth to groundwater, the lower the requirement for groundwater and the more tolerant *Banksia* are to groundwater decline due to the corresponding increase in alternative water sources. These alternative sources are primarily the larger volume of unsaturated zone (with increasing soil depth) exploitable by the plant's root system. The categories have been based on research on *Banksia attenuata* and *B. menziesii* only (Froend & Zencich, 2001).

Within the categories of 0-3 m, 3-6 and 6-10 m, *Banksia* are phreatophytic and derive some of their water from groundwater throughout the dry-wet cycle. Between these categories the degree to which groundwater is utilised by *Banksia* is dependent on the proximity of groundwater, availability of moisture in shallower horizons of the soil profile, root system distribution and maximum root depth. The highest proportion (>50%) of groundwater is used by the 0-3 and 3-6 m depth to groundwater vegetation category. Given the apparent high dependency of *Banksia* in these shallow areas of the landscape on summer access to groundwater, it is suggested that they are particularly susceptible to groundwater drawdown. Vegetation in the 6-10 m category also use groundwater, however, they use proportionately more water from the upper layers of the soil profile as they have a larger volume of subsurface soil moisture store beyond the influence of direct evaporation (Zencich *et al.*, 2002).

The results suggested that both *B. attenuata* and *B. ilicifolia* are phreatophytic as they derived some of their water from groundwater throughout the dry-wet cycle, with the exception of *B. attenuata* at the site of greatest depth to groundwater (30 m) which did not use groundwater (Zencich *et al.*, 2002). A high proportion (>50%) of groundwater use was not maintained throughout all seasons. With the onset of the hot Mediterranean summer, progressive drying of the surface soils resulted in increased use of groundwater and deep soil moisture. During the wet winter plants used proportionately more water from the upper layers of the soil profile. The degree to which groundwater was utilised by the study species was dependent on the proximity of groundwater, availability of moisture in shallower horizons of the soil profile, root system distribution and maximum root depth.

WETLAND ECOSYSTEMS

The relationship between groundwater and wetlands has been the focus of much research world-wide and represents a body of work too extensive to review in this report. This section will therefore focus on one component of wetland ecosystems providing a brief overview of wetland vegetation and groundwater dynamics.

There are a number of components of the water regime that influence wetland vegetation (Roberts *et al.*, 2000). The season of flooding determines the climatic variables, such as day length and temperature that persist during inundation (Roberts *et al.*, 2000). The combination of climatic variables and water availability a species requires will determine when it grows and reproduces (Roberts *et al.*, 2000). The

rate at which water rises is important as a rapid increase in depth will not allow emergent species to grow quickly enough to stay above the water (Brock & Casanova, 1997). The frequency of flooding and the interval between flood episodes are also important for growth and reproduction. For example, the seeds of some species may become unviable if dry for too long a period, while other species may require lengthy dry periods to germinate and establish (Roberts et al., 2000).

The most important components of the water regime, however, are the depth of inundation and the duration of the flood event (Roberts et al., 2000). The impact of depth is dependent on the size and growth form of a species. As discussed above large species can grow above the water, however, smaller plants will drown (Roberts et al., 2000). The duration of inundation, or the time that surface water is present, will determine whether some species produce sexually or vegetatively, or whether others, tolerant of short periods of inundation only, will survive at all (Roberts et al., 2000). These two water regime components are also the most significant as they have a greater impact on a wider range of species than other factors. For example, inundation will kill many intolerant species regardless of the season of flooding and rate of rise (Mountford & Chapman, 1993).

A strong relationship therefore exists between the distribution, growth and reproduction of wetland vegetation and the depth and duration of seasonal flooding (Brownlow, Sparrow, & Ganf, 1994; Froend & McComb, 1994; Mountford & Chapman, 1993; Neilsen & Chick, 1997). This relationship is especially obvious where vegetation forms bands around a wetland and each successive band is less tolerant of inundation (Wheeler, 1999).

Altered water regimes also demonstrate the importance of water levels to wetland vegetation (Wheeler, 1999). As each species is adapted to a specific water level range, or hydrological envelope, any change in water levels can ultimately affect its distribution. Long-term persistent changes can cause a shift in community composition and structure as species better adapted to the new conditions become established (Harding, 1993). Lowering water tables can result in the loss of species intolerant of drying and their gradual replacement by terrestrial species with drier hydrological (Keddy & Reznicek, 1986; Moore & Keddy, 1988). Changed climatic patterns and human activities such as groundwater abstraction are the main causes of declining water levels in Australia (Balla, 1994; Froend et al., 1993).

Due to their larger size, longer life-span and more expansive root systems, wetland trees are often more tolerant and respond more slowly to changes in water levels than other wetland species (Balla, 1994; Jenik, 1990). Muir (1983) found evidence of this in a study of vegetation of sandplain wetlands, in which a young band of trees was found growing inside a band of an older species known to be more tolerant of inundation. This suggests that, although conditions had dried enough to allow the new species to establish, the other wetland trees persisted.

Emergent macrophytes, that is sedges and rushes with vegetative parts emerging from seasonal fresh water (Semeniuk, 1987), respond much quicker to altered water regimes than trees and many other perennial wetland species (Froend et al., 1993). Not only are they lost to declining water tables, like many species they are also affected by rising (McComb & Lake, 1990; ter Heerdt & Drost, 1994). Increased groundwater levels can result from climatic changes as well as increased runoff from urban areas and the removal of native vegetation (Balla, 1994).

Emergent macrophytes generally respond to increasing water depths in two ways (van der Valk, 1994). Firstly, if levels rise quickly, they may be lost due to drowning if they do not have enough leaf area above the water surface to allow respiration (van der Valk, 1994). Secondly, if the water rises more gradually they may respond by migrating upslope to more suitable (Froend & McComb, 1994; van der Valk, 1994). Migration downslope will occur in response to lower water levels (Froend & McComb, 1994; ter Heerdt & Drost, 1994).

The distribution and composition of perennial wetland shrubs, herbs and ferns are also influenced by water level gradients (Harding, 1993). These species generally tolerate lower depths of inundation for shorter periods than trees and emergent macrophytes and are often more prominent as fringing species (Keddy & Reznicek, 1986). However, changed water regimes will affect these species in a similar fashion to the emergent macrophytes as they are either lost or migrate to more suitable water levels (Keddy & Reznicek, 1986).

The groundwater dependence of many wetland ecosystems has been largely inferred from their position in the landscape, their response to altered water regimes and the occurrence of vegetation species associated with shallow groundwater. Hatton and Evans (1998) described the groundwater dependence of wetlands as ranging from entirely dependent through to highly dependent and proportionally dependent, according to the permanence of the water body. For example permanent lakes were classified as entirely dependent, while seasonally wet or waterlogged wetlands supporting fringing vegetation communities were described as only proportionally dependent.

Groundwater dependency of wetlands has also been inferred through the impact of altered water regimes on the distribution and composition of wetland ecosystems (Carbon, 1976; Havel, 1975; McComb & McComb, 1967). Unlike terrestrial vegetation, wetland species are often shallow rooted having adapted to shallower water tables (Groom *et al.*, 2000; Muir, 1983). Therefore, in response to declining groundwater levels species are either lost from a wetland or have migrated towards more suitable water levels, to be replaced by more xeric species (Froend *et al.*, 1993; Groom *et al.*, 2000; Muir, 1983; Research Group on Groundwater Management, 1989).

Wetlands also support a diverse range of fauna including invertebrates, fish and birds. Many invertebrate species have no requirement for permanent surface water due to a desiccation resistant life-stage or to a long-lived, non-aquatic adult stage (Balla & Davis, 1993; Davis, Harrington, & Friend, 1991; Davis & Rolls, 1987; Water Authority of Western Australia, 1986). They do, however, require water to complete their life-cycles with many also dependent on emergent wetland vegetation for habitat and food (Arrowsmith, 1996), while other invertebrates and fish species depend on permanent water for all life-stages (Water and Rivers Commission, 1997). Waterbirds rely on wetlands as breeding sites, feeding grounds and drought refuges (Arrowsmith, 1996; Storey, Vervest, Pearson, & Halse, 1993). The groundwater dependency of the faunal component of wetland ecosystems can be initially inferred as they occur in groundwater-fed systems and a fundamental tenet of ecology is that ecosystems will generally use resources in proportion to their availability. Secondary inferences arise from their potential loss from a wetland as a result of declining water tables and the associated reduction in surface water and/or wetland vegetation.

The presence at a site of a suite of known wetland vegetation species can also identify an ecosystem as groundwater dependent. Froend & McComb, (1994) identified 10 key species common across the Gngangara Mound of which one or more were likely to occur at any wetland. Muir (1983), Smith and Ladd (1994) and Groom *et al.* (2000) discussed a group of shallow-rooted, myrtaceous shrub species commonly associated with winter-wet depressions concluding that these species were generally reliant on shallow groundwater tables.

Loomes (2000) described the water depth ranges of 60 wetland vegetation species found across the Swan Coastal Plain in Western Australia. The distributions of these species across 27 annually monitored permanent transects were compared to monthly surface water data to determine the mean minimum and maximum water depths experienced by each species at each wetland (see section 3.1: Review of existing methodologies for further detail). Data for all wetlands were combined to provide absolute and mean water depth ranges. Loomes and Froend (2001a; 2001b; 2001c) used these ranges to review the water level criteria set under the 'East Gngangara Environment Water Provisions Plan' (Water and Rivers Commission, 1997) and the 'Review of Proposed Changed to Environmental Conditions – Gngangara Mound Groundwater Resources' (Water Authority of Western Australia, 1995) and also to assess the potential impacts of altered water regimes on the vegetation of six wetlands in the Muir-Byenup peat swamp system (Froend & Loomes, 2001).

The methodology discussed above involved the use of hydrological ranges, including depth and duration, to describe the water requirements of individual species. To establish EWRs for a wetland vegetation community at a specific site the ranges of the most susceptible species were considered. To determine which species was the most susceptible, comparisons between changes in the cover and abundance, health and distribution were made with trends in the current water regime. For example, declining water levels may coincide with a decline in health, cover and abundance of an emergent macrophyte which requires inundation to a depth not reached in recent seasons. As this species required a greater depth of inundation for longer periods of time than all other species at the particular wetland, it was deemed the most susceptible and a community EWR set to protect it. In comparison, the same emergent macrophyte may have increased in cover and abundance in response to increasing water

levels, while at the same time, a fringing tree species in the overstorey showed signs of declining health. The tree species was regarded as the most susceptible and EWRs set accordingly.

CAVE AND AQUIFER (HYPOGEAN) ECOSYSTEMS

The ecosystems that exist in cave streams and in aquifers themselves have been identified as entirely groundwater dependent (Hatton & Evans, 1998). This level of dependence relates to the evolution of these ecosystems in a stable, confined environment and is best illustrated by the potential of any changes in water depth or quality to have an impact on faunal assemblages (Gillieson, Hamilton-Smith, & Watson, 1995; Sinclair Knight Merz, 2001).

Although there is a paucity of literature related to the water requirements of these communities, in Europe and the US, hypogean invertebrates are increasingly being recognised for their potential as bio-indicators of groundwater quality, especially in relation to heavy metals and other pollutants (Notenboom, Plenet, & Turquin, 1994; Plenet, 1999; Plenet & Gilbert, 1994; Plenet *et al.*, 1992).

A large body of work has been undertaken on the fauna of cave and aquifers systems in north-west Western Australia (Bradbury & Williams, 1996; Humphreys, 1993a, 1993b; Humphreys, Poole, Eberhard, & Warren, 1999; Poore & Humphreys, 1992) with karst ecosystems of the Cape Range recognised as amongst the most diverse in the world (Spate & Thurgate, 1998). Studies have shown that the invertebrate species living in these ecosystems are grazers and predators dependent on the biofilm that forms in freshwater habitats. These ancient species also provide insights into the interconnectedness of groundwater systems, past climate and evolutionary changes.

Yanchep National Park on the Gngangara Mound contains 273 documented caves (Water Authority of Western Australia, 1995). Groundwater streams or pools in five of these systems are known to support between 30 and 40 invertebrate species, which is up to nine times higher than the number of species recorded elsewhere in the world (Jasinska & Knott, 1991). The ability of these species to survive drying is unknown, but it is thought that permanent or temporary drying of cave streams represents the greatest threat to cave fauna (Jasinska & Knott, 1991).

TERRESTRIAL FAUNA

Groundwater dependent terrestrial and wetland vegetation provides habitat and food for fauna which by extension must also be groundwater dependent (Sinclair Knight Merz, 2001). However, there are other groups of fauna that also depend on groundwater as a source of drinking water. Evans and Hatton (Sinclair Knight Merz, 2001) do not describe the level of dependence of faunal ecosystems, however, it can be assumed they are opportunistically dependent as they would use surface water were available.

This group is dominated by birds and larger mammals, as respiration supplies many small mammals with their water requirements (Sinclair Knight Merz, 2001). Some species of kangaroo are known to dig to shallow groundwater while numbers of both native and exotic species have increased as a result of the extensive use of groundwater for livestock watering. As a recent addition to the list of groundwater dependent ecosystems, little or no research has been undertaken specifically on the groundwater dependency of terrestrial fauna.

RIVER-BASE FLOW SYSTEMS

Base flow is the part of river or stream flow derived from the discharge of groundwater and bank storage (Sinclair Knight Merz, 2001). River base flow systems support both aquatic and riparian vegetation as well as dependent fauna (Hatton & Evans, 1998). The majority of research undertaken on these systems internationally relates to the requirements of riparian vegetation in North America and South Africa as discussed in a previous section on terrestrial vegetation.

The river ecosystems of the south-west of Western Australia were classified as proportionally dependent by Hatton and Evans (1998) as base-flow contributes to surface water flow throughout the year. Coastal rivers of northern Australia are also proportionally dependent, however, this is due to the seasonal nature of surface water availability and the subsequent dependence on groundwater during the dry season.

The dependency of river base flow systems has been experimentally illustrated through the use of the stable isotope technique in the study of water relations of river red gums (*Eucalyptus camaldulensis*) on floodplains in Eastern Australia (Cramer, Thorburn, & Fraser, 1999; Mensforth, Thorburn, Tyerman, & Walker, 1994; Thorburn & Walker, 1994; Thorburn et al., 1993; Thorburn, Walker, & Hatton, 1992). The findings of these studies generally suggested that the dependency of river red gums on groundwater varied with the availability of surface water, but that the uptake of groundwater continued throughout the year.

Despite the body of work by Thorburn and others on the river red gum, there remains a need for further research into the interaction between groundwater and surface water and the extent to which riparian vegetation depends on groundwater (Arthington & Zalucki, 1998).

World-wide more than 100 different approaches over 30 countries have been developed to determine the environmental flows required to maintain riverine and stream ecosystems and ecological processes (Arthington, 2001). A large proportion of this work has been undertaken to identify the water requirements of freshwater fish species (Koehn, 1988; Pusey, 1998; Shields, Knight, & Cooper, 1994; Tenant, 1976) with numerous studies also aimed at the in-stream needs of invertebrates (Davis & Humphries, 1995; Gowns, 1998; Halse, 2000). Although base-flows are identified as essential to the maintenance of habitat in the form of summer pools (Davis, Harrington, & Friend, 1993; Storey, 2001), there is little research that addresses the degree of reliance of fauna on groundwater with the literature generally focussed on overall water requirements with little distinction made between surface and groundwater sources.

ESTUARINE AND NEAR-SHORE MARINE ECOSYSTEMS

It is known that mixing at the interface of freshwater and seawater produce a large number of food sources and habitat for a diverse range of species. Tidal freshwater marshes provide nursery grounds for many anadromous and semianadromous fish species, while organic materials including plants and microbes sustain bivalves and crustaceans (Howes, Weiskel, Goehring, & Teal, 1996).

The majority of work on these ecosystems has been undertaken in the US and has focussed on surface sources of freshwater, however, the importance of groundwater has been increasingly recognised. Early studies generated conflicting results with estimates of the volume of submarine groundwater discharge ranging from an amount equal to 1% of river discharge to the ocean to 10% of surface water runoff (Simmons, 1992). The focus of later work seemingly shifted from quantitative to qualitative, with research in the Gulf of Mexico describing the composition of water from offshore springs through the analysis of samples for traces of chemicals and nutrients that originated in freshwater (Stuller, 1994). More recently, research in Florida has identified a number of negative impacts resulting largely from altered groundwater quality, however, the magnitude of these impacts to marine species is still largely unknown (Bacchus, 2001a). Changes in volumes of groundwater discharge and a subsequent increase in salinity have been identified as detrimental to seagrass and turtle-grass beds in Florida Bay (Bacchus, 2001a, 2001b; Duarte, 1995; Durako & Kuss, 1994).

Hatton and Evans (1998) described the majority of estuarine and near-shore marine habitats as using groundwater opportunistically or to a very limited extent. The exception to this was the stromatolite systems of southern Western Australia which have developed in groundwater fed coastal lakes (McNamara, 1992) and were therefore classified as entirely groundwater dependent. Lake Thetis south of Cervantes in the Jurien-Arrowsmith area supports stromatolites and should also be classified as a GDE.

The potential of seagrass systems and near shore fisheries to be groundwater dependent has become a recent area of focus for marine ecologists (J. Griffith, ECU, pers. comm. 2001). Studies have shown that seagrass composition can be altered following groundwater abstraction and the resultant reduction in freshwater input (Hemminga & Duarte, 2000). Groundwater may also provide seagrass in some coastal areas with nutrients (Hatton & Evans, 1998).

Mangroves and salt marshes, although strongly associated with salt water, are also known to occur in areas where fresh groundwater discharge into the sea (Adam, 1994). The groundwater dependence of these systems is unknown, however, Tack and Polk (1999) described a large-scale decline in mangroves following groundwater abstraction.

The groundwater dependence of marine animals is also largely undetermined. However, fauna including fish, turtles, crocodiles and macro-invertebrates may feed on other groundwater dependent species or rely on them for habitat (Haywood, Vance, & Loneragan, 1995; Hyndes, Potter, & Lenanton, 1996; Sinclair Knight Merz, 2001).

Despite increasing interest in the importance of groundwater discharge to near-shore marine and estuarine ecosystems a great number of questions regarding the nature and degree of dependence remain unanswered.

1.3 REVIEW OF EXISTING APPROACHES TO DETERMINING ECOLOGICAL WATER REQUIREMENTS

A number of approaches have been developed to determine the water requirements of water dependent ecosystems. The majority of these, however, focus on the requirements of systems dominated by surface water flows with fewer approaches directed entirely towards groundwater dependent ecosystems. The approaches that do exist for GDEs generally focus on one type of ecosystem (eg. wetlands) or on one component of that ecosystem (eg. wetland vegetation). Surface water system approaches are more holistic in nature, considering the requirements of the many interacting components of river systems. Further differences exist in terms of the spatial scale of approaches, for example the water requirements of an individual wetland or an entire catchment. The greatest variation, however relates to available time and resources. These factors in turn influence the extent of fieldwork, intensity of data analysis and the level of involvement by experts.

In this section, the existing WA approach for GDEs will be summarised and general strengths and limitations assessed. For a full review and comparison of other approaches used for groundwater and surface water systems, refer to Froend and Loomes (2004). Particular emphasis will be placed on identifying the recognised weaknesses of past WA approaches and improvements in a revised approach to determining EWRs for GDEs.

CURRENT WA APPROACH

The current WA approach is defined here by the Review of Proposed Changes to Environmental Conditions, Gngangara Mound Groundwater Resource (Section 46) – Western Australian Water Authority (1995).

In response to further proposed increases in groundwater abstraction, changes in private groundwater usage and an improved understanding of groundwater dependent ecosystems, a review of environmental conditions of the Gngangara Mound was undertaken (Section 46) (Water Authority of Western Australia, 1995). The requirements of three types of GDEs were determined, wetland ecosystems, terrestrial vegetation and cave streams.

The specific approach to defining EWR was;

- Identification of GDE components (wetlands, terrestrial vegetation, cave streams and pools).
- Selection of representative parts for which EWRs were set to ensure appropriate protection for the region.
- Identification of values of those parts, including social and environmental aspects.
- Determination of management objectives based on the values.
- Establishing water levels for each ecosystem component that satisfy the identified management objectives and which define the EWR.

Determination of EWRs for wetland ecosystems involved the following steps;

1. Identifying characteristics of the wetland.
2. Identifying values of the wetland, both environmental and social.
3. Determining management objectives that reflect wetland values, in particular those achievable through management of water levels.
4. Developing a water regime consistent with the management objectives, with water levels to describe that regime.

Wetlands were identified as groundwater dependent ecosystems and wetland vegetation was selected as the representative component for protection due to the interdependent nature of wetland biota. Management objectives included conserving the existing distribution and composition of fringing and emergent vegetation. EWRs were set as minimum and maximum water levels. Absolute minimum water levels for each wetland were set to ensure populations of the sedge *Baumea articulata* were sufficiently inundated and that surface water was present long enough for aquatic invertebrates to complete their life-cycles. The water requirements of *B. articulata* were considered as this species is known to be the most susceptible to declining water levels. Maximum water levels were based on ensuring wetland trees were dry for a minimum period per year.

The approach to setting EWRs for terrestrial vegetation was identified separately to that for wetlands, with the aim of determining water levels required for survival and a level of drawdown that could be tolerated by the vegetation. The approach involved;

1. Identification of areas of susceptible native vegetation.
2. Selection of monitoring bores within the areas that best represent water table levels and which can be used to monitor compliance with water levels.
3. Defining rates of change and minimum groundwater levels to minimise the potential for vegetation deaths due to water stress.

This involved the setting of absolute and preferred minimum groundwater levels that did not represent a static volumetric amount. Instead, these were expressed as dynamic water level regimes that could be changed in response to differing needs and situations. In areas where extraction had already been occurring and had resulted in a stabilised drop in the watertable, the philosophy of no further impact on groundwater levels was adopted.

Minimum water level requirements were selected for susceptible terrestrial vegetation, those existing at shallow depths to groundwater (0-8 m), on the basis of previously observed water levels and resulting impacts on the vegetation. Minimum groundwater level requirements were determined using historical monitoring records from groundwater monitoring wells located within areas of susceptible vegetation. The hydrographs from the monitoring well data were analysed to ascertain a 'normal' minimum groundwater level defined as the average minimum groundwater level occurring at the end of summer periods in the early 1970's prior to abstraction and the continuing drought period. The absolute minimum groundwater level was determined by subtracting 1.5 m from what was considered to be the 'normal' groundwater level.

In areas where abstraction had not been occurring for long enough to result in a stabilised watertable, a vegetation water stress study was used to derive the maximum rate of watertable drop that could still support the extant vegetation. The study indicated that the overstorey component of the vegetation could tolerate a water table drawdown of 1.5 m in total (this is where the figure of 1.5 m was derived to arrive at absolute groundwater levels), and that this drawdown could be tolerated at no more than an average rate of 0.2 m per year.

Due to the limited information on groundwater levels in cave streams and pools at the time of the Section 46 review, EWRs were not set. However management objectives were developed to maintain the existing hydrological regimes and permanent water in streams supporting fauna.

EWRs were established following comparisons of groundwater modelling of preferred abstraction and land use scenarios and EWRs. Finally, management and monitoring programs were implemented to minimize the impact of land use activities on groundwater resources and GDEs.

Strengths and limitations

The setting of EWRs for a wetland based on the pre-determined requirements of a single vegetation species (*Baumea articulata*) represents a relatively quick and inexpensive approach. The use of a species identified as most susceptible to water levels changes also ensures that the requirements of other, less susceptible species are met. However, this species generally occurs only in wetlands that hold surface water for some part of the year, making the approach inapplicable to many systems.

The use of pre-determined requirements in the approach for terrestrial vegetation is also quick and inexpensive. However, setting the same water levels for susceptible vegetation (0-8m groundwater depth) does not recognize the variation in dependence of vegetation at different depths to groundwater. For example, vegetation at 0-3m is more susceptible to drawdown than that at 6-8m. Setting a maximum allowable drawdown of 1.5m also does not consider the greater susceptibility of vegetation at shallower depths to groundwater.

This approach was, however the first attempt at setting preferred and absolute minimum groundwater levels that did not represent a static volumetric amount and reflected the dynamic nature of water level regimes.

Since 1995 there have been numerous interim assessments and research conducted on GDEs on the SCP and elsewhere [refer to (Froend & Loomes, 2004) for review] that has led to an improved understanding of the ecology of these systems and the identification of their EWRs. Incremental changes to the approach described above have been made in recognition of observed limitations and increased knowledge. A summary of these limitations is presented below.

Limitations relevant to identification of EWRs:

- Insufficient consideration of all recognised groundwater dependent ecosystems. The original approach assessed wetlands, terrestrial vegetation and cave streams only with little acknowledgement in the variability within each type of GDE.
- Consideration of the water requirements of only one component of a GDE; e.g. determining EWRs of a whole wetland based on wetland vegetation water requirements alone.
- No acknowledgement of the variability in groundwater dependency within a GDE and/or an ecological component; e.g. variability in groundwater dependency of phreatophytic vegetation relative to depth the water table and hydrological ranges (tolerances) of wetland vegetation. Leads to insufficient awareness of biological/ecological variability and incorrect interpretation of EWRs as absolute 'thresholds' of tolerance.
- Simplification of water requirements into minimum water table depths without recognition of other hydrological variables important to the ecology of the system; e.g. duration, timing and rate of seasonal flooding/drying and the episodicity of extreme flooding/drying events.
- No consideration of cumulative effects of reduced groundwater availability or a lag-response in the ecology.
- No consideration of the resilience of GDEs to drawdown impacts.
- Consideration of GDEs as single units only without a system/catchment approach towards identifying water requirements and possible impacts.

These limitations have often led to the identification of EWRs that do not accurately reflect the requirements of the ecology, often resulting in technical breaches of environmental conditions (without obvious ecological impact) or understated water requirements leading to unexpected environmental impacts.

Other limitations reflect how EWRs are used in the determination of environmental water provisions (EWPs) or determining likely impacts. Limitations relevant to identification of EWPs:

- Absence of a risk (of impact) assessment incorporating variability in current vulnerabilities (water requirements and drought stress) and potential degree of change/impact.
- Management (environmental compliance) criteria based on simplified minimum 'threshold' water table levels without consideration of acceptable changes to ecological values.
- Direct translation of EWRs to EWPs or management criteria without sufficient consideration of social and economic water requirements.
- Inaccurate assessment of groundwater levels/wetland surface water level relative to GDE ecology; e.g. no groundwater monitoring at vegetation monitoring sites.

REVISED APPROACH

Revision of the current WA approach to identification of GDE EWRs should involve the adoption of frameworks described in SKM (2001) and Froend and Loomes (2004). Specifically, a revised approach should:

- Recognise all identifiable GDEs within the study region and set about collecting sufficient information to identify their EWRs. In the case of the SCP, this would see the expansion of

wetlands assessed to include damplands, assessment of phreatophytic vegetation over a variety of depths to groundwater, assessment of baseflow-dominated systems, the inclusion of near-shore marine and estuarine systems and increased assessment of cave and mound spring systems.

- Consider the EWRs of as many components of the GDE ecology for which necessary data are available. For example, this would require the determination of wetland EWRs to be an integration of vegetation, vertebrate, macroinvertebrate and physicochemical water requirements. Single components may dominate the EWR assessment of particular GDEs if insufficient data exist to incorporate the other components of the ecology, or if the requirements of one component (e.g. 'umbrella' species) can be demonstrated to cater for all other key components.
- Acknowledge variability in EWRs within ecological components (e.g. vegetation) of a GDE. Not all phreatophytic vegetation has the same degree of dependency on groundwater and therefore the same response to drawdown. This variability in dependency has a significant effect on the risk of impact from groundwater drawdown. The expression of EWRs should therefore incorporate the range in water requirements (not absolute 'threshold' values only) and or categories of differing requirements/dependency.
- Recognise other hydrological variables important to the ecology of the system; e.g. duration, timing and rate of seasonal flooding/drying and the episodicity of extreme flooding/drying events.
- Consider the cumulative effects of reduced groundwater availability by assessing historical changes in water tables/surface water levels and determine the net change in groundwater availability over key periods of time. This historical change should then be considered in addition to any impacts from proposed developments. A lag-response in a GDE may occur after EWRs have been compromised for some time without obvious ecological response. Identification of EWRs should consider the rate at which GDEs are likely to respond to changes in groundwater availability.
- Acknowledge the resilience of GDEs to altered groundwater availability. Ecological values are able to be restored/maintained if remedial/mitigation practices are put in place. Therefore a longer-term perspective in water requirements necessary to maintain ecological values should be adopted.
- Consider system/catchment level water requirements as well as single GDE requirements. Important landscape level ecological processes should be considered, e.g. acid sulphate soils.

SECTION 2 –EWRs

2.1 GENERAL EWRs

In this section EWRs are described for all GDEs identified in Task 1 (Table 2). As previous studies have not been undertaken on the majority of these systems, their ecological values, condition and general structure are widely unknown. At the time of writing, site visits to ‘new’ wetlands and terrestrial vegetation GDEs identified in Task 1a.2 were being undertaken. However, assessments of values were restricted to vegetation and/or general wetland condition. Assessment of values related to macroinvertebrates, waterbirds, other vertebrates and water quality were beyond the scope of these assessments, as were assessments of ‘new’ cave pool and near-shore marine systems. EWRs therefore could not be described for a vast number of GDEs while the EWRs for many others remain qualitative and based on what little information is available. However, where the required level of information is available detailed/quantitative EWRs are described.

Vegetation

Where the dominant vegetation species of ‘new’ and ‘previously identified’ wetlands have been determined, basic water requirements were described (Table 4). These were based on a previous study of minimum and maximum water depths and duration of inundation experienced by common tree, shrub and emergent macrophyte species of monitored Gnangara and Jandakot wetlands (Loomes, 2000). Comments on the likely magnitude (m) and rate (m/year) of water level decline a wetland can tolerate were also noted (Tables 2 and 3).

Due to the vast number of ‘new’ wetlands, dominant species are merely listed. The following represents the water depth ranges of the most common/dominant species at ‘new’ wetlands;

- *M. rhapsiophylla* – mean 0.006 to -2.14 m, absolute 1.03 to -4.49 m.
- *M. preissiana* – mean -0.54 to -2.62 m; absolute 1.03 to -5.04 m.
- *E. rudis* – mean -0.7 to -3.26 m, absolute 1.03 to -6.44 m.
- *B. littoralis* – mean -0.39 to -1.92 m, absolute 0.43 to -3.09 m.
- *B. articulata* – mean 0.28 to -1.22 m, absolute 0.81 to -2.59 m.
- *T. orientalis* – mean 0.74 to -0.95 m, absolute 1.49 to -1.9 m.
- *A. fascicularis* – mean -0.35 to -2.26 m, absolute 1.03 to -4.6 m.

Duration of inundation (mean months/year) for the same set of species is as follows;

- *M. rhapsiophylla* – mean 2.15, absolute 9.4 (months/year).
- *M. preissiana* – mean 0.6, absolute 4.4 (months/year).
- *E. rudis* – mean 1.55, absolute 12 (months/year).
- *B. littoralis* – mean 0.3, absolute 2.8 (months/year).
- *B. articulata* – mean 3.26, absolute 12 (months/year).
- *T. orientalis* – mean 7.7, absolute 12 (months/year).
- *A. fascicularis* – mean 0.66, absolute 2.6 (months/year).

EWRs for terrestrial vegetation were based on previous investigations into the tolerance and dependence of selected *Banksia* sp. to various groundwater regimes (Froend, Loomes, & Zencich, 2002; Froend & Zencich, 2001). In these studies the potential risk of groundwater declines to phreatophytic vegetation were qualitatively assessed. The risk assessment involved categorising areas according to the depth to groundwater as follows;

- 0-3m
- 3-6m
- 6-10m
- >10m.

Within each of these depth categories, an individual plant is thought to respond to the magnitude of drawdown according to a species response curve (Tables 2 and 3). The threshold curve has so far only been developed for two *Banksia* species on the Swan Coastal Plain, *B. ilicifolia* and *B. attenuata*. For these species it is suggested that for each depth category, increasing the magnitude of groundwater decline will lead to a differing level of response. Those populations in areas of highest water tables (0-3m) are most highly dependent on groundwater and are therefore at greater risk of impact from the

same degree of drawdown than populations at 3-6m and 6-10m. Where *M. preissiana*, *E. rudis* and/or *B. littoralis* occurred within an area of 0-3m, the site was regarded as a wetland.

For each terrestrial vegetation site (or 0-3m site with wetland species) EWRs are described as the risk of impact (low, moderate or high) that phreatophytic vegetation of the appropriate depth to groundwater category is at for a range of groundwater level declines. Groundwater level declines are expressed as magnitude (m) and rate (m/year). For example, phreatophytic vegetation in the 0-3m category is at low risk of impact from a decline of 0.75m at a rate of 0.1m/year.

Table 2: Risk of impact level and magnitude of permissible change (m) for phreatophytic vegetation.

Phreatophytic category	Low	Moderate	High	Severe
0-3m (wetland)	0-0.25	0.25-0.5	0.5-0.75	>0.75
0-3m (terrestrial)	0-0.75	0.75-1.25	1.25-1.75	>1.75
3-6m	0-1.0	1.0-1.5	1.5-2.25	>2.25
6-10m	0-1.25	1.25-2.0	2.0-2.75	>2.75

Table 3: Risk of impact level and rate of permissible change (m/year) for phreatophytic vegetation.

Phreatophytic category	Low	Moderate	High	Severe
0-3m (wetland)	0-0.1	0.1-0.2	0.2-0.3	>0.3
0-3m (terrestrial)	0-0.1	0.1-0.25	0.25-0.5	>0.5
3-6m	0-0.1	0.1-0.25	0.25-0.5	>0.5
6-10m	0-0.1	0.1-0.25	0.25-0.5	>0.5

Vertebrates

The water requirements needed to maintain the fauna can only be discussed in a general sense. For some species of fauna, such as frogs, the species present may be determined by the lowest water levels experienced in the recent past. These would have acted as a bottleneck through which only the more tolerant species could pass. For other faunal groups, however, water levels over successive years will have influenced the abundance and presence of species. All that can be confidently stated is that the faunal assemblage present now has been influenced by the recent history of water levels and the current levels in the area. This faunal assemblage is also dynamic, with rapid changes in some groups but gradual changes in others. This means that maintaining current water levels could still lead to changes in the faunal assemblage, as it is very likely that the assemblage is still influenced by high water levels probably experienced in the 1950s and 1960s.

Macroinvertebrates

Although many of the wetlands of the Gngangara and Jandakot mounds support significant macroinvertebrate assemblages the water requirements needed to maintain macroinvertebrates can only be discussed in a general sense.

Where macroinvertebrate richness is significant for a wetland the known temporal and spatial habitat heterogeneity needs to be maintained by ensuring the mix of vegetation assemblages can persist. Vegetation assemblages may include the following;

- Metaphyton - where known to occur it must remain permanently inundated, all year, every year.
- Submergent - requires inundation according to the specifications of the dominant taxa.
- Emergent - requires inundation according to the specifications of the dominant taxa.
- Littoral assemblages - requires inundation according to the specifications of the dominant taxa.

Rationale: habitat heterogeneity in SCP wetlands is dictated by water regimes as they interact with

- Depression/ landscape geomorphology.
- Vegetation assemblages.

- Sediment processes.
- Water quality.
- Other biotic/abiotic interactions.

These factors are all inter-related and the degree to which any or all of these interact or influence habitat heterogeneity is wetland dependent. Assigning water requirements to one of these as a surrogate for all may, if comprehensively achieved, be adequate to maintain macroinvertebrate richness. Choosing vegetation assemblages as the surrogate has the advantages of contributing to structural heterogeneity, being likely to reflect and contribute to all other influences anyway, and being more likely to be mapped than sediments and water quality.

Where macroinvertebrate proportional endemism is significant for a wetland then the endemic features need to be identified. This is beyond the scope of this work and no EWRs can be set as it requires specific understanding of EWR's of endemic species or assemblages. This type of analysis is begging to be done for plants, invertebrates and microbes. To what degree will endemism be important in wetlands of the SCP? Probably relatively low for macroinvertebrates (>0.5 mm), higher for microinvertebrates (<0.5 mm).

Where macroinvertebrate proportional rarity is significant for a wetland then the rare features need to be identified. This is usually beyond the scope of this work and no EWRs can be set. However, wetland/landscape geomorphology may be a sufficient surrogate for this significant feature, particularly since most proportional rarity is encountered in geomorphologically distinct wetlands like springs, caves, etc. EWRs can therefore be deferred to those set for these wetlands. This type of analysis gives an indication of relative uniqueness and representativeness of any wetland on the SCP.

Waterbirds/waders

Although many of the wetlands of the Gngangara and Jandakot mounds support significant waterbird assemblages water requirements can only be discussed in a general sense. Comments are made on requirements in terms of surface water permeance and depth where possible.

Water quality/sediments

Although wetland water quality is often impacted by inflow of nutrients and pollutants from external sources, in-situ sediment processes also have a major influence. Drying and wetting of sediments containing significant amounts of nutrients can result in the remobilisation of nutrients into the water column. Drying of sediments can also reduce habitat and expose peats and other types of organic matter to fire. The sediment type is generally the determining factor in these processes and may require different water regimes.

Where wetlands have peat or sandy peat, water regime contributions to sedimentary processes leading to the formation of peat need to be maintained. To achieve this, sediments must remain saturated/moist throughout summer, each year. This means that the water table must not drop below the stratigraphic level/layer that is capable of providing water to surface organics through capillary rise during summer.

Where *Baumea articulata* dominates the system this species needs to be inundated each year. The rationale behind this is that sediments that receive predominantly allochthonous organic matter, usually faster than it can be broken down or metabolized or washed away, will accrue layers of peat. This process requires a moisture regime to keep sediments anaerobic (to slow the metabolism) and prevent them from burning (since burning is very rapid metabolism). EWR's for this objective will need to ensure that sediments remain saturated/moist throughout summer, each year, and that vegetation communities that contribute the bulk of this material continue to do so. *Baumea articulata* dominated assemblages are identified as such here, but there are others. Sediments need to be mapped across the SCP.

Where wetlands are known to have, or are likely to have potentially acid sulphate soils (PASS) in their sediments, anaerobic sediments need to be prevented from drying, cracking and aerating. Exposure of anaerobic sediments by lowering water table during periods of high temperatures, exacerbated if associated with removing covering vegetation, will produce the undesired effect. To prevent this, sediments must remain saturated during late summer and early autumn every year.

Sediments need to be mapped across the SCP to identify where PASS occur and where local vulnerabilities exist. Management becomes awkward because two management paradigms currently operating contradict the water regimes required to prevent PASS. One of the management options for eutrophic systems is to dry the sediments out so that phosphorus can be more effectively bound in the sediment the other is that most wetlands on the SCP need to dry out seasonally.

Cave fauna

Root mat communities of the Yanchep Caves persist in permanent pools or streams. As excessive declines in levels are known to expose the suspended root mats and cause them to die-off, stable water levels are required. Water quality is also an important issue for cave fauna which require stable pH, DO and temperature, with minimal diel, seasonal or annual variation.

Water group / GHF	WFLANIS	Chagara	Lebanon Complex	Lebanon	Lebanon	Lebanon
Water regime component						
Depth of groundwater (negative value) or surface						
Duration of inundation or waterlogging (month/year)						
Rate (m/year) and magnitude (m) of decline and risk of impact level (ROI)						
Impacts associated with water regime change and/or other disturbances						
Reliability of information						
Water regime component						
Depth of groundwater (negative value) or surface						
Duration of inundation or waterlogging (month/year)						
Rate (m/year) and magnitude (m) of decline and risk of impact level (ROI)						
Impacts associated with water regime change and/or other disturbances						
Reliability of information						
Water regime component						
Depth of groundwater (negative value) or surface						
Duration of inundation or waterlogging (month/year)						
Rate (m/year) and magnitude (m) of decline and risk of impact level (ROI)						
Impacts associated with water regime change and/or other disturbances						
Reliability of information						

Table 4: (cont.) E/Ws for all GHFs identified in Table 1. E/Ws for wetland vegetation are described in terms of species, water depth ranges and duration of inundation. E/Ws for terrestrial vegetation and macroinvertebrates are based on previous investigations and where possible depth selected. Bankside up to various ground water regimes. * denotes a new E/W.

Sub-group / GDE	Water regime component Depth of groundwater (negative value) or surface water (positive value) (m)	Duration of inundation or waterlogging (months/year)	Rate (m/year) and magnitude (m) of decline and risk of impact level (ROI)	Impacts associated with water regime change and/or other disturbances.	Reliability of information
	<p>assemblages persist.</p> <p>Submergent - requires inundation according to specifications of dominant taxa.</p> <p>Emergent - requires inundation according to specifications of dominant taxa.</p> <p>Littoral - requires inundation according to specifications of dominant taxa.</p> <p>Water quality/sediment processes</p> <p>Sediments must remain saturated/moist throughout the summer each year. The water table therefore must not drop below the stratigraphic level layer capable of providing water to surface organics through capillary rise during summer.</p>	<p>assemblages persist.</p> <p>Metaphyton - where known to occur must remain permanently inundated.</p> <p>Water quality/sediment processes</p> <p>Sediments to be permanently saturated/moist.</p>			
Lake Wigamap (3797650793)	<p>Vegetation - 5 year mean and absolute water depth ranges.</p> <p><i>M. rhizophylla</i> - mean 0.006 to -2.14m, absolute 1.03 to -4.49m.</p> <p><i>B. arcticola</i> - mean 0.28 to -1.22m, absolute 0.81 to -2.59m.</p> <p>Sediment processes</p> <p>Sediments must remain saturated/moist throughout the summer each year. The water table therefore must not drop below the stratigraphic level layer capable of providing water to surface organics through capillary rise during summer. To address PASS anaerobic sediments need to remain saturated during late summer and early autumn.</p>	<p>Vegetation - 5 year mean and absolute maximum period of inundation (months/year).</p> <p><i>M. rhizophylla</i> - mean 2.15, absolute 9.4 (months/year).</p> <p><i>B. arcticola</i> - mean 3.26, absolute 12 (months/year).</p> <p>Sediment processes</p> <p>Sediments to be saturated from late winter to early autumn.</p>	<p>Vegetation</p> <p>Low ROI - rate 0.1m/year, magnitude 0.25m.</p> <p>Moderate ROI - rate 0.1-0.2m/year, magnitude 0.25-0.5m.</p> <p>High ROI - rate 0.2-0.3m/year, magnitude 0.5-0.7m.</p>	<ul style="list-style-type: none"> Drying of organic rich sediments. Widespread loss of <i>M. rhizophylla</i>. Thinning of <i>B. arcticola</i> & <i>L. longistylus</i>. Exotics encroaching into the basin. Low macroinvertebrate richness. 	<ul style="list-style-type: none"> Wetland species depth ranges based on extrapolation of surface and groundwater levels across the length of the monitoring transects rather than actual measured depths to groundwater.
Pyralany Swamp (3794650121)	<p>Vegetation - 5 year mean and absolute water depth ranges.</p> <p><i>M. rhizophylla</i> - mean 0.006 to -2.14m, absolute 1.03 to -4.49m.</p> <p><i>B. arcticola</i> - mean 0.28 to -1.22m, absolute 0.81 to -2.59m.</p> <p>Waterbirds</p> <p>Extensive winter spring flooding required.</p> <p>Vertebrates</p> <p>Permanent or near-permanent surface water required for long-necked turtles.</p> <p>Macrobenthos</p> <p>The known spatial and temporal habitat heterogeneity will be maintained by ensuring the following mix of vegetation assemblages persist:</p> <p>Submergent - requires inundation according to specifications of dominant taxa.</p> <p>Emergent - requires inundation according to specifications of dominant taxa.</p> <p>Littoral - requires inundation according to specifications of dominant taxa.</p>	<p>Vegetation - 5 year mean and absolute maximum period of inundation (months/year).</p> <p><i>M. rhizophylla</i> - mean 2.15, absolute 9.4 (months/year).</p> <p><i>B. arcticola</i> - mean 3.26, absolute 12 (months/year).</p> <p>Waterbirds</p> <p>At least certain periods of inundation.</p>	<p>Vegetation</p> <p>Low ROI - rate 0.1m/year, magnitude 0.25m.</p> <p>Moderate ROI - rate 0.1-0.2m/year, magnitude 0.25-0.5m.</p> <p>High ROI - rate 0.2-0.3m/year, magnitude 0.5-0.7m.</p>	<ul style="list-style-type: none"> Increasing conductivity in ponds near dunes. Exotic flora invading wetland. Some suggestion that period of inundation has declined to detriment of waterbirds. 	<ul style="list-style-type: none"> Wetland species depth ranges based on extrapolation of surface and groundwater levels across the length of the monitoring transects rather than actual measured depths to groundwater. Specific site conditions that may influence groundwater dependence are not considered (eg. stratigraphy).
Lake Nowegap (3794649229)	<p>Vegetation - 5 year mean and absolute water depth ranges.</p> <p><i>M. rhizophylla</i> - mean 0.006 to -2.14m, absolute 1.03 to -4.49m.</p> <p><i>E. rufa</i> - mean -0.7 to -3.26m, absolute 1.03 to -6.44m.</p>	<p>Vegetation - 5 year mean and absolute maximum period of inundation (months/year).</p> <p><i>M. rhizophylla</i> - mean 2.15, absolute 9.4 (months/year).</p> <p><i>E. rufa</i> - mean 1.55, absolute 12 (months/year).</p>	<p>Vegetation</p> <p>Rate - 0.1m/year; magnitude - 0.25m.</p> <p>Rate of decline not known - fish are mobile and can probably withstand reasonably rapid natural declines.</p>	<ul style="list-style-type: none"> Declining health of <i>M. rhizophylla</i> & <i>E. rufa</i>. Thinning of <i>B. arcticola</i>. Encroachment of <i>Zypha arctica</i> into wetland. 	<ul style="list-style-type: none"> Wetland species depth ranges based on extrapolation of surface and groundwater levels across the length of the monitoring transects rather than actual measured depths to

Sub-group / GDE	Water regime component	Duration of inundation or waterlogging (months/year)	Rate (m/year) and magnitude (m) of decline and risk of Impact level (ROI)	Impacts associated with water regime change and/or other disturbances.	Reliability of Information
	<p><i>B. articulata</i> – mean 0.28 to -1.22m, absolute 0.81 to -2.59m.</p> <p>Waterbirds Retention of water in summer and autumn an important feature of this wetland. Winter/spring peak levels flooding fringing vegetation important.</p> <p>Vertebrates Permanent water and high peak levels for Rakali and frogs. Needs to be permanently inundated for fish - critical minimum threshold depth for survival not known.</p> <p>Macroinvertebrates The known spatial and temporal habitat heterogeneity will be maintained by ensuring the following mix of vegetation assemblages persist.</p> <p>Submergent – requires inundation according to specifications of dominant taxa.</p> <p>Emergent – requires inundation according to specifications of dominant taxa.</p> <p>Littoral – requires inundation according to specifications of dominant taxa.</p> <p>Water quality/sediment processes Sediments must remain saturated moist throughout the summer each year. The water table therefore must not drop below the stratigraphic level layer capable of providing water to surface organics through capillary rise during summer.</p>	<p><i>B. articulata</i> – mean 3.26, absolute 12 (months/year).</p> <p>Waterbirds Permanent.</p> <p>Vertebrates Permanently inundated for fish and frogs.</p> <p>Macroinvertebrates The known spatial and temporal habitat heterogeneity will be maintained by ensuring the following mix of vegetation assemblages persist.</p> <p>Metaphyton – where known to occur must remain permanently inundated.</p> <p>Water quality/sediment processes Sediments to be permanently saturated moist.</p>	<p>particularly in basins with even bathymetry.</p>	<ul style="list-style-type: none"> Change in water quality; increase in pH, decreased conductivity, nutrients & chlorophyll-<i>a</i>. Slight decline in summer invertebrate richness; however, species of <i>Cladocera (Lepidocera ethusa)</i> most known. 	<p>groundwater.</p> <ul style="list-style-type: none"> Specific site conditions that may influence groundwater dependence are not considered (eg. stratigraphy).
Lake Jondalup (181766-875)	<p>Vegetation - 5 year mean and absolute water depth ranges.</p> <p><i>M. raphiophylla</i> – mean 0.006 to -2.14m, absolute 1.03 to -4.49m.</p> <p><i>E. rostrata</i> – mean -0.7 to -3.26m, absolute 1.03 to -6.44m.</p> <p><i>B. littoralis</i> – mean -0.39 to -1.92m, absolute 0.43 to -3.09m.</p> <p><i>B. articulata</i> – mean 0.28 to -1.22m, absolute 0.81 to -2.59m.</p> <p><i>B. juncea</i> – mean -0.52 to -2.65m, absolute 1.03 to -4.64m.</p> <p>Waterbirds Retention of water in summer and autumn an important feature of this wetland. Winter/spring peak levels flooding fringing vegetation important.</p> <p>Vertebrates Permanent water and high peak levels for Rakali and frogs. Needs to be permanently inundated for fish - critical minimum threshold depth for survival not known.</p> <p>Permanent or near-permanent surface water required for long-necked tortoises.</p> <p>Macroinvertebrates The known spatial and temporal habitat heterogeneity will be maintained by ensuring the following mix of vegetation assemblages persist.</p> <p>Submergent – requires inundation according to specifications of dominant taxa.</p> <p>Emergent – requires inundation according to specifications of</p>	<p>Vegetation - 5 year mean and absolute maximum period of inundation (months/year).</p> <p><i>M. raphiophylla</i> – mean 2.15, absolute 9.4 (months/year).</p> <p><i>E. rostrata</i> – mean 1.55, absolute 12 (months/year).</p> <p><i>B. littoralis</i> – mean 0.3, absolute 2.8 (months/year).</p> <p><i>B. articulata</i> – mean 3.26, absolute 12 (months/year).</p> <p><i>B. juncea</i> – mean 0.71, absolute 3.6 (months/year).</p> <p>Waterbirds Permanent.</p> <p>Vertebrates Permanently inundated for fish, frogs and Rakali. Near-permanent for long-necked tortoises.</p> <p>Macroinvertebrates The known spatial and temporal habitat heterogeneity will be maintained by ensuring the following mix of vegetation assemblages persist.</p> <p>Metaphyton – where known to occur must remain permanently inundated.</p> <p>Water quality/sediment processes Sediments to be permanently saturated moist.</p>	<p>Vegetation</p> <p>Low ROI – rate 0 for year, magnitude 0.25m</p> <p>Moderate ROI – rate 0.1-0.2m/year, magnitude 0.25-0.5m.</p> <p>High ROI – rate 0.2-0.3m/year, magnitude 0.5-0.7m.</p> <p>Vertebrates Rate of decline not known – fish are mobile and can probably withstand reasonably rapid natural declines, particularly in basins with even bathymetry.</p>	<ul style="list-style-type: none"> Flow water quality. Fringing vegetation & <i>E. rostrata</i> impacted by frequent fires and wind throw due to drying sediments. <i>Typha orientalis</i> encroaching in southern section of lake. 	<ul style="list-style-type: none"> Wetland species depth ranges based on extrapolation of surface and groundwater levels across the length of the monitoring transects rather than actual measured depths to groundwater. Specific site conditions that may influence groundwater dependence are not considered (eg. stratigraphy).

Sub-group / GDE	Water regime component Depth of groundwater (negative value) or surface water (positive value) (m)	Duration of inundation or waterlogging (months/year)	Rate (m/year) and magnitude (m) of decline and risk of Impact level (ROI)	Impacts associated with water regime change and/or other disturbances.	Reliability of information
	dominant taxa Littoral – requires inundation according to specifications of dominant taxa Water quality/sediment processes Sediments must remain saturated/moist throughout the summer each year. The water table therefore must not drop below the stratigraphic level layer capable of providing water to surface organics through capillary rise during summer.				
Lake Gualidal (14710617968)	Vegetation - 5 year mean and absolute water depth ranges. <i>M. rhaphiophylla</i> - mean 0.06 to -2.14m, absolute 1.03 to -4.49m. <i>E. rubra</i> - mean -0.7 to -3.26m, absolute 1.03 to -6.44m. <i>B. articulata</i> - mean 0.28 to -1.22m, absolute 0.81 to -2.29m. Waterbirds Retention of water in summer and autumn an important feature of this wetland. Winter/spring peak levels flooding fringing vegetation important Vertebrates Needs to be permanently inundated for fish – critical minimum threshold depth for survival not known Permanent water and high peak levels for Rakali and frogs. Lake appears to have a large population of the Rakali, probably reflecting relatively stable water levels with flooded fringing vegetation all year round. Water quality/sediment processes Sediments must remain saturated/moist throughout the summer each year. The water table therefore must not drop below the stratigraphic level layer capable of providing water to surface organics through capillary rise during summer.	Vegetation - 5 year mean and absolute maximum period of inundation (months/year) : <i>M. rhaphiophylla</i> - mean 2.15, absolute 9.4 (months/year) <i>E. rubra</i> - mean 1.55, absolute 12 (months/year) <i>B. articulata</i> - mean 3.26, absolute 12 (months/year) Waterbirds Permanent. Vertebrates Permanently inundated for fish, frogs and Rakali. Fringing vegetation remaining flooded to some degree in summer and autumn. Water quality/sediment processes Sediments to be permanently saturated/moist.	Vegetation Low ROI - rate 0.1m/year, magnitude 0.25m. Moderate ROI - rate 0.1-0.2m/year, magnitude 0.25-0.5m. High ROI - rate 0.2-0.3m/year, magnitude 0.5-0.7m. Vertebrates Rate of decline not known – fish are mobile and can probably withstand reasonably rapid natural declines, particularly in basins with even bathymetry.	<ul style="list-style-type: none"> Increasing <i>A. hypophylla</i> levels leading to eutrophication. Low macroinvertebrate family richness however, a high abundance of <i>Gambusia</i> sp. Decline in health of <i>M. rhaphiophylla</i> & <i>E. rubra</i>. Contraction of <i>B. articulata</i> banks Invasion by exotic flora. 	<ul style="list-style-type: none"> Wetland species depth ranges based on extrapolation of surface and groundwater levels across the length of the monitoring transects rather than actual measured depths to groundwater. Specific site conditions that may influence groundwater dependence are not considered (eg. stratigraphy)
Caratooda Lake* (178496150146)	Vegetation <i>M. rhaphiophylla</i> , <i>E. rubra</i> and <i>T. orientalis</i> .		Vegetation Low ROI - rate 0.1m/year, magnitude 0.25m. Moderate ROI - rate 0.1-0.2m/year, magnitude 0.25-0.5m. High ROI - rate 0.2-0.3m/year, magnitude 0.5-0.7m.	<ul style="list-style-type: none"> Surrounded by market gardens & pasture, extensive clearing of terrestrial vegetation & some infilling. Annual & perennial weeds encroaching margins of lake. 	<ul style="list-style-type: none"> No permanent vegetation monitoring transect. Specific site conditions that may influence groundwater dependence are not considered (eg. stratigraphy)
Lake Nershap* (18204449442)	Vegetation <i>M. rhaphiophylla</i> , <i>E. rubra</i> , <i>B. articulata</i> and <i>T. orientalis</i> .		Vegetation Low ROI - rate 0.1m/year, magnitude 0.25m. Moderate ROI - rate 0.1-0.2m/year, magnitude 0.25-0.5m. High ROI - rate 0.2-0.3m/year, magnitude 0.5-0.7m.	<ul style="list-style-type: none"> Encroachment of <i>Zizya</i> Eutrophication from surrounding land-use Market gardens / semi-rural development intruding into wetland. Rensselaer bushland disturbed by grazing. Road intersects wetland Some areas of severe weed infestation. 	<ul style="list-style-type: none"> No permanent vegetation monitoring transect. Specific site conditions that may influence groundwater dependence are not considered (eg. stratigraphy)
Lake Gwelop* (18516447226)	Vegetation <i>M. rhaphiophylla</i> and <i>E. rubra</i> Waterbirds Retention of water in summer and autumn an important feature of this wetland. Winter/spring peak levels flooding fringing vegetation important.	Waterbirds Permanent in most years, but seasonal variation important. Vertebrates Permanent in most years beneficial to frogs. Not known if Rakali present. Water quality/sediment processes	Vegetation Low ROI - rate 0.1m/year, magnitude 0.25m. Moderate ROI - rate 0.1-0.2m/year, magnitude 0.25-0.5m. High ROI - rate 0.2-0.3m/year, magnitude 0.5-0.7m.	<ul style="list-style-type: none"> Previously disturbed by rural practices now by urban development. Several drains feed into wetland Annual weed species present. Surrounded by parkland with some remnant bushland in the north. 	<ul style="list-style-type: none"> No permanent vegetation monitoring transect. Specific site conditions that may influence groundwater dependence are not considered (eg. stratigraphy)

Sub-group / GDE	Water regime component	Duration of inundation or waterlogging (months/year)	Rate (m/year) and magnitude (m) of decline and risk of impact level (ROI)	Impacts associated with water regime change and/or other disturbances.	Reliability of information
	Vertebrates High peak levels in winter/spring for frogs. Water quality/sediment processes Sediments must remain saturated moist throughout the summer each year. The water table therefore must not drop below the stratigraphic level layer capable of providing water to surface organics through capillary rise during summer.	Sediments to be permanently saturated moist.		<ul style="list-style-type: none"> <i>Zygo eucumbria</i> further into wetland. Terrestrial & wetland trees affected by fire. 	
Heensay Swamp* (138025640247)	Vegetation <i>M. rhizophyllita</i> and <i>E. rubra</i> .		Vegetation Low ROI - rate 0.1m/year, magnitude 0.25m. Moderate ROI - rate 0.1-0.2m/year, magnitude 0.25-0.5m. High ROI - rate 0.2-0.3m/year, magnitude 0.5-0.7m.	<ul style="list-style-type: none"> Surrounded by cleared parkland. Annual & perennial weed invasion at perimeter of swamp. 	<ul style="list-style-type: none"> No permanent vegetation monitoring transect. Specific site conditions that may influence groundwater dependence are not considered (eg. stratigraphy).
Dig Curlew Swamp* (13806647515)	Vegetation <i>M. rhizophyllita</i> , <i>E. rubra</i> , <i>B. arctostylis</i> and <i>T. orientalis</i> . Waterbirds Retention of water in summer and autumn an important feature of this wetland. Winter spring peak levels flooding (longing vegetation important). Vertebrates High peak levels in winter/spring for frogs. Water quality/sediment processes Sediments must remain saturated moist throughout the summer each year. The water table therefore must not drop below the stratigraphic level layer capable of providing water to surface organics through capillary rise during summer.	Waterbirds Permanent in most years, but seasonal variation important. Vertebrates Permanent in most years beneficial in frogs. Not known if Rakali present. Water quality/sediment processes Sediments to be permanently saturated moist.	Vegetation Low ROI - rate 0.1m/year, magnitude 0.25m. Moderate ROI - rate 0.1-0.2m/year, magnitude 0.25-0.5m. High ROI - rate 0.2-0.3m/year, magnitude 0.5-0.7m.	<ul style="list-style-type: none"> Situated in large recreation reserve. Previously turf with small sections of remnant vegetation. Fringing <i>M. rhizophyllita</i> on west & southern side generally in higher section of littoral zone are showing signs of drought stress. 	<ul style="list-style-type: none"> No permanent vegetation monitoring transect. Specific site conditions that may influence groundwater dependence are not considered (eg. stratigraphy).
Chermsay Swamp* (138195647509)	Vegetation <i>M. rhizophyllita</i> , <i>E. rubra</i> , <i>B. arctostylis</i> and <i>T. orientalis</i> .		Vegetation Low ROI - rate 0.1m/year, magnitude 0.25m. Moderate ROI - rate 0.1-0.2m/year, magnitude 0.25-0.5m. High ROI - rate 0.2-0.3m/year, magnitude 0.5-0.7m.	<ul style="list-style-type: none"> Highly modified with mulling and urban development on all sides. Receives road runoff & is highly eutrophic. Vegetation degraded through physical disturbance & invasion of weeds. 	<ul style="list-style-type: none"> No permanent vegetation monitoring transect. Specific site conditions that may influence groundwater dependence are not considered (eg. stratigraphy).
Wallabecup Swamp* (138066481190)	Vegetation <i>M. rhizophyllita</i> , <i>E. rubra</i> , <i>B. arctostylis</i> and <i>T. orientalis</i> . Waterbirds Extensive winter/spring flooding of <i>Melaluca</i> important for waterbird breeding.		Vegetation Low ROI - rate 0.1m/year, magnitude 0.25m. Moderate ROI - rate 0.1-0.2m/year, magnitude 0.25-0.5m. High ROI - rate 0.2-0.3m/year, magnitude 0.5-0.7m.	<ul style="list-style-type: none"> East side cleared for semi-rural use. Littoral vegetation cleared around perimeter. Recent fire scorched wetland trees. 	<ul style="list-style-type: none"> No permanent vegetation monitoring transect. Specific site conditions that may influence groundwater dependence are not considered (eg. stratigraphy).
Badgerup Lake* (138025640311)	Vegetation <i>Melaluca prostrata</i> , <i>E. rubra</i> and <i>T. orientalis</i> . Water quality/sediment processes Sediments must remain saturated moist throughout the summer each year. The water table therefore must not drop below the stratigraphic level layer capable of providing water to surface organics through capillary rise during summer.	Water quality/sediment processes Sediments to be permanently saturated moist.	Vegetation Low ROI - rate 0.1m/year, magnitude 0.25m. Moderate ROI - rate 0.1-0.2m/year, magnitude 0.25-0.5m. High ROI - rate 0.2-0.3m/year, magnitude 0.5-0.7m.	<ul style="list-style-type: none"> East side cleared for semi-rural use encroaching. Removal of wetland trees in areas of semi-rural use. 	<ul style="list-style-type: none"> No permanent vegetation monitoring transect. Specific site conditions that may influence groundwater dependence are not considered (eg. stratigraphy).
Little Badgerup Lake* (13807660274)	Vegetation <i>Melaluca prostrata</i> , <i>E. rubra</i> and <i>T. orientalis</i> . Water quality/sediment processes Sediments must remain saturated moist throughout the	Water quality/sediment processes Sediments to be permanently saturated moist.	Vegetation Low ROI - rate 0.1m/year, magnitude 0.25m. Moderate ROI - rate 0.1-0.2m/year, magnitude 0.25-0.5m.	<ul style="list-style-type: none"> Wide buffer of vegetation, some semi-rural use encroaching. Removal of wetland trees in areas of semi-rural use. 	<ul style="list-style-type: none"> No permanent vegetation monitoring transect. Specific site conditions that may influence groundwater dependence are not considered (eg. stratigraphy).

Sub-group / GDE	Water regime component	Duration of inundation or waterlogging (months/year)	Rate (m/year) and magnitude (m) of decline and risk of impact level (ROI)	Impacts associated with water regime change and/or other disturbances.	Reliability of information
	Depth of groundwater (negative value) or surface water (positive value) (m)				
	summer each year. The water table therefore must not drop below the stratigraphic level layer capable of providing water to surface organics through capillary rise during summer.		High ROI – rate 0.2-0.3m/year, magnitude 0.5-0.7m.	<ul style="list-style-type: none"> Some littoral vegetation lost to clearing. Disturbed areas of littoral zone are heavily weed infested. 	
Stomplund* (383460-49557)	<p>Vegetation <i>M. rhaphiophylla</i> and <i>E. radiis</i></p>		<p>Vegetation Low ROI – rate 0.1m/year, magnitude 0.25m. Moderate ROI – rate 0.1-0.2m/year, magnitude 0.25-0.5m. High ROI – rate 0.2-0.3m/year, magnitude 0.5-0.7m.</p>	<ul style="list-style-type: none"> Substantial vegetation buffer where joins Nerrabup National Park rest private property. Wetland perimeter degraded from grazing by horses. 	<ul style="list-style-type: none"> No permanent vegetation monitoring transect. Specific site conditions that may influence groundwater dependence are not considered (eg. stratigraphy).
Pinejar Complex Lake Manginup (387340-49554)	<p>Vegetation - 5 year mean and absolute water depth ranges: <i>M. rhaphiophylla</i> – mean 0.006 to -2.14m, absolute 1.03 to -4.40m. <i>E. radiis</i> – mean -0.7 to -3.26m, absolute 1.03 to -6.44m <i>B. verticillata</i> – mean 0.28 to -1.22m, absolute 0.81 to -2.59m. <i>T. orientalis</i> – mean 0.74 to -0.95, absolute 1.49 to -1.3m. Verticillates Needs to be permanently inundated for fish – critical minimum threshold depth for survival not known. Wading birds Persistence of shallow water into summer/autumn. High levels in winter may be needed to provide vegetation from chocking open shallows. Macrolvertebrates The known spatial and temporal habitat heterogeneity will be maintained by ensuring the following mix of vegetation assemblages persists: Submergent – requires inundation according to specifications of dominant taxa. Emergent – requires inundation according to specifications of dominant taxa. Littoral – requires inundation according to specifications of dominant taxa. Water quality/sediment processes Sediments must remain saturated moist throughout the summer each year. The water table therefore must not drop below the stratigraphic level layer capable of providing water to surface organics through capillary rise during summer. To address PASS anaerobic sediments need to remain saturated during late summer and early autumn.</p>	<p>Vegetation - 5 year mean and absolute maximum period of inundation (months/year). <i>M. rhaphiophylla</i> – mean 2.15, absolute 9.4 (months/year). <i>E. radiis</i> – mean 1.55, absolute 12 (months/year). <i>B. verticillata</i> – mean 3.26, absolute 12 (months/year). Verticillates Permanently inundated for fish. Wading birds Shallow water should persist into autumn some years. Water quality/sediment processes Sediments to be permanently saturated moist.</p>	<p>Vegetation Low ROI – rate 0.1m/year, magnitude 0.25m. Moderate ROI – rate 0.1-0.2m/year, magnitude 0.25-0.5m. High ROI – rate 0.2-0.3m/year, magnitude 0.5-0.7m. Verticillates Rate of decline not known – fish are mobile and can probably withstand reasonably rapid natural declines, particularly in basins with even bathymetry</p>	<ul style="list-style-type: none"> Declining surface and groundwater levels since 1995 (dries most summers), leading to drying of organic rich sediments. Becoming increasingly acidic, critical macroinvertebrate species not yet showing signs of stress. Decline in florin species richness in plots. Decline in condition of fringing vegetation due to drying, fire, physical disturbance and exotic species. 	<ul style="list-style-type: none"> Wetland species depth ranges based on extrapolation of surface and groundwater levels across the length of the monitoring transect (rather than actual measured depths to groundwater). Specific site conditions that may influence groundwater dependence are not considered (eg. stratigraphy).
Lake Jandakop (390260-48649)	<p>Vegetation - 5 year mean and absolute water depth ranges. <i>M. preussiana</i> – mean -0.54 to -2.02m, absolute 1.03 to -5.04m. <i>B. littoralis</i> – mean -0.39 to -1.92m, absolute 0.43 to -3.02m <i>A. fasciculata</i> – mean -0.35 to -2.26m, absolute 1.03 to -4.6m.</p>	<p>Vegetation - 5 year mean and absolute maximum period of inundation (months/year). <i>M. preussiana</i> – mean 0.6, absolute 4.4 (months/year). <i>B. littoralis</i> – mean 0.3, absolute 2.8 (months/year). <i>A. fasciculata</i> – mean 0.66, absolute 2.6 (months/year). <i>B. ellipticum</i> – mean 0.2, absolute 0.6 (months/year).</p>	<p>Vegetation Low ROI – rate 0.1m/year, magnitude 0.25m. Moderate ROI – rate 0.1-0.2m/year, magnitude 0.25-0.5m. High ROI – rate 0.2-0.3m/year, magnitude 0.5-0.7m.</p>	<ul style="list-style-type: none"> Increasing surface water levels since 1995 following artificial maintenance. Water quality was deteriorating however, since maintenance quality is increasing. Changed water quality lead to shifts in macroinvertebrates. There were local 	<ul style="list-style-type: none"> Wetland species depth ranges based on extrapolation of surface and groundwater levels across the length of the monitoring transect (rather than actual measured depths to groundwater). Specific site conditions that may influence

Sub-group / GDE	Water regime component	Duration of inundation or waterlogging (months/year)	Rate (m/year) and magnitude (m) of decline and risk of impact level (ROI)	Impacts associated with water regime change and/or other disturbances	Reliability of information
	<p><i>P. allipticum</i> – mean -0.61 to -2.22 m, absolute 0 to -3.53m <i>H. angustifolium</i> – mean -0.16 to -3.53m, absolute -0.16 to -3.53m <i>B. verticillata</i> – mean 0.28 to -1.22m, absolute 0.81 to -2.59m</p> <p>Waterbirds/waders Flooded meads known to be important for waterbird brooding in winter/spring. Shallows in summer/autumn used by waders so high peak levels may be required to prevent spread of vegetation.</p> <p>Macrophytes The known spatial and temporal habitat heterogeneity will be maintained by ensuring the following mix of vegetation assemblages persist: Submergent – requires inundation according to specifications of dominant taxa Emergent – requires inundation according to specifications of dominant taxa Littoral – requires inundation according to specifications of dominant taxa</p> <p>Water quality/sediment processes Sediments must remain saturated moist throughout the summer each year. The water table therefore must not drop below the stratigraphic level layer capable of providing water to surface organics through capillary rise during summer. To address PASS anaerobic sediments need to remain saturated during late summer and early autumn.</p>	<p><i>H. angustifolium</i> – mean 0.1, absolute 0.6 (months/year) <i>B. verticillata</i> – mean 3.26, absolute 12 (months/year)</p> <p>Waterbirds/waders Persistence of shallows into autumn.</p> <p>Macrophytes The known spatial and temporal habitat heterogeneity will be maintained by ensuring the following mix of vegetation assemblages persist. Metaphyton – where known to occur must remain permanently inundated</p> <p>Water quality/sediment processes Sediments to be permanently saturated moist</p>		<ul style="list-style-type: none"> • Reductions & a decrease in sensitive species and then an increase in acid-tolerant species and finally the return of some significant species found prior to acidification. • Decline in health of fringing <i>E. rubra</i> & <i>M. rhaphanophylla</i> • Disappearance of emergent macrophytes. • Decline in flora species richness in plots since 1997 	<p>groundwater dependence are not considered (eg. stratigraphy)</p>
Lake Pinar* (387666-87933)	<p>Vegetation <i>M. rhaphanophylla</i>, <i>E. rubra</i>, <i>M. praevariana</i> and <i>B. verticillata</i></p> <p>Terrestrial vertebrates Unknown but depth to groundwater affects terrestrial vegetation.</p>		<p>Vegetation Low ROI – rate 0.1m/year, magnitude 0.25m Moderate ROI – rate 0.1-0.2m/year, magnitude 0.25-0.5m High ROI – rate 0.2-0.3m/year, magnitude 0.5-0.7m</p>	<ul style="list-style-type: none"> • Vegetation heavily modified by agriculture. • Little undisturbed vegetation remains. • <i>E. rubra</i> shows signs of stress with many dead trees. 	<ul style="list-style-type: none"> • No permanent vegetation monitoring transect. • Specific site conditions that may influence groundwater dependence are not considered (eg. stratigraphy)
Little Manginap* (388,906-49035)	<p>Vegetation <i>E. rubra</i></p> <p>Water quality/sediment processes Sediments must remain saturated moist throughout the summer each year. The water table therefore must not drop below the stratigraphic level layer capable of providing water to surface organics through capillary rise during summer. To address PASS anaerobic sediments need to remain saturated during late summer and early autumn.</p>	<p>Water quality/sediment processes Sediments to be permanently saturated moist</p>	<p>Vegetation Low ROI – rate 0.1m/year, magnitude 0.25m Moderate ROI – rate 0.1-0.2m/year, magnitude 0.25-0.5m High ROI – rate 0.2-0.3m/year, magnitude 0.5-0.7m</p>	<ul style="list-style-type: none"> • On private property and predominantly cleared. • Entire area appears to be grazed. • Some scattered <i>Fragaria</i> remain around fringe. 	<ul style="list-style-type: none"> • No permanent vegetation monitoring transect. • Specific site conditions that may influence groundwater dependence are not considered (eg. stratigraphy)
Hawkins Rd Swamp* (391204-49261)	<p>Vegetation <i>M. praevariana</i>, <i>A. fasciculata</i> and <i>B. verticillata</i></p>		<p>Vegetation Low ROI – rate 0.1m/year, magnitude 0.25m Moderate ROI – rate 0.1-0.2m/year, magnitude 0.25-0.5m High ROI – rate 0.2-0.3m/year, magnitude 0.5-0.7m.</p>	<ul style="list-style-type: none"> • Lies within pine plantation and adjacent to cleared land. • Degraded by tracks, dumping of rubbish and regular fires. • Some invasion of exotics grasses. • Some terrestrialising occurring. 	<ul style="list-style-type: none"> • No permanent vegetation monitoring transect. • Specific site conditions that may influence groundwater dependence are not considered (eg. stratigraphy)

Sub-group / GDE	Water regime component Depth of groundwater (negative value) or surface water (positive value) (m)	Duration of inundation or waterlogging (months/year)	Rate (m/year) and magnitude (m) of decline and risk of Impact level (ROI)	Impacts associated with water regime change and/or other disturbances.	Reliability of information
Lake Adams* Swamp* (33344549190)	Vegetation <i>E. rostrata</i> , <i>M. preissiana</i> and <i>A. fascicularis</i>		Vegetation Low ROI - rate 0.1m/year, magnitude 0.25m. Moderate ROI - rate 0.1-0.2m/year, magnitude 0.25-0.5m. High ROI - rate 0.2-0.3m/year, magnitude 0.5-0.7m	<ul style="list-style-type: none"> Over half is privately owned & used as paddock. Some wetland trees remain, with a weedy understorey. Crown reserve section not cleared but has a walkway constructed through it with planting's of exotic tree species. 	<ul style="list-style-type: none"> No permanent vegetation monitoring transect. Specific site conditions that may influence groundwater dependence are not considered (eg. stratigraphy).
Little Adams Swamp* (33334649226)	Vegetation <i>E. rostrata</i> and <i>M. preissiana</i>		Vegetation Low ROI - rate 0.1m/year, magnitude 0.25m. Moderate ROI - rate 0.1-0.2m/year, magnitude 0.25-0.5m. High ROI - rate 0.2-0.3m/year, magnitude 0.5-0.7m	<ul style="list-style-type: none"> Extensively on cleared private property with grazing access to lake bed. 	<ul style="list-style-type: none"> No permanent vegetation monitoring transect. Specific site conditions that may influence groundwater dependence are not considered (eg. stratigraphy).
Dampland* (391234998)	Vegetation <i>E. rostrata</i> and <i>M. preissiana</i>		Vegetation Low ROI - rate 0.1m/year, magnitude 0.25m. Moderate ROI - rate 0.1-0.2m/year, magnitude 0.25-0.5m. High ROI - rate 0.2-0.3m/year, magnitude 0.5-0.7m	<ul style="list-style-type: none"> Surrounded by cleared farmland with scattered remnant <i>Encalyptus</i> and <i>Banksia</i> sp. Vines invading from east. Some die-back of <i>E. rostrata</i> on west side. 	<ul style="list-style-type: none"> No permanent vegetation monitoring transect. Specific site conditions that may influence groundwater dependence are not considered (eg. stratigraphy).
Bassendean Central & South Complex					
Lake Gungahra (39278648249)	Water quality/sediment processes Sediments must remain saturated moist throughout the summer each year. The water table therefore must not drop below the stratigraphic level layer capable of providing water to surface organics through capillary rise during summer. To address PASS anaerobic sediments need to remain saturated during late summer and early autumn.	Water quality/sediment processes Sediments to be permanently saturated moist	Water quality	<ul style="list-style-type: none"> Low macroinvertebrate family richness. Low pH & evidence of eutrophication. Reduced inundation of littoral & fringing vegetation & therefore lower habitat complexity. 	<ul style="list-style-type: none"> No permanent vegetation monitoring transect. Specific site conditions that may influence groundwater dependence are not considered (eg. stratigraphy).
Bassendean North Complex - Lanks					
Lanka B6 (40135649037)	Vegetation - 3 year mean and absolute water depth ranges. <i>M. preissiana</i> - mean -0.54 to -2.62m, absolute 1.03 to -5.04m. <i>B. littoralis</i> - mean -0.39 to -1.92m, absolute 0.43 to -3.09m. <i>A. fascicularis</i> - mean -0.35 to -2.26m, absolute 1.03 to -4.6m. <i>P. ellipticum</i> - mean -0.61 to -2.22 m, absolute 0 to -3.53m. <i>H. angustifolium</i> - mean -0.16 to -3.53m, absolute -0.16 to -3.53m. <i>B. articulata</i> - mean 0.28 to -1.22m, absolute 0.81 to -2.59m. Vertebrates Higher water/spring water levels needed for frogs. Depth of surface water in spring 2003 was sufficient to induce breeding of mooring frog, which had not recruited the previous year. Macrolin vertebrates The known spindal and lamphead habitat heterogeneity will be maintained by ensuring the following mix of vegetation assemblages persist.	Vegetation - 3 year mean and absolute maximum period of inundation (months/year). <i>M. preissiana</i> - mean 0.6, absolute 4.4 (months/year) <i>B. littoralis</i> - mean 0.3, absolute 2.9 (months/year) <i>A. fascicularis</i> - mean 0.66, absolute 2.6 (months/year) <i>P. ellipticum</i> - mean 0.2, absolute 0.6 (months/year) <i>H. angustifolium</i> - mean 0.1, absolute 0.6 (months/year) <i>B. articulata</i> - mean 3.26, absolute 12 (months/year) Vertebrates 4 months inundation for frogs to breed? Long-necked Tortoises have been found in this wetland but were in very poor condition; these probably require inundation of at least 9 months? Water quality/sediment processes Sediments to be permanently saturated moist	Vegetation Low ROI - rate 0.1m/year, magnitude 0.25m. Moderate ROI - rate 0.1-0.2m/year, magnitude 0.25-0.5m. High ROI - rate 0.2-0.3m/year, magnitude 0.5-0.7m.	<ul style="list-style-type: none"> Drying of organic rich sediment. Decline in health & patch density of fringing <i>M. preissiana</i> & <i>B. distefolia</i>. Encroachment of fringing vegetation into wetland basin as <i>B. articulata</i> contracts. Reduction in recruitment of mooring frog. 	<ul style="list-style-type: none"> Wetland species depth ranges based on extrapolation of surface and groundwater levels across the length of the monitoring transects rather than actual measured depths to groundwater. Specific site conditions that may influence groundwater dependence are not considered (eg. stratigraphy).

Sub-group / GDE	Water regime component	Duration of inundation or waterlogging (months/year)	Rate (m/year) and magnitude (m) of decline and risk of impact level (ROI)	Impacts associated with water regime change and/or other disturbances.	Reliability of information
	<p>Submergent – requires inundation according to specifications of dominant taxa.</p> <p>Emergent - requires inundation according to specifications of dominant taxa.</p> <p>Epifaunal – requires inundation according to specifications of dominant taxa.</p> <p>Water quality/sediment processes</p> <p>Sediments must remain saturated moist throughout the summer each year. The water table therefore must not drop below the stratigraphic level layer capable of providing water to surface organisms through capillary rise during summer. To address PASS anaerobic sediments need to remain saturated during late summer and early autumn.</p>				
Lexa 186 (4016449750)	<p>Vegetation - 5 year mean and absolute water depth ranges:</p> <p><i>M. prouviana</i> - mean -0.54 to -2.62m, absolute 1.03 to -3.64m</p> <p><i>B. lateralis</i> - mean -0.39 to -1.92m, absolute 0.43 to -3.09m</p> <p><i>A. fascicularis</i> - mean -0.35 to -2.26m, absolute 1.03 to -4.6m</p> <p><i>P. ellipticum</i> - mean -0.61 to -2.22 m, absolute 0 to -3.53m</p> <p><i>H. angustifolium</i> - mean -0.16 to -3.53m, absolute -0.16 to -3.53m</p> <p><i>B. articulata</i> - mean 0.28 to -1.22m, absolute 0.81 to -2.59m</p> <p>Vertebrates</p> <p>Frogs are present but appear to be unable to breed, so higher spring levels required.</p> <p>Water quality/sediment processes</p> <p>Sediments must remain saturated moist throughout the summer each year. The water table therefore must not drop below the stratigraphic level layer capable of providing water to surface organisms through capillary rise during summer. To address PASS anaerobic sediments need to remain saturated during late summer and early autumn.</p>	<p>Vegetation - 5 year mean and absolute maximum period of inundation (months/year):</p> <p><i>M. prouviana</i> - mean 0.6, absolute 4.4 (months/year)</p> <p><i>B. lateralis</i> - mean 0.3, absolute 2.8 (months/year)</p> <p><i>A. fascicularis</i> - mean 0.66, absolute 2.6 (months/year)</p> <p><i>P. ellipticum</i> - mean 0.2, absolute 0.6 (months/year)</p> <p><i>H. angustifolium</i> - mean 0.1, absolute 0.6 (months/year)</p> <p><i>B. articulata</i> - mean 3.26, absolute 12 (months/year)</p> <p>Vertebrates</p> <p>Frogs require 4 months inundation.</p> <p>Water quality/sediment processes</p> <p>Sediments to be permanently saturated moist.</p>	<p>Vegetation</p> <p>Low ROI - rate 0.4m/year, magnitude 0.25m</p> <p>Moderate ROI - rate 0.14/0.2m/year, magnitude 0.25-0.5m</p> <p>High ROI - rate 0.2-0.3m/year, magnitude 0.5-0.7m</p>	<ul style="list-style-type: none"> Drying of organic rich sediments. Low macroinvertebrate family richness Decline in health of fringing tree species Entravement of fringing trees species into basin as <i>B. articulata</i> contracts. 	<ul style="list-style-type: none"> Wetland species depth ranges based on extrapolation of surface and groundwater levels across the length of the monitoring transects rather than actual measured depths to groundwater. Specific site conditions that may influence groundwater dependence are not considered (eg. stratigraphy).
Lexa 94 (3993664935)	<p>Vegetation - 5 year mean and absolute water depth ranges:</p> <p><i>M. prouviana</i> - mean -0.54 to -2.62m, absolute 1.03 to -3.64m</p> <p><i>A. fascicularis</i> - mean -0.35 to -2.26m, absolute 1.03 to -4.6m</p> <p><i>P. ellipticum</i> - mean -0.61 to -2.22 m, absolute 0 to -3.53m</p> <p><i>H. angustifolium</i> - mean -0.16 to -3.53m, absolute -0.16 to -3.53m</p> <p>Vertebrates</p> <p>Frogs are present but appear to be unable to breed, so higher spring levels required.</p>	<p>Vegetation - 5 year mean and absolute maximum period of inundation (months/year):</p> <p><i>M. prouviana</i> - mean 0.6, absolute 4.4 (months/year)</p> <p><i>A. fascicularis</i> - mean 0.66, absolute 2.6 (months/year)</p> <p><i>P. ellipticum</i> - mean 0.2, absolute 0.6 (months/year)</p> <p><i>H. angustifolium</i> - mean 0.1, absolute 0.6 (months/year)</p> <p>Vertebrates</p> <p>Frogs require 4 months inundation.</p>	<p>Vegetation</p> <p>Low ROI - rate 0.1m/year, magnitude 0.25m</p> <p>Moderate ROI - rate 0.14/0.2m/year, magnitude 0.25-0.5m</p> <p>High ROI - rate 0.2-0.3m/year, magnitude 0.5-0.7m</p>	<ul style="list-style-type: none"> Drying of organic rich sediments. Decline in health of fringing <i>M. prouviana</i>. Drying & thinning of wetland shrubs & emergent macrophytes across basin 	<ul style="list-style-type: none"> Wetland species depth ranges based on extrapolation of surface and groundwater levels across the length of the monitoring transects rather than actual measured depths to groundwater. Specific site conditions that may influence groundwater dependence are not considered (eg. stratigraphy).
A (un)landed* (40141641676) 40122648626	<p>Vegetation</p> <p>No vegetation monitoring transect and vegetation not assessed.</p>				

Sub-group / EPI	Water regime component	Depth of groundwater (negative value) or surface water (positive value) (m)	Duration of inundation or waterlogging (month/year)	Rate (m/year) and magnitude (m) of decline and rate of impact level (ROI)	Impacts associated with water regime change and/or other disturbances	Reliability of Information
391564917-391564920						
391564917		391564917 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564918		391564918 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564919		391564919 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564920		391564920 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564921		391564921 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564922		391564922 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564923		391564923 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564924		391564924 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564925		391564925 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564926		391564926 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564927		391564927 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564928		391564928 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564929		391564929 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564930		391564930 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564931		391564931 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564932		391564932 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564933		391564933 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564934		391564934 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564935		391564935 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564936		391564936 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564937		391564937 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564938		391564938 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564939		391564939 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564940		391564940 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564941		391564941 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564942		391564942 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564943		391564943 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564944		391564944 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564945		391564945 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564946		391564946 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564947		391564947 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564948		391564948 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564949		391564949 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564950		391564950 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564951		391564951 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564952		391564952 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564953		391564953 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564954		391564954 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564955		391564955 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564956		391564956 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564957		391564957 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564958		391564958 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564959		391564959 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564960		391564960 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564961		391564961 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564962		391564962 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564963		391564963 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564964		391564964 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564965		391564965 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564966		391564966 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564967		391564967 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564968		391564968 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564969		391564969 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564970		391564970 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564971		391564971 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564972		391564972 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564973		391564973 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564974		391564974 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564975		391564975 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564976		391564976 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564977		391564977 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564978		391564978 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564979		391564979 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564980		391564980 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564981		391564981 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564982		391564982 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564983		391564983 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564984		391564984 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564985		391564985 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564986		391564986 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564987		391564987 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564988		391564988 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564989		391564989 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564990		391564990 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564991		391564991 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564992		391564992 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564993		391564993 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564994		391564994 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564995		391564995 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564996		391564996 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564997		391564997 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564998		391564998 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391564999		391564999 - <i>M. pruriens</i> and <i>A. fasciculata</i>				
391565000		391565000 - <i>M. pruriens</i> and <i>A. fasciculata</i>				

Sub-group / GDE	Water regime component	Duration of inundation or waterlogging (months/year)	Rate (m/year) and magnitude (m) of decline and risk of impact level (ROI)	Impacts associated with water regime change and/or other disturbances	Reliability of information
(390604750)	Depth of groundwater (negative value) or surface water (positive value) (m)		Moderate ROI - rate 0.1-0.2m/year, magnitude 0.25-0.5m High ROI - rate 0.2-0.3m/year, magnitude 0.5-0.7m	<ul style="list-style-type: none"> Run-off from stormwater has lead to massive weed invasion Remnant vegetation surrounds the Lake although it has been degraded by fire and weeds 	stratigraphy)
<i>Cattistea Central and South Complex</i> Bridges*	Vegetation <i>E. rudis</i> and <i>M. prostrata</i> Terrestrial vertebrates Unknown relationship between groundwater, upland vegetation and terrestrial vertebrates.		Vegetation Low ROI - rate 0.1m/year, magnitude 0.25m Moderate ROI - rate 0.1-0.2m/year, magnitude 0.25-0.5m High ROI - rate 0.2-0.3m/year, magnitude 0.5-0.7m	<ul style="list-style-type: none"> Some clearing in north section of wetland. Degraded by tracks & dumping of rubbish & car bodies. Not monitored since 1996 due to fire. Mortality of <i>B. thecifolia</i> since 2001. Weeds generally restricted to SW area Mature <i>E. rudis</i> show high degree of stress <i>K. ericifolia</i> appear drought stressed 	Specific site conditions that may influence groundwater dependence are not considered (eg. stratigraphy).
<i>Bassaclean North Transition Complex - North</i> 11 damplands* 34612451737, 38368617180, 38256517149, 38609651738, 38721651019, 3799652211, 3822652147, 38871652172, 3881652207, 38919652275, 3893652070	Vegetation 34612451737, 38731651019, 38708652311, 3861652407, 38919652275 and 3893652070 - <i>M. prostrata</i> 38636517149, 38368617180 and 38609651738 - <i>M. prostrata</i> and <i>E. rudis</i> 38871652172 and 38825652147 - <i>B. thecifolia</i>		Vegetation Low ROI - rate 0.1m/year, magnitude 0.25m Moderate ROI - rate 0.1-0.2m/year, magnitude 0.25-0.5m High ROI - rate 0.2-0.3m/year, magnitude 0.5-0.7m	<ul style="list-style-type: none"> System of generally connected damplands situated within a large area of high quality bushland. (38612451737): Dominated by terrestrial species in understorey. (38636517149): Some evidence of stress in <i>E. rudis</i> occupying the lowest areas. (38609651738): Vegetation variable across dampland. Some chlorosis in <i>E. rudis</i> appears recent. (38609651738): Number of very stressed <i>M. prostrata</i> & occasional dead <i>B. thecifolia</i>. (38721651019): Approximately 50% of mature <i>M. prostrata</i> are dead. Patches of <i>Koeleria sp.</i> are severely drought affected. (38708652311): Dieback occurs in adjacent blocks of the nature reserve. (38825652147 & 38871652172): <i>M. prostrata</i> are dead. Majority of <i>B. thecifolia</i> are resprouting. (38861652407): Only small patches of dead vegetation. Some death of mature <i>M. prostrata</i>. (38919652275): Road through wetland has had a detrimental impact. (3893652070): Adjacent land appears to be severely dieback affected. 60% of <i>M. prostrata</i> very stressed or dead. Most of tall <i>Koeleria</i> scrubland dead. 	<ul style="list-style-type: none"> No permanent vegetation monitoring transect. Specific site conditions that may influence groundwater dependence are not considered (eg. stratigraphy)
<i>Bassaclean North Complex - Yal Swamp</i> Yal Swamp* 39271651711	Vegetation <i>M. prostrata</i> and <i>E. rudis</i>	Terrestrial vertebrates Unknown	Vegetation Low ROI - rate 0.1m/year, magnitude 0.25m	<ul style="list-style-type: none"> Declining health of overstorey species. Vegetation changes from open woodland to 	Specific site conditions that may influence groundwater dependence are not considered (eg.

Sub-group / GDE	Water regime component Depth of groundwater (negative value) or surface water (positive value) (m)	Duration of inundation or waterlogging (months/year)	Rate (m/year) and magnitude (m) of decline and risk of impact level (ROI)	Impacts associated with water regime change and/or other disturbances.	Reliability of information
	Terrestrial vertebrates Unknown relationship between groundwater, upland vegetation and terrestrial vertebrates.		Moderate ROI – rate 0.1-0.2m/year, magnitude 0.25-0.3m High ROI – rate 0.2-0.3m/year, magnitude 0.5-0.7m	<ul style="list-style-type: none"> closed health – tall scrub with small changes in topography. Mining of distasteful earth in recent years. Disturbance from vehicle tracks & invasion of annual weeds. Some <i>E. rufa</i> death in southern section. <i>Kaibor sp.</i> show signs of drought stress. 	stratigraphy)
Himalay Lake* (31131615941)	Vegetation <i>M. pruriens</i> , <i>E. rufa</i> and <i>B. littoralis</i> Terrestrial vertebrates Unknown relationship between groundwater, upland vegetation and terrestrial vertebrates.	Terrestrial vertebrates Unknown	Vegetation Low ROI – rate 0.1m/year, magnitude 0.25m Moderate ROI – rate 0.1-0.2m/year, magnitude 0.25-0.5m High ROI – rate 0.2-0.3m/year, magnitude 0.5-0.7m	<ul style="list-style-type: none"> Declining health of <i>E. rufa</i> Excellent vegetation buffer around wetland Flies 100m from west side. Vehicles access clay pan in NW – some localised damage to vegetation Dec. April 2004 	<ul style="list-style-type: none"> No permanent vegetation monitoring transect. Specific site conditions that may influence groundwater dependence are not considered (eg stratigraphy)
Dampland* (3844651846)	Vegetation <i>M. pruriens</i> and <i>E. rufa</i> .		Vegetation Low ROI – rate 0.1m/year, magnitude 0.25m Moderate ROI – rate 0.1-0.2m/year, magnitude 0.25-0.5m High ROI – rate 0.2-0.3m/year, magnitude 0.5-0.7m	<ul style="list-style-type: none"> Undisturbed with intact vegetation. Large vegetation buffer separates damplands from vehicle tracks Some <i>E. rufa</i> show signs of stress. 	<ul style="list-style-type: none"> No permanent vegetation monitoring transect. Specific site conditions that may influence groundwater dependence are not considered (eg stratigraphy)
2 damplands* (3844651762 & 38337651800)	Vegetation 38340651762 - <i>M. pruriens</i> , <i>E. rufa</i> and <i>B. littoralis</i> 38337651800 - <i>M. pruriens</i> , <i>E. rufa</i> , <i>B. littoralis</i> and <i>A. fuscicollis</i> .		Vegetation Low ROI – rate 0.1m/year, magnitude 0.25m Moderate ROI – rate 0.1-0.2m/year, magnitude 0.25-0.5m High ROI – rate 0.2-0.3m/year, magnitude 0.5-0.7m	<ul style="list-style-type: none"> 38340651762: Wetland in excellent condition. Evidence of fire approximately 2 years ago in terrestrial vegetation. 38337651800: Small steep-sided dampland in nature reserve. Shows sharp transition from terrestrial to wetland vegetation. Closed low forest of <i>Malabau</i> suggests that site is wetter than surrounding damplands. 	
Bussenden North Complex – Yal West					
2 damplands* (38144652776, 38174652305)	Vegetation 38144652776 - <i>M. pruriens</i> and <i>B. littoralis</i> . 38174652305 - <i>M. pruriens</i> , <i>E. rufa</i> and <i>H. unguiculatum</i> .		Moderate ROI – rate 0.1-0.2m/year, magnitude 0.25-0.5m High ROI – rate 0.2-0.3m/year, magnitude 0.5-0.7m	<ul style="list-style-type: none"> 38144652776: some dead <i>M. pruriens</i> 38174652305: Numerous dead and stressed <i>M. pruriens</i> and <i>E. rufa</i>. 	<ul style="list-style-type: none"> No permanent vegetation monitoring transect Specific site conditions that may influence groundwater dependence are not considered (eg stratigraphy).
Sampland* (38331652325)	Vegetation <i>M. pruriens</i> and <i>H. unguiculatum</i> .		Moderate ROI – rate 0.1-0.2m/year, magnitude 0.25-0.5m High ROI – rate 0.2-0.3m/year, magnitude 0.5-0.7m	<ul style="list-style-type: none"> Indications of previous fire in northern area of wetland. 	<ul style="list-style-type: none"> No permanent vegetation monitoring transect Specific site conditions that may influence groundwater dependence are not considered (eg stratigraphy).
Tanglefoot Swamp* (37987652972)	Vegetation <i>M. pruriens</i> , <i>E. rufa</i> and <i>A. fuscicollis</i> .		Vegetation Low ROI – rate 0.1m/year, magnitude 0.25m Moderate ROI – rate 0.1-0.2m/year, magnitude 0.25-0.5m High ROI – rate 0.2-0.3m/year, magnitude 0.5-0.7m	<ul style="list-style-type: none"> Although terrestrialisation is occurring vegetation is in excellent condition 	<ul style="list-style-type: none"> Specific site conditions that may influence groundwater dependence are not considered (eg stratigraphy).
63 damplands* (37917652461, 37948652434, 37987652446, 38089652530, 38109652440)	Vegetation 37917652461, 37948652434, 37987652446, 38089652530, 38109652440 - <i>M. pruriens</i> , <i>E. rufa</i> and <i>B. littoralis</i> .		Vegetation Low ROI – rate 0.1m/year, magnitude 0.25m Moderate ROI – rate 0.1-0.2m/year, magnitude 0.25-0.5m High ROI – rate 0.2-0.3m/year, magnitude 0.5-0.7m	<ul style="list-style-type: none"> <i>InE. (2009)</i> 37917652461, 37948652434 & 37987652446: Myrtaceous shrubs show signs of drought stress across the entire area, significant areas of tall open scrub dead or very stressed in the eastern section 	<ul style="list-style-type: none"> No permanent vegetation monitoring transect. Specific site conditions that may influence groundwater dependence are not considered (eg stratigraphy).

Sub-group / GDE	Water regime component Depth of groundwater (negative value) or surface water (positive value) (m)	Duration of inundation or waterlogging (month/year)	Rate (m/year) and magnitude (m) of decline and risk of impact level (ROI)	Impacts associated with water regime change and/or other disturbances	Reliability of information
37987652446, 38036652577, 38099652550, 38024652285, 38026652641, 38039652524, 38073652411, 38056652578, 38046652035, 38058652434, 38089652724, 38078652433, 38090652033, 38082652102, 38088652520, 38097652471, 38119652641, 38122652574, 38147652733, 38151652708, 38168652666, 38162652733, 38167652737, 38182652712, 38226652737, 38226652446, 38230652721, 38231652411, 38248652664, 38252652483, 38266652435, 38280652700, 38285652373, 38289652487, 38287652725, 38319652707, 38309652440, 38317652442, 38356652318, 38342652392, 38346652578, 38346652085, 38341652553, 38381652418, 38416652349, 38455652738, 38455652438, 38456652444, 38480652351, 38529652115, 38533652365, 38560652328, 38580652413, 38587652906, 38586652104.	38726652377, 38136652901 - <i>M. praxiana</i> and <i>E. radix</i> 38106652085 - <i>M. praxiana</i> , <i>E. radix</i> , <i>B. littoralis</i> and <i>M. rhaphiophylla</i> . 38098652914, 38108652767, 38304652578, 38416652549, 38435652188, 38486652591, 38586652413 - <i>M. praxiana</i> , <i>B. littoralis</i> . 38117862442, 38336652318 - <i>A. faurcoides</i> 37978652736, 37981652342, 38030652677, 38024652295, 38026652641, 38039652524, 38033652611, 38036652718, 38046652635, 38083652724, 38078652433, 38090652633, 38082652102, 38088652520, 38097652471, 38119652641, 38122652574, 38147652733, 38151652708, 38168652666, 38162652733, 38167652737, 38182652712, 38226652737, 38226652446, 38230652721, 38231652411, 38248652664, 38252652483, 38266652435, 38280652700, 38285652373, 38289652487, 38287652725, 38319652707, 38309652440, 38317652442, 38356652318, 38342652392, 38346652578, 38346652085, 38341652553, 38381652418, 38416652349, 38455652738, 38455652438, 38456652444, 38480652351, 38529652115, 38533652365, 38560652328, 38580652413, 38587652906, 38586652104.			Much of the <i>M. praxiana</i> dead or dying in the centre & eastern sections. Dead <i>Banksia</i> can be seen in the lower section. • 37987652736: Wetland in pristine condition. • 37981652582: Some <i>M. praxiana</i> are in poor condition. • 38030652677: Some dead & stressed <i>B. littoralis</i> to the south. 50% of <i>E. radix</i> very stressed in the western section. <i>Metolenea</i> sp. stags amongst healthy individuals in the north-west. Some stressed <i>E. radix</i> & recently dead <i>Banksia</i> sp. & large patches of dead <i>Myrtaceus</i> scrub. • 38099652550: <i>M. praxiana</i> & <i>E. radix</i> on higher ground in excellent condition however, those on lower ground are very stressed. • 38024652295: Majority of the <i>E. radix</i> appear stressed with numerous dead stems in the basin. • 38026652641: Vegetation in excellent condition, with some <i>M. praxiana</i> saplings present. • 38039652524: Occasional <i>Banksia</i> & <i>M. praxiana</i> stags & stressed individuals. • 38033652611: Wetland terrestrialising <i>M. praxiana</i> population is senescent but living. • 38086652738: The occasional dead <i>Banksia</i> sp. • 38046652635: Vegetation is in excellent condition. • 38058652554: Some scattered dead <i>B. littoralis</i> & senescent <i>M. praxiana</i> . • 38083652724: Some localized patches of dead scrub & occasional dead or stressed <i>M. praxiana</i> & <i>Banksia</i> sp. • 38078652433: Some dead <i>Banksia</i> sp. & <i>M. praxiana</i> & localized areas of dead <i>Myrtaceus</i> scrub. • 38000652633: Significant deaths of <i>Myrtaceus</i> shrubs and a general decrease in both over & understorey species. • 38082652102: Previous fire had a large impact on vegetation however as regeneration progresses vegetation is generally in excellent condition. • 38086652550: Vegetation in excellent condition. • 38097652471: Minor localised drought stress in the <i>Avicoria</i> & <i>M. praxiana</i> . • 38139652631: Large areas of dead <i>M. praxiana</i> & <i>B. littoralis</i> . • 38122652574: <i>Metolenea</i> is all but gone. Some	

Sub-Group / Code	Water regime component	Depth of groundwater (negative value) or surface water (positive value) (m)	Duration of inundation or waterlogging (months/yr)	Rate (m/yr) and magnitude (m) of decline and risk of impact level (RDI)	Impacts associated with water regime change and/or other disturbances	Reliability of information
<p>248952138 3484262041 2481642925 24812062173 24812062047 24810952047 24810952047 24810952047 24810952047 24810952047 24810952047 24810952047</p>	<p>Water regime component</p>	<p>Depth of groundwater (negative value) or surface water (positive value) (m)</p>	<p>Duration of inundation or waterlogging (months/yr)</p>	<p>Rate (m/yr) and magnitude (m) of decline and risk of impact level (RDI)</p>	<p>Impacts associated with water regime change and/or other disturbances</p>	<p>Reliability of information</p>

Sub-group / GDE	Water regime component	Depth of groundwater (negative value) or surface water (positive value) (m)	Duration of inundation or waterlogging (months/year)	Rate (m/year) and magnitude (m) of decline and risk of Impact Level (HOL)	Impacts associated with water regime change and/or other disturbances	Reliability of information	
					<p>Most <i>M. pruriens</i> are stressed or dead & extensive shrub & <i>Koeleria</i> spp. death</p> <ul style="list-style-type: none"> 38287652725: Majority of <i>M. pruriens</i> dead or very stressed 38310652707: Signs of dieback & stress in the dampland with 25% of <i>Banksia</i> & 30% of <i>M. pruriens</i> affected 38309652440: Some of the larger trees are dead in local dampland 38317052442: 60% of the subland in the bush 38306652318: Possible <i>Phytophthora cinnamomi</i> & drought stress particularly of <i>Banksia</i> spp., some <i>Fraxinus</i> spp. & myrtaceous herbs 38320652392: Some localised areas of dead <i>Koeleria</i> spp., stressed & dead <i>B. integrifolia</i> & <i>B. integrifolia</i> & scattered dead <i>M. pruriens</i> 38304652578: Occasional <i>M. pruriens</i> stag 38306652688: Occasional stressed <i>M. pruriens</i> & <i>Banksia</i> spp.: Substantial death of <i>F. paniculata</i> 38306652718: <i>M. pruriens</i> virtually all gone & the shrubs appear drought stressed with some localised dead patches 3831652128: Some <i>M. pruriens</i> stags 38416652149: <i>M. pruriens</i> recently stressed in very stressed. Scattered dead <i>Banksia</i> spp. & localised areas of dead myrtaceous shrubs 38455652718: Terrestrial & wetland vegetation in pristine condition 38415652188: Many <i>M. pruriens</i> in wetland areas have been killed by fire 38456652441: No longer any live <i>M. pruriens</i> in the bush 38480652511: <i>M. pruriens</i> populations stressed with some recently dead individuals 38532652185: Numerous <i>M. pruriens</i> stags 38532652305: Scattered dead <i>B. integrifolia</i> occur 38532652305: Scattered dead <i>B. integrifolia</i> occur in the centre of the dampland. Occasional within the wetland 38566652228: Numerous stressed <i>M. pruriens</i> & many, very stressed trees 38587652096: A few stags & stressed <i>M. pruriens</i> 38587652113: Some localised dieback 38587652194: Some stressed <i>M. pruriens</i> 		

Sub-group / GDE	Water regime component Depth of groundwater (negative value) or surface water (positive value) (m)	Duration of inundation or waterlogging (months/year)	Rate (m/year) and magnitude (m) of decline and risk of impact level (ROI)	Impacts associated with water regime change and/or other disturbances	Reliability of information
(3786652293, 3737652291, 3758652296, 3793652266)	<i>M. pruriens</i>		Low ROI - rate 0.1m/year, magnitude 0.25m. Moderate ROI - rate 0.1-0.2m/year, magnitude 0.25-0.5m. High ROI - rate 0.2-0.3m/year, magnitude 0.5-0.7m.	<ul style="list-style-type: none"> wetland, evidence of recent fire Majority <i>M. pruriens</i> dead / very stressed Localised dead areas in understory (3757652291): Small wetland in central section of Tick Flat complex. Unburnt in the recent fire. Occasional dead <i>Banksia</i> (37593652546; 37588652556): Wetlands lie to the west of the main Tick Flat wetland in a <i>Banksia</i> and <i>Melaleuca</i> woodland with a variable understory consisting of terrestrial and dampland species. Unburnt areas in good condition Fires have killed some areas of shrubland. 	<ul style="list-style-type: none"> Specific site conditions that may influence groundwater dependence are not considered (eg stratigraphy).
<i>Batsokan North Complex - Teal East</i> Lala Makabura* (3440551108)	Vegetation No vegetation monitoring transect and vegetation not assessed.		Vegetation Low ROI - rate 0.1m/year, magnitude 0.25m. Moderate ROI - rate 0.1-0.2m/year, magnitude 0.25-0.5m. High ROI - rate 0.2-0.3m/year, magnitude 0.5-0.7m.		<ul style="list-style-type: none"> No permanent vegetation monitoring transect Specific site conditions that may influence groundwater dependence are not considered (eg stratigraphy).
17 damplands* (3821652464, 3829652508, 3833165198, 3889652268, 3884652005, 3891652246, 38913652012, 38919652274, 3892652250, 3891652230, 3892652208, 3900652266, 3900832298, 3902652224, 39045652254, 39048652234, 3863652685)	Vegetation 38821652464, 3883165198, 38861652005, 39008652386, 3902652224, 39045652254, 39058652235 - <i>M. pruriens</i> 3889652268 - <i>M. pruriens</i> , <i>B. littoralis</i> and <i>E. rudis</i> 3884652005, 3891652246, 3891652230, 39008652208, 38685652685, 38829652308, 38913652246 - <i>M. pruriens</i> and <i>B. littoralis</i> 38913652012, 3892652208 - <i>M. pruriens</i> and <i>B. unguiculatum</i>		Vegetation Low ROI - rate 0.1m/year, magnitude 0.25m. Moderate ROI - rate 0.1-0.2m/year, magnitude 0.25-0.5m. High ROI - rate 0.2-0.3m/year, magnitude 0.5-0.7m.	<ul style="list-style-type: none"> 388 21652464 - Wetland in good condition. 38829652308 - <i>M. pruriens</i> stressed. 3883165198 - Wetland terrestrialising, most <i>M. pruriens</i> dead. 3889652268 - 50% <i>M. pruriens</i> very stressed or dead. 3884652005 - Some drought stress in understory. 38913652246 - Some <i>M. pruriens</i> stressed. 38913652012 - Some death in understory. 3891652230 - Vegetation in excellent condition. 3892652208 - Most <i>M. pruriens</i> dead or stressed. 39008652386 - Wetland vegetation in good condition, but wetland terrestrialising. 3902652224 - Vegetation in excellent condition. 39026652224 - Some <i>M. pruriens</i> stags and stressed individuals. 39045652254 - Some <i>M. pruriens</i> stags and stressed individuals. 39058652235 - Most <i>M. pruriens</i> dead due to drought stress. 3863652685 - 50% <i>M. pruriens</i> very stressed or dead. 	<ul style="list-style-type: none"> No permanent vegetation monitoring transect Specific site conditions that may influence groundwater dependence are not considered (eg stratigraphy).
2 damplands* (38570652700)	Vegetation 38570652700 - <i>M. pruriens</i> , <i>B. littoralis</i> and <i>E. rudis</i> .		Vegetation Low ROI - rate 0.1m/year, magnitude 0.25m.	<ul style="list-style-type: none"> 38570652700 - Recent fire in wetland, but regeneration appears healthy. 	<ul style="list-style-type: none"> No permanent vegetation monitoring transect Specific site conditions that may influence groundwater dependence are not considered (eg stratigraphy).

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3806652771	3806652771 - <i>M. praevisiana</i> , <i>M. rhaphiophylla</i> and <i>B. littoralis</i>		Moderate ROI - rate 0.1-0.2m/year, magnitude 0.25-0.5m. High ROI - rate 0.2-0.3m/year, magnitude 0.5-0.7m.	• 3806652771 - Recent fire in wetland, but regeneration appears healthy.	• Groundwater dependence are not considered (eg. stratigraphy).
1.1 upland* (3977108300)	Vegetation No vegetation monitoring transect and vegetation not assessed.				• No permanent vegetation monitoring transect. • Specific site conditions that may influence groundwater dependence are not considered (eg. stratigraphy).
1.1 floodplain* (39771065222)	Vegetation No vegetation monitoring transect and vegetation not assessed.				• No permanent vegetation monitoring transect. • Specific site conditions that may influence groundwater dependence are not considered (eg. stratigraphy).
1.1 upland* (3892882625)	Vegetation <i>M. praevisiana</i>		Vegetation Low ROI - rate 0.1m/year, magnitude 0.25m. Moderate ROI - rate 0.1-0.2m/year, magnitude 0.25-0.5m. High ROI - rate 0.2-0.3m/year, magnitude 0.5-0.7m.	• Wetland is on private property and has been severely degraded by grazing.	• No permanent vegetation monitoring transect. • Specific site conditions that may influence groundwater dependence are not considered (eg. stratigraphy).
Jangka Complex Bamban Lake* (3943562293)	Vegetation <i>M. rhaphiophylla</i> , <i>E. rufa</i> and <i>B. articulata</i> Vertebrates Unknown.		Vegetation Low ROI - rate 0.1m/year, magnitude 0.25m. Moderate ROI - rate 0.1-0.2m/year, magnitude 0.25-0.5m. High ROI - rate 0.2-0.3m/year, magnitude 0.5-0.7m.	• Permanent wetland. • Narrow fringe of littoral vegetation. • Some buffer remains although majority surrounding land is cleared farmland. • Very weedy understorey around lake.	• No permanent vegetation monitoring transect. • Specific site conditions that may influence groundwater dependence are not considered (eg. stratigraphy).
Lake Nambung* (39421652108)	Vegetation <i>M. rhaphiophylla</i> and <i>E. rufa</i> Vertebrates Unknown.		Vegetation Low ROI - rate 0.1m/year, magnitude 0.25m. Moderate ROI - rate 0.1-0.2m/year, magnitude 0.25-0.5m. High ROI - rate 0.2-0.3m/year, magnitude 0.5-0.7m.	• Upland lake with narrow strip of littoral vegetation to the south and east separating the wetland from farmland. • Some reedbank vegetation occurs in the north-west.	• No permanent vegetation monitoring transect. • Specific site conditions that may influence groundwater dependence are not considered (eg. stratigraphy).
Lake Mungala* (39482652119)	Vegetation <i>M. rhaphiophylla</i> and <i>E. rufa</i> Waterbirds Unknown Vertebrates Unknown.		Vegetation Low ROI - rate 0.1m/year, magnitude 0.25m. Moderate ROI - rate 0.1-0.2m/year, magnitude 0.25-0.5m. High ROI - rate 0.2-0.3m/year, magnitude 0.5-0.7m.	• Wetland completely surrounded by private property. Owners refused access. • Wetland appears to be dry. • Trees appear to be in good health.	• No permanent vegetation monitoring transect. • Specific site conditions that may influence groundwater dependence are not considered (eg. stratigraphy).
Springs on Lot 11 Archibald St, Mischea	Macroinvertebrates Permanently flowing - therefore sufficient hydrostatic head to ensure perennial flow from spring. Volume of flow not known - but probably not large (matter of several litres per second at a maximum).	Macroinvertebrates Perennial flows.	Macroinvertebrates Not known - assume there could be a seasonal reduction in flows in summer/autumn from winter/spring highs, but still maintain perennial flows.		
Spring sites 3a, 3b, 3c, 4, 5m, 5p1, 5d, 6, and 7	Macroinvertebrates Permanently flowing - therefore sufficient hydrostatic head to ensure perennial flow from spring. Volume of flow not known - but probably not large (matter of several litres per second at a maximum).	Macroinvertebrates Perennial flows.	Macroinvertebrates Not known - assume there could be a seasonal reduction in flows in summer/autumn from winter/spring highs, but still maintain perennial flows.		
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Sub-group / GDE	Water regime component Depth of groundwater (negative value) or surface water (positive value) (m)	Duration of inundation or waterlogging (months/year)	Rate (m/year) and magnitude (m) of decline and risk of Impact level (ROI)	Impacts associated with water regime change and/or other disturbances	Reliability of information
<p>Hindman Complex Thames Lake (189264227)</p>	<p>Vegetation - 5 year mean and absolute water depth ranges: <i>M. rhaphiophylla</i> - mean 0.006 to -2.14m, absolute 1.03 to -4.40m <i>E. rostrata</i> - mean -0.7 to -3.26m, absolute 1.03 to -6.44m <i>B. articulata</i> - mean 0.28 to -1.22m, absolute 0.81 to -2.59m</p> <p>Waterbirds Declining peak water levels and lake drying out in early summer had coincided with much lower waterbird numbers than previously recorded. High levels may be required to prevent spread of vegetation into open water.</p> <p>Vertebrates Frogs require extensive flooding of fringing vegetation.</p> <p>Macrolvertebrates The known spatial and temporal habitat heterogeneity will be maintained by ensuring the following mix of vegetation assemblages persist: Submergent - requires inundation according to specifications of dominant taxa. Emergent - requires inundation according to specifications of dominant taxa. Littoral - requires inundation according to specifications of dominant taxa.</p> <p>Water quality/sediment processes Sediments must remain saturated moist throughout the summer each year. The water table therefore must not drop below the stratigraphic level layer capable of providing water to surface organics through capillary rise during summer.</p>	<p>Vegetation - 5 year mean and absolute maximum period of inundation (months/year): <i>M. rhaphiophylla</i> - mean 2.15, absolute 9.4 (months/year) <i>E. rostrata</i> - mean 1.55, absolute 12 (months/year) <i>B. articulata</i> - mean 3.26, absolute 12 (months/year)</p> <p>Waterbirds Persistence of water into late summer and autumn important for migratory species.</p> <p>Vertebrates Frogs require at least 4 months. Long-necked Tortoises etc present may require periods of 9 months or more.</p>	<p>Vegetation Low ROI - rate 0.1m/year, magnitude 0.25m. Moderate ROI - rate 0.1-0.2m/year, magnitude 0.25-0.5m. High ROI - rate 0.2-0.3m/year, magnitude 0.5-0.7m</p>	<ul style="list-style-type: none"> Poor water quality (saline, eutrophic and high pH) Declines in health of some mature <i>E. rostrata</i> Decline in density of <i>B. articulata</i> since 1996 & prolific sapling growth (near lake possibly) due to lower water levels. Increased weed invasion due to lack of inundation Values influenced by GW abstraction & water quality issues associated with increasing urban development. 	<ul style="list-style-type: none"> Wetland species depth ranges based on extrapolation of surface and groundwater levels across the length of the monitoring transects rather than actual measured depths to groundwater. Specific site conditions that may influence groundwater dependence are not considered (eg. stratigraphy)
<p>North Lake (18491645024)</p>	<p>Vegetation - 5 year mean and absolute water depth ranges: <i>M. rhaphiophylla</i> - mean 0.006 to -2.14m, absolute 1.03 to -4.40m <i>M. peruviana</i> - mean -0.54 to -2.62m, absolute 1.03 to -5.56m <i>B. littoralis</i> - mean -0.39 to -1.92m, absolute 0.43 to -3.09m <i>E. rostrata</i> - mean -0.7 to -3.26m, absolute 1.03 to -6.44m <i>A. fasciculata</i> - mean -0.35 to -2.26m, absolute 1.03 to -4.6m <i>B. articulata</i> - mean 0.28 to -1.22m, absolute 0.81 to -2.59m</p> <p>Waterbirds High winter spring peaks and retention of deep water in summer autumn for deep-water species</p> <p>Water quality/sediment processes Sediments must remain saturated moist throughout the summer each year. The water table therefore must not drop below the stratigraphic level layer capable of providing water to surface organics through capillary rise during summer.</p>	<p>Vegetation - 5 year mean and absolute maximum period of inundation (months/year): <i>M. rhaphiophylla</i> - mean 2.15, absolute 9.4 (months/year) <i>E. rostrata</i> - mean 1.55, absolute 12 (months/year) <i>M. peruviana</i> - mean 0.6, absolute 4.4 (months/year) <i>B. littoralis</i> - mean 0.3, absolute 2.8 (months/year) <i>A. fasciculata</i> - mean 0.66, absolute 2.6 (months/year) <i>B. articulata</i> - mean 3.26, absolute 12 (months/year)</p> <p>Waterbirds Permanent.</p>	<p>Vegetation Low ROI - rate 0.1m/year, magnitude 0.25m. Moderate ROI - rate 0.1-0.2m/year, magnitude 0.25-0.5m. High ROI - rate 0.2-0.3m/year, magnitude 0.5-0.7m.</p>	<ul style="list-style-type: none"> Encroachment of native vegetation into basin (where previously inundated) Decline in condition & health of mature <i>E. rostrata</i> around basin in response to water level decline & insect attack. Exotic threatening to become dominant in some areas. 	<ul style="list-style-type: none"> Wetland species depth ranges based on extrapolation of surface and groundwater levels across the length of the monitoring transects rather than actual measured depths to groundwater. Specific site conditions that may influence groundwater dependence are not considered (eg. stratigraphy)
<p>Barigoupp Swamp (18927644011)</p>	<p>Vegetation - 5 year mean and absolute water depth ranges: <i>M. peruviana</i> - mean -0.54 to -2.62m, absolute 1.03 to -</p>	<p>Vegetation - 5 year mean and absolute maximum period of inundation (months/year):</p>	<p>Vegetation Low ROI - rate 0.1m/year, magnitude 0.25m.</p>	<ul style="list-style-type: none"> Drying lead to zonation of <i>Zypha</i>. Cultural eutrophication has occurred. 	<ul style="list-style-type: none"> Wetland species depth ranges based on extrapolation of surface and groundwater levels

Sub-group / GDE	Water regime component Depth of groundwater (negative value) or surface water (positive value) (m)	Duration of inundation or waterlogging (months/year)	Rate (m/year) and magnitude (m) of decline and risk of impact level (ROI)	Impacts associated with water regime change and/or other disturbances	Reliability of information
	<p>Solms</p> <p><i>S. littoralis</i> - mean -0.39 to -1.92m, absolute 0.43 to -3.09m. <i>E. rubra</i> - mean -0.7 to -3.26m, absolute 1.03 to -6.44m. <i>A. fascicularis</i> - mean -0.35 to -2.26m, absolute 1.03 to -4.6m. <i>B. articulata</i> - mean 0.28 to -1.22m, absolute 0.81 to -2.59m.</p> <p>Terrestrial vertebrates Relationship between groundwater, upland vegetation and terrestrial fauna may be important.</p> <p>Water quality/sediment processes Sediments must remain saturated/moist throughout the summer each year. The water table therefore must not drop below the stratigraphic level/layers capable of providing water to surface organics through capillary rise during summer.</p>	<p><i>E. rubra</i> - mean 1.55, absolute 12 (months/year) <i>M. prasinus</i> - mean 0.6, absolute 4.4 (months/year) <i>B. littoralis</i> - mean 0.3, absolute 2.8 (months/year) <i>A. fascicularis</i> - mean 0.66, absolute 2.6 (months/year) <i>B. articulata</i> - mean 3.26, absolute 12 (months/year)</p> <p>Terrestrial vertebrates Unknown</p>	<p>Moderate ROI - rate 0.1-0.2m/year, magnitude 0.25-0.5m High ROI - rate 0.2-0.3m/year, magnitude 0.5-0.7m</p>		<ul style="list-style-type: none"> • Across the length of the monitoring transects (other than actual measured depths to groundwater). • Specific site conditions that may influence groundwater dependence are not considered (e.g. stratigraphy).
<p>Dibra Lake (7894944459)</p>	<p>Vegetation - 5 year mean and absolute water depth ranges <i>M. rhaphiophylla</i> - mean 0.006 to -2.14m, absolute 1.03 to -4.0m. <i>M. prasinus</i> - mean -0.54 to -3.62m, absolute 1.03 to -3.04m. <i>B. articulata</i> - mean 0.28 to -1.22m, absolute 0.81 to -2.59m.</p> <p>Waterbirds/waders High winter spring peaks and retention of deep water in summer/autumn for deep-water species.</p> <p>Water quality/sediment processes Sediments must remain saturated/moist throughout the summer each year. The water table therefore must not drop below the stratigraphic level/layers capable of providing water to surface organics through capillary rise during summer.</p>	<p>Vegetation - 5 year mean and absolute maximum period of inundation (months/year). <i>M. rhaphiophylla</i> - mean 2.15, absolute 0.4 (months/year) <i>M. prasinus</i> - mean 0.6, absolute 4.4 (months/year) <i>B. articulata</i> - mean 3.26, absolute 12 (months/year)</p> <p>Waterbirds/waders Permanent</p>	<p>Vegetation Low ROI - rate 0.1m/year, magnitude 0.25m Moderate ROI - rate 0.1-0.2m/year, magnitude 0.25-0.5m. High ROI - rate 0.2-0.3m/year, magnitude 0.5-0.7m</p>	<ul style="list-style-type: none"> • Eucalypts are threatening to become dominant in some areas • Decline in wetland tree condition due to water level decline & insect attack 	<ul style="list-style-type: none"> • Wetland species depth ranges based on extrapolation of surface and groundwater levels across the length of the monitoring transects (rather than actual measured depths to groundwater). • Specific site conditions that may influence groundwater dependence are not considered (e.g. stratigraphy).
<p>Yampobay Lake (3869644501)</p>	<p>Vegetation No vegetation monitoring transect and vegetation not assessed.</p> <p>Waterbirds High winter spring peaks and retention of deep water in summer/autumn for deep-water species.</p> <p>Macrosinvertebrates The known spatial and temporal habitat heterogeneity will be maintained by ensuring the following mix of vegetation assemblages persists: Subemergent - requires inundation according to specifications of dominant taxa. Emergent - requires inundation according to specifications of dominant taxa. Littoral - requires inundation according to specifications of dominant taxa.</p> <p>Water quality/sediment processes Sediments must remain saturated/moist throughout the summer each year. The water table therefore must not drop below the stratigraphic level/layers capable of providing water to surface organics through capillary rise during summer.</p>	<p>Waterbirds Permanent.</p> <p>Water quality/sediment processes Sediments to be permanently saturated/moist.</p>		<ul style="list-style-type: none"> • Cultural eucalyptization has occurred. • Reduction in macroinvertebrates species richness since monitoring began. 	

Sub-group / GDE	Water regime component	Duration of inundation or waterlogging (months/year)	Rate (m/year) and magnitude (m) of decline and risk of [Imp] level (ROI)	Impacts associated with water regime change and/or other disturbances.	Reliability of information
	To address PASS aerobic sediments need to remain saturated during late summer and early autumn.				
Kingfish Lake (1899664422)	<p>Vegetation - 5 year mean and absolute water depth ranges - <i>M. prasinum</i> - mean -0.54 to -2.62m; absolute 1.03 to -5.0m <i>E. rufus</i> - mean -0.7 to -3.26m; absolute 1.03 to -6.44m Waterbirds High water spring peaks and extensive shallows in summer-autumn. Macrolinvertebrates The known spatial and temporal habitat heterogeneity will be maintained by ensuring the following mix of vegetation assemblages persist: Submergent - requires inundation according to specifications of dominant taxa. Emergent - requires inundation according to specifications of dominant taxa. Littoral - requires inundation according to specifications of dominant taxa. Water quality/sediment processes Sediments must remain saturated moist throughout the summer each year. The water table therefore must not drop below the stratigraphic level layer capable of providing water to surface organics through capillary rise during summer. To address PASS aerobic sediments need to remain saturated during late summer and early autumn.</p>	<p>Vegetation - 5 year mean and absolute maximum period of inundation (months/year) <i>E. rufus</i> - mean 1.55, absolute 12 (months/year) <i>M. prasinum</i> - mean 0.6, absolute 4.4 (months/year) Waterbirds Water should persist into early autumn. Water quality/sediment processes Sediments to be permanently saturated moist.</p>	<p>Vegetation Low ROI - rate 0.1m/year, magnitude 0.25m Moderate ROI - rate 0.1-0.2m/year, magnitude 0.25-0.5m High ROI - rate 0.2-0.3m/year, magnitude 0.5-0.7m.</p>	<ul style="list-style-type: none"> Cultural eutrophication has occurred. Loss of fringing vegetation due to water-logging. Decline in <i>E. rufus</i> health since 1998. Increased weed invasion however, weediness still low. 	<ul style="list-style-type: none"> Wetland species depth ranges based on extrapolation of surface and groundwater levels across the length of the monitoring transects rather than actual measured depths to groundwater. Specific site conditions that may influence groundwater dependence are not considered (eg. stratigraphy)
Little Bush Lake* (1899665557)					
Speacles North* (1899164245)	<p>Vegetation As there is not a vegetation monitoring transect at Speacles North and the wetland had not been assessed at the time of writing, no comment can be made on water requirements of wetland species. Waterbirds Breeding by waterbirds affected by flooding around <i>Melaleuca</i>. Vertebrates Needs to be permanently inundated for fish - critical minimum threshold depth for survival not known Terrestrial vertebrates Relationship between groundwater, upland vegetation and terrestrial fauna may be important. Sediments/water quality Organic sediments must remain saturated throughout the summer each year. The water table must therefore not drop below the stratigraphic level layer capable of providing water to surface organics through capillary rise during summer.</p>	<p>Vegetation Unknown Vertebrates Permanently inundated for fish. North Speacles is currently permanent. South Speacles is seasonal and water should persist into summer.</p>	<p>Vegetation Low ROI - rate 0.1m/year, magnitude 0.25m. Moderate ROI - rate 0.1-0.2m/year, magnitude 0.25-0.5m. High ROI - rate 0.2-0.3m/year, magnitude 0.5-0.7m. Vertebrates Rate of decline not known - fish are mobile and can reasonably withstand reasonably rapid natural declines, particularly in basins with even bathymetry.</p>		
East Swamp* (18996644985)	<p>Vegetation No vegetation monitoring transect and vegetation not</p>	<p>Terrestrial vertebrates Unknown</p>			

Sub-group / GDE	Water regime component	Duration of inundation or waterlogging (months/year)	Rate (m/year) and magnitude (m) of decline and risk of Impact level (ROI)	Impacts associated with water regime change and/or other disturbances.	Reliability of information
	assessed Terrestrial vertebrates Relationship between groundwater, upland vegetation and terrestrial fauna may be important.				
Hope Rd* (328524487)	Vegetation No vegetation monitoring transect and vegetation not assessed.				
<i>Bassendean Central & South Complex</i> Shirley Halla Swamp (294196426)	Vegetation - 5 year mean and absolute water depth ranges <i>M. preoxiana</i> - mean -0.54 to -2.62m; absolute 1.03 to -5.04m <i>M. rhaphiophylla</i> - mean 0.006 to -2.14m; absolute 1.03 to -4.6m <i>A. fascicularis</i> - mean -0.35 to -2.20m; absolute 1.03 to -4.6m <i>H. angustifolium</i> - mean -0.16 to -3.53m; absolute -0.16 to -3.53m Terrestrial vertebrates Relationship between groundwater, upland vegetation and terrestrial fauna may be important. Macroinvertebrates The known spatial and temporal habitat heterogeneity will be maintained by ensuring the following mix of vegetation assemblages persist: Emergent - requires inundation according to specifications of dominant taxa. Littoral - requires inundation according to specifications of dominant taxa. Water quality/sediment processes Sediments must remain saturated moist throughout the summer each year. The water table therefore must not drop below the stratigraphic level layer capable of providing water to surface organisms through capillaries, rise during summer.	Vegetation - 5 year mean and absolute maximum period of inundation (months/year). <i>M. preoxiana</i> - mean 0.6, absolute 4.4 (months/year) <i>M. rhaphiophylla</i> - mean 2.15, absolute 9.4 (months/year) <i>A. fascicularis</i> - mean 0.66, absolute 2.6 (months/year) <i>H. angustifolium</i> - mean 0.1, absolute 0.6 (months/year) Terrestrial vertebrates Unknown.	Vegetation Low ROI - rate 0.1m/year, magnitude 0.25m. Moderate ROI - rate 0.1-0.2m/year, magnitude 0.25-0.5m. High ROI - rate 0.2-0.3m/year, magnitude 0.5-0.7m	<ul style="list-style-type: none"> Contaminated with hydrocarbons. Leach used by waterbirds. Decline in macroinvertebrates since 1996. Vegetation impacted by fire & physical disturbance. 	<ul style="list-style-type: none"> Wetland species depth ranges based on extrapolation of surface and groundwater levels across the length of the monitoring transects rather than actual measured depths to groundwater. Specific site conditions that may influence groundwater dependence are not considered (eg. stratigraphy).
Twine Bartram (2917464118)	Vegetation - 5 year mean and absolute water depth ranges. <i>M. rhaphiophylla</i> - mean 0.006 to -2.14m; absolute 1.03 to -4.6m <i>B. littoralis</i> - mean -0.39 to -1.92m; absolute 0.43 to -3.09m. Waterbirds High water spring water levels for breeding. Water quality/sediment processes Sediments must remain saturated moist throughout the summer each year. The water table therefore must not drop below the stratigraphic level layer capable of providing water to surface organisms through capillaries, rise during summer.	Vegetation - 5 year mean and absolute maximum period of inundation (months/year). <i>M. rhaphiophylla</i> - mean 2.15, absolute 9.4 (months/year) <i>B. littoralis</i> - mean 0.3, absolute 2.8 (months/year) Waterbirds Persistence of shallows into summer of value.	Vegetation Low ROI - rate 0.1m/year, magnitude 0.25m. Moderate ROI - rate 0.1-0.2m/year, magnitude 0.25-0.5m. High ROI - rate 0.2-0.3m/year, magnitude 0.5-0.7m	<ul style="list-style-type: none"> High level of exotic species. Disturbed by fire & weed invasion. 	<ul style="list-style-type: none"> Wetland species depth ranges based on extrapolation of surface and groundwater levels across the length of the monitoring transects rather than actual measured depths to groundwater. Specific site conditions that may influence groundwater dependence are not considered (eg. stratigraphy).
Herbyup Rd Swamp (3994164497)	Vegetation - 5 year mean and absolute water depth ranges. <i>M. preoxiana</i> - mean -0.54 to -2.62m; absolute 1.03 to -5.04m	Vegetation - 5 year mean and absolute maximum period of inundation (months/year). <i>M. preoxiana</i> - mean 0.6, absolute 4.4 (months/year)	Vegetation Low ROI - rate 0.1m/year, magnitude 0.25m. Moderate ROI - rate 0.1-0.2m/year, magnitude 0.25-	<ul style="list-style-type: none"> Decline in health of <i>M. rhaphiophylla</i>. Decreased density of <i>B. verticillata</i>. Decline in density of wetland shrubs. 	<ul style="list-style-type: none"> Wetland species depth ranges based on extrapolation of surface and groundwater levels across the length of the monitoring transects.

Sub-group / GDE	Water regime component	Duration of inundation or waterlogging (months/year)	Rate (m/year) and magnitude (m) of decline and risk of impact level (ROI)	Impacts associated with water regime change and/or other disturbances.	Reliability of information
	Depth of groundwater (negative value) or surface water (positive value) (m)				
	<i>M. rhizophylla</i> – mean 0.006 to -2.14m, absolute 1.03 to -4.49m. Terrestrial vertebrates Relationship between groundwater, upland vegetation and terrestrial fauna may be important.	<i>M. rhizophylla</i> – mean 2.15, absolute 9.4 (months/year) Terrestrial vertebrates Unknown	0.5m High ROI – rate 0.2-0.3m/year, magnitude 0.5-0.7m	<ul style="list-style-type: none"> Exotics dominant in understorey. 	<ul style="list-style-type: none"> rather than actual measured depths to groundwater. Specific site conditions that may influence groundwater dependence are not considered (eg. stratigraphy).
Maitai Reserve* (39361644293)	Vegetation No vegetation monitoring transect and vegetation not assessed. Waterbirds High winter spring water levels for breeding. Terrestrial vertebrates Relationship between groundwater upland vegetation and terrestrial fauna may be important.	Waterbirds Breeding may require 6 months inundation. Terrestrial vertebrates Unknown			
Copship Lake* (39072644156)	Vegetation No vegetation monitoring transect and vegetation not assessed.				
Branch St Swamp* (39094644246)	Vegetation No vegetation monitoring transect and vegetation not assessed.				
Forest Tappet Swamp* (39297644306)	Vegetation No vegetation monitoring transect and vegetation not assessed.				
Solomon Rd Swamp* (39232644307)	Vegetation No vegetation monitoring transect and vegetation not assessed.				
Mandapalap (Wattleup) Lake* (38938643850)	Vegetation No vegetation monitoring transect and vegetation not assessed.				
Karrolatta Central & South Complex Fumessdale Lake (39606644134)	Vegetation - 5 year mean and absolute water depth ranges. <i>M. rhizophylla</i> – mean 0.006 to -2.14m, absolute 1.03 to -4.49m. <i>E. radiata</i> – mean -0.7 to -3.26m, absolute 1.03 to -6.44m. <i>B. articulata</i> – mean 0.28 to -1.22m, absolute 0.81 to -2.39m. Waterbirds High winter spring peaks important, especially for drowning vegetation that threatens to choke the open shallows on which migratory waders depend in summer and autumn. Vertebrates High spring peaks for frogs and persistence into autumn. Water quality/sediment processes Sediments must remain saturated moist throughout the summer each year. The water table therefore must not drop below the stratigraphic level layer capable of providing water to surface organics through capillary rise during summer.	Vegetation - 5 year mean and absolute maximum period of inundation (months/year): <i>M. rhizophylla</i> – mean 2.15, absolute 9.4 (months/year). <i>E. radiata</i> – mean 1.55, absolute 12 (months/year). <i>B. articulata</i> – mean 3.26, absolute 12 (months/year). Waterbirds Shallows should persist into summer and early autumn for migratory waders. Vertebrates Long-necked Tortoises were present in the 1970s and may still be there; require at least 9 months?	Vegetation Low ROI – rate 0.1m/year, magnitude 0.25m. Moderate ROI – rate 0.1-0.2m/year, magnitude 0.25-0.5m. High ROI – rate 0.2-0.3m/year, magnitude 0.5-0.7m.	<ul style="list-style-type: none"> Increased weed invasion due to lack of inundation Drying, fire and physical disturbance has disturbed <i>MacLarenia</i> sp. Declining waterable affected vegetation including <i>M. rhizophylla</i> & <i>E. radiata</i>. 	<ul style="list-style-type: none"> No permanent vegetation monitoring transect Specific site conditions that may influence groundwater dependence are not considered (eg. stratigraphy).

Sub-group / GDE	Water regime component Depth of groundwater (negative value) or surface water (positive value) (m)	Duration of inundation or waterlogging (months/year)	Rate (m/year) and magnitude (m) of decline and risk of impact level (ROI)	Impacts associated with water regime change and/or other disturbances.	Reliability of information
Southern River Complex					
Harmsdale Swamp* (598/7944655)	Vegetation As there is not a vegetation monitoring transect and the wetland had not been assessed at the time of writing, no comment can be made on water requirements of wetland species. Terrestrial vertebrates Relationship between groundwater, upland vegetation and terrestrial fauna may be important. Sediment processes/water quality Organic sediments must remain saturated throughout the summer each year. The water table must therefore not drop below the stratigraphic level layer capable of providing water to surface organics through capillary rise during summer.				
Lake Halamby* (4001644610)	Vegetation No vegetation monitoring transect and vegetation not assessed.				
TERRESTRIAL ECOSYSTEMS					
Gungahra					
Herdsman Complex					
PM24 (Hush Fore or Site 382)	Vegetation - 5 year mean and absolute water depth ranges <i>E. rubis</i> - mean -0.7 to -3.2m; absolute 1.03 to -6.44m <i>M. prostrata</i> - mean -0.54 to -2.62m; absolute 1.03 to -3.64m	Vegetation - 5 year mean and absolute maximum period of inundation (months/year) <i>E. rubis</i> - mean 0.6; absolute 4.4 (months/year) <i>M. prostrata</i> - mean 1.32; absolute 12 (months/year)	Vegetation Low ROI - rate 0.1m/year, magnitude 0.25m Moderate ROI - rate 0.1-0.2m/year, magnitude 0.25-0.5m High ROI - rate 0.2-0.3m/year, magnitude 0.5-0.7m		<ul style="list-style-type: none"> No permanent vegetation monitoring transect Specific site conditions that may influence groundwater dependence are not considered (eg. stratigraphy)
Badjeryn Lake Bushland* (Hush Fore or Site 327)	Vegetation No terrestrial vegetation monitoring transect and vegetation not assessed				<ul style="list-style-type: none"> Habitat type and species present are undescribed EWRs cannot be determined for 'new' terrestrial ecosystems due to the absence of hydrological data
Yellagona Regional Park* (Hush Fore or Site 299)	Vegetation No terrestrial vegetation monitoring transect and vegetation not assessed				<ul style="list-style-type: none"> Habitat type and species present are largely undescribed EWRs cannot be determined for 'new' terrestrial ecosystems due to the absence of hydrological data
Pinyar Complex MT35 (Hush Fore or Site 324)			Vegetation Phreatophytic <i>Banksia</i> woodland at 6-10m depth to groundwater. Low ROI - rate -0.1m/year, magnitude -1.25m Moderate ROI - rate 0.1-0.25m/year, magnitude 1.25-2.0m High ROI - rate 0.25-0.5m/year, magnitude 2.0-2.75m	<ul style="list-style-type: none"> Decreased abundance of healthy <i>E. rubis</i>, <i>M. prostrata</i> & <i>B. dieckhoffii</i> since 1993 Decreased abundance of <i>A. fasciculata</i>, <i>P. ellipticum</i> & <i>H. angustifolium</i> since 1993 Increased abundance of healthy <i>B. attenuata</i> & <i>B. menziesii</i> since 1993 	<ul style="list-style-type: none"> Water requirements are approximate as further validation is required Habitat type and species present are largely undescribed The hydrology of a terrestrial site is based on water levels as measured at groundwater monitoring bores. This does not represent the variation in topography and its impact on

Sub-group / GDE	Water regime component Depth of groundwater (negative value) or surface water (positive value) (m)	Duration of inundation or waterlogging (months/year)	Rate (m/year) and magnitude (m) of decline and risk of impact level (ROI)	Impacts associated with water regime change and/or other disturbances.	Reliability of information
					groundwater levels across a site. • The spatial area of vegetation represented by each bore is not defined.
Humbot Rd Bushland* (Bush Forever Site 141/146)	Vegetation No terrestrial vegetation monitoring transect and vegetation not assessed.				• Habitat type and species present are largely undescribed. • EWRs cannot be determined for 'new' terrestrial ecosystems due to the absence of hydrological data.
Little Cosque Flat* (Bush Forever Site 44)	Vegetation No terrestrial vegetation monitoring transect and vegetation not assessed.				• Habitat type and species present are largely undescribed. • EWRs cannot be determined for 'new' terrestrial ecosystems due to the absence of hydrological data.
Bassendean Central & South Complex					
MM18 (Bush Forever Site 304)			Vegetation Phreatophytic <i>Banksia</i> woodland at 3-6m depth to groundwater. Low ROI - rate <0.1m/year, magnitude <1.0m. Moderate ROI - rate 0.1-0.25m/year, magnitude 1.0-1.5m. High ROI - rate 0.25-0.5m/year, magnitude 1.5-2.25m.	• Decline in number of healthy <i>M. preissiana</i> & <i>P. thicketii</i> since 1999. • Decline in abundance of <i>P. ellipticum</i> since 1999.	• Water requirements are approximate as further validation is required. • Habitat type and species present are largely undescribed. • The hydrology of a terrestrial site is based on water levels as measured at groundwater monitoring bores. This does not represent the variation in topography and its impact on groundwater levels across a site. • The spatial area of vegetation represented by each bore is not defined.
MM33 (Bush Forever Site 304)			Vegetation Phreatophytic <i>Banksia</i> woodland at 3-6m depth to groundwater. Low ROI - rate <0.1m/year, magnitude <1.0m. Moderate ROI - rate 0.1-0.25m/year, magnitude 1.0-1.5m. High ROI - rate 0.25-0.5m/year, magnitude 1.5-2.25m.	• Number of small dead <i>Banksias</i> in area. • Vegetation density decreased.	• Water requirements are approximate as further validation is required. • Habitat type and species present are largely undescribed. • The hydrology of a terrestrial site is based on water levels as measured at groundwater monitoring bores. This does not represent the variation in topography and its impact on groundwater levels across a site. • The spatial area of vegetation represented by each bore is not defined.
MM55II (Bush Forever Site 304)	Vegetation - 5 year mean and absolute water depth ranges: <i>M. preissiana</i> - mean -0.54 to -2.62m; absolute 1.03 to -5.04m.	Vegetation - 5 year mean and absolute maximum period of inundation (months/year): <i>M. preissiana</i> - mean 0.6, absolute 4.4 (months/year).		• Generally modified by grazing (fenced see monitoring).	
MM39II (Bush Forever Site 304)			Vegetation Phreatophytic <i>Banksia</i> woodland at 3-6m depth to groundwater. Low ROI - rate <0.1m/year, magnitude <1.0m. Moderate ROI - rate 0.1-0.25m/year, magnitude 1.0-1.5m. High ROI - rate 0.25-0.5m/year, magnitude 1.5-	• Number of small dead <i>Banksias</i> in area. • Vegetation density increased.	• Water requirements are approximate as further validation is required. • Habitat type and species present are largely undescribed. • The hydrology of a terrestrial site is based on water levels as measured at groundwater monitoring bores. This does not represent the

Sub-Group /	Water regime component	Depth of groundwater (negative value) or surface water (positive value) (m)	Duration of inundation or waterlogging (months) (cat)	Rate (m/yr) and magnitude (m) of decline and risk of impact level (RDI)	Impacts associated with water regime change and/or other disturbances	Reliability of information
GH2	Water regime component	Depth of groundwater (negative value) or surface water (positive value) (m)	Duration of inundation or waterlogging (months) (cat)	Rate (m/yr) and magnitude (m) of decline and risk of impact level (RDI)	Impacts associated with water regime change and/or other disturbances	Reliability of information
MM10	Urban Forest Site			Vegetation <i>Fraxino</i> <i>Quercus</i> woodland at 3-6m depth to ground level High RDI - rate 0.25-0.5m/yr, magnitude 1.5-2.25m Medium RDI - rate 0.1-0.25m/yr, magnitude 1.0-1.5m Low RDI - rate 0.1m/yr, magnitude <1.0m ground level	• The spatial area of vegetation represented by each bore is not defined	• Vegetation in topography and its impact on groundwater levels across a site
GH10	Urban Forest Site			Vegetation <i>Fraxino</i> <i>Quercus</i> woodland at 3-6m depth to ground level High RDI - rate 0.25-0.5m/yr, magnitude 1.5-2.25m Medium RDI - rate 0.1-0.25m/yr, magnitude 1.0-1.5m Low RDI - rate 0.1m/yr, magnitude <1.0m ground level	• The spatial area of vegetation represented by each bore is not defined	• Vegetation in topography and its impact on groundwater levels across a site
GH9	Urban Forest Site			Vegetation <i>Fraxino</i> <i>Quercus</i> woodland at 3-6m depth to ground level High RDI - rate 0.25-0.5m/yr, magnitude 1.5-2.25m Medium RDI - rate 0.1-0.25m/yr, magnitude 1.0-1.5m Low RDI - rate 0.1m/yr, magnitude <1.0m ground level	• The spatial area of vegetation represented by each bore is not defined	• Vegetation in topography and its impact on groundwater levels across a site
GH8	Urban Forest Site			Vegetation <i>Fraxino</i> <i>Quercus</i> woodland at 3-6m depth to ground level High RDI - rate 0.25-0.5m/yr, magnitude 1.5-2.25m Medium RDI - rate 0.1-0.25m/yr, magnitude 1.0-1.5m Low RDI - rate 0.1m/yr, magnitude <1.0m ground level	• The spatial area of vegetation represented by each bore is not defined	• Vegetation in topography and its impact on groundwater levels across a site
GH7	Urban Forest Site			Vegetation <i>Fraxino</i> <i>Quercus</i> woodland at 3-6m depth to ground level High RDI - rate 0.25-0.5m/yr, magnitude 1.5-2.25m Medium RDI - rate 0.1-0.25m/yr, magnitude 1.0-1.5m Low RDI - rate 0.1m/yr, magnitude <1.0m ground level	• The spatial area of vegetation represented by each bore is not defined	• Vegetation in topography and its impact on groundwater levels across a site
GH6	Urban Forest Site			Vegetation <i>Fraxino</i> <i>Quercus</i> woodland at 3-6m depth to ground level High RDI - rate 0.25-0.5m/yr, magnitude 1.5-2.25m Medium RDI - rate 0.1-0.25m/yr, magnitude 1.0-1.5m Low RDI - rate 0.1m/yr, magnitude <1.0m ground level	• The spatial area of vegetation represented by each bore is not defined	• Vegetation in topography and its impact on groundwater levels across a site
GH5	Urban Forest Site			Vegetation <i>Fraxino</i> <i>Quercus</i> woodland at 3-6m depth to ground level High RDI - rate 0.25-0.5m/yr, magnitude 1.5-2.25m Medium RDI - rate 0.1-0.25m/yr, magnitude 1.0-1.5m Low RDI - rate 0.1m/yr, magnitude <1.0m ground level	• The spatial area of vegetation represented by each bore is not defined	• Vegetation in topography and its impact on groundwater levels across a site
GH4	Urban Forest Site			Vegetation <i>Fraxino</i> <i>Quercus</i> woodland at 3-6m depth to ground level High RDI - rate 0.25-0.5m/yr, magnitude 1.5-2.25m Medium RDI - rate 0.1-0.25m/yr, magnitude 1.0-1.5m Low RDI - rate 0.1m/yr, magnitude <1.0m ground level	• The spatial area of vegetation represented by each bore is not defined	• Vegetation in topography and its impact on groundwater levels across a site
GH3	Urban Forest Site			Vegetation <i>Fraxino</i> <i>Quercus</i> woodland at 3-6m depth to ground level High RDI - rate 0.25-0.5m/yr, magnitude 1.5-2.25m Medium RDI - rate 0.1-0.25m/yr, magnitude 1.0-1.5m Low RDI - rate 0.1m/yr, magnitude <1.0m ground level	• The spatial area of vegetation represented by each bore is not defined	• Vegetation in topography and its impact on groundwater levels across a site
GH2	Urban Forest Site			Vegetation <i>Fraxino</i> <i>Quercus</i> woodland at 3-6m depth to ground level High RDI - rate 0.25-0.5m/yr, magnitude 1.5-2.25m Medium RDI - rate 0.1-0.25m/yr, magnitude 1.0-1.5m Low RDI - rate 0.1m/yr, magnitude <1.0m ground level	• The spatial area of vegetation represented by each bore is not defined	• Vegetation in topography and its impact on groundwater levels across a site
GH1	Urban Forest Site			Vegetation <i>Fraxino</i> <i>Quercus</i> woodland at 3-6m depth to ground level High RDI - rate 0.25-0.5m/yr, magnitude 1.5-2.25m Medium RDI - rate 0.1-0.25m/yr, magnitude 1.0-1.5m Low RDI - rate 0.1m/yr, magnitude <1.0m ground level	• The spatial area of vegetation represented by each bore is not defined	• Vegetation in topography and its impact on groundwater levels across a site
GH0	Urban Forest Site			Vegetation <i>Fraxino</i> <i>Quercus</i> woodland at 3-6m depth to ground level High RDI - rate 0.25-0.5m/yr, magnitude 1.5-2.25m Medium RDI - rate 0.1-0.25m/yr, magnitude 1.0-1.5m Low RDI - rate 0.1m/yr, magnitude <1.0m ground level	• The spatial area of vegetation represented by each bore is not defined	• Vegetation in topography and its impact on groundwater levels across a site

Sub-group / GDE	Water regime component Depth of groundwater (negative value) or surface water (positive value) (m)	Duration of inundation or waterlogging (month/year)	Rate (m/year) and magnitude (m) of decline and risk of impact level (ROI)	Impacts associated with water regime change and/or other disturbances	Reliability of information
399			groundwater; Low ROI – rate < 0.1m/year, magnitude < 1.0m. Moderate ROI – rate 0.1-0.25m/year, magnitude 1.0-1.5m. High ROI – rate 0.25-0.5m/year, magnitude 1.5-2.25m.		
WM6			Vegetation Threatophytic <i>Banksia</i> woodland at 6-10m depth to groundwater. Low ROI – rate < 0.1m/year, magnitude < 1.25m. Moderate ROI – rate 0.1-0.25m/year, magnitude 1.25-2.0m. High ROI – rate 0.25-0.5m/year, magnitude 2.0-2.75m.	<ul style="list-style-type: none"> Decrease abundance of <i>A. fuscoides</i>, <i>P. ellipticum</i> since 1999. Decreased number of healthy <i>B. theophrasti</i> since 1999. Signs of stress in <i>Banksia</i> sp. north of bore & <i>M. preissiana</i> to south. 	• See above
WME (Bush Forever Site 399)			Vegetation Threatophytic <i>Banksia</i> woodland at 3-6m depth to groundwater. Low ROI – rate < 0.1m/year, magnitude < 1.0m. Moderate ROI – rate 0.1-0.25m/year, magnitude 1.0-1.5m. High ROI – rate 0.25-0.5m/year, magnitude 1.5-2.25m.		• See above
NR6C (Bush Forever Site 399)			Vegetation Threatophytic <i>Banksia</i> woodland at 3-6m depth to groundwater. Low ROI – rate < 0.1m/year, magnitude < 1.0m. Moderate ROI – rate 0.1-0.25m/year, magnitude 1.0-1.5m. High ROI – rate 0.25-0.5m/year, magnitude 1.5-2.25m.	• Decreased vegetation density.	• See above.
NR11C (Bush Forever Site 399)			Vegetation Threatophytic <i>Banksia</i> woodland at 3-6m depth to groundwater. Low ROI – rate < 0.1m/year, magnitude < 1.0m. Moderate ROI – rate 0.1-0.25m/year, magnitude 1.0-1.5m. High ROI – rate 0.25-0.5m/year, magnitude 1.5-2.25m.	• No change in vegetation density between 1988 – 2000	• See above.
L30C (Bush Forever Site 399)			Vegetation Threatophytic <i>Banksia</i> woodland at 3-6m depth to groundwater. Low ROI – rate < 0.1m/year, magnitude < 1.0m. Moderate ROI – rate 0.1-0.25m/year, magnitude 1.0-1.5m. High ROI – rate 0.25-0.5m/year, magnitude 1.5-2.25m.	• Decreased vegetation density.	• See above.
L110C (Bush Forever Site 399)			Vegetation Threatophytic <i>Banksia</i> woodland at 6-10m depth to groundwater.	• Decreased vegetation density.	• See above.

Sub-group / GDE	Water regime component		Rate (m/year) and magnitude (m) of decline and risk of impact level (ROI)	Impacts associated with water regime change and/or other disturbances	Reliability of information
	Depth of groundwater (negative value) or surface water (positive value) (m)	Duration of inundation or waterlogging (months/year)			
			Low ROI - rate <0.1m/year, magnitude <1.25m. Moderate ROI - rate 0.1-0.25m/year, magnitude 1.25-2.0m. High ROI - rate 0.25-0.5m/year, magnitude 2.0-2.75m.		
L220C (Bush Forever Site 399)			Vegetation Phreatophytic <i>Banksia</i> woodland at 3-6m depth to groundwater. Low ROI - rate <0.1m/year, magnitude <1.0m. Moderate ROI - rate 0.1-0.25m/year, magnitude 1.0-1.5m. High ROI - rate 0.25-0.5m/year, magnitude 1.5-2.25m.	<ul style="list-style-type: none"> Decrease in vegetation density north & west of bore 	<ul style="list-style-type: none"> See above
Ellenbrook Bushland (Bush Forever Site 398)	Vegetation No terrestrial vegetation monitoring transect and vegetation not assessed			<ul style="list-style-type: none"> Decrease in abundance of <i>P. ellipticum</i>. Vegetation density grades from a decrease in east to a increase in west. Decrease in healthy <i>M. ypresiana</i>, <i>B. decipiens</i>, <i>B. attenuata</i> & <i>B. menziesii</i> in Marulla site. 	<ul style="list-style-type: none"> Habitat type and species present are largely undescribed. EWRs cannot be determined for 'new' terrestrial ecosystems due to the absence of hydrological data
MM12 (Bush Forever Site 192)			Vegetation Phreatophytic <i>Banksia</i> woodland at 3-6m depth to groundwater. Low ROI - rate <0.1m/year, magnitude <1.0m. Moderate ROI - rate 0.1-0.25m/year, magnitude 1.0-1.5m. High ROI - rate 0.25-0.5m/year, magnitude 1.5-2.25m.		<ul style="list-style-type: none"> Water requirements are approximate as further validation is required. Habitat type and species present are largely undescribed. The hydrology of a terrestrial site is based on water levels as measured at groundwater monitoring bores. This does not represent the variation in topography and its impact on groundwater levels across a site. The spatial area of vegetation represented by each bore is not defined.
Rosella Rd Bushland (Bush Forever Site 388)	Vegetation No terrestrial vegetation monitoring transect and vegetation not assessed				<ul style="list-style-type: none"> Habitat type and species present are largely undescribed. EWRs cannot be determined for 'new' terrestrial ecosystems due to the absence of hydrological data
State Forest 63 - Gungahra Plantation Bushland* (Multiple Bush Forever Sites)	Vegetation No terrestrial vegetation monitoring transect and vegetation not assessed				<ul style="list-style-type: none"> See above
Della Road South Bushland* (Bush Forever Site 298)	Vegetation No terrestrial vegetation monitoring transect and vegetation not assessed				<ul style="list-style-type: none"> See above
Wabling Management Priority Area*	Vegetation No terrestrial vegetation monitoring transect and vegetation not assessed				<ul style="list-style-type: none"> See above
Yard Nature					<ul style="list-style-type: none"> See above

Sub-group / GDE	Water regime component Depth of groundwater (negative value) or surface water (positive value) (m)	Duration of inundation or waterlogging (months/year)	Rate (m/year) and magnitude (m) of decline and risk of impact level (ROI)	Impacts associated with water regime change and/or other disturbances.	Reliability of Information
Reserve*					
Tanglelog*					
Kirby Rd Bushland* (Bush Forever Site 97)	Vegetation No terrestrial vegetation monitoring transect and vegetation not assessed				* See above
Murchie Air Weapons Range Bushland*	Vegetation No terrestrial vegetation monitoring transect and vegetation not assessed				* See above
<i>Catcoloe Central and South Complex</i>					
Wilbinga-Carahun Bushland* (Bush Forever Site 406)	Vegetation No terrestrial vegetation monitoring transect and vegetation not assessed				* See above
Yanchey National Park* (Bush Forever Site 718)					* See above
<i>Catcoloe North Catcoloe Central & South Complex</i>					
Ridge & adjacent Bushland* (Bush Forever Site 341)	Vegetation - 5 year mean and absolute water depth ranges. <i>E. rudis</i> - mean -0.7 to -3.26m, absolute 1.03 to -6.44m. <i>M. preissiana</i> - mean -0.54 to -2.62m; absolute 1.03 to -5.04m. Vertebrates Unknown relationship between groundwater, upland vegetation and terrestrial vertebrates.		Vegetation - 5 year mean and absolute maximum period of inundation (months/year). <i>M. preissiana</i> - mean 0.6, absolute 4.4 (months/year). <i>E. rudis</i> - mean 1.55, absolute 12 (months/year) Terrestrial vertebrates Unknown		* See above
State Forest 65 - Pajar Plantation South Bushland* (Multiple Bush Forever Sites)	Vegetation No terrestrial vegetation monitoring transect and vegetation not assessed				* See above
Nearabup National Park, Lake Novergap Nature* (Bush Forever Site 383)	Vegetation No terrestrial vegetation monitoring transect and vegetation not assessed				* See above
Garden Park Bushland* (Bush Forever Site 479)	Vegetation No terrestrial vegetation monitoring transect and vegetation not assessed				* See above
High Road Bushland* (Bush Forever Site 471)	Vegetation No terrestrial vegetation monitoring transect and vegetation not assessed				* See above
Erina Road	Vegetation				* See above

Sub-group / GDE	Water regime component		Duration of inundation or waterlogging (month/year)	Rate (m/year) and magnitude (m) of decline and risk of Impact level (ROI)	Impacts associated with water regime change and/or other disturbances.	Reliability of information
	Depth of groundwater (negative value) or surface water (positive value) (m)	Vegetation				
Bushland* (Bush Forest Site 491)	No terrestrial vegetation monitoring transect and vegetation not assessed					
Lake Gwelp Reserve* (Bush Forest Site 212)	Vegetation No terrestrial vegetation monitoring transect and vegetation not assessed					• See above
Deconroy Way Bushland* (Bush Forest Site 328)	Vegetation No terrestrial vegetation monitoring transect and vegetation not assessed					• See above
Landsdale Road Bushland* (Bush Forest Site 199)	Vegetation No terrestrial vegetation monitoring transect and vegetation not assessed					• See above
Koondoola Regional Bushland* (Bush Forest Site 201)	Vegetation No terrestrial vegetation monitoring transect and vegetation not assessed					• See above
<i>Bassendean North Transition Complex</i>						
Hawkins Rd Bushland* (Bush Forest Site 326)	Vegetation No terrestrial vegetation monitoring transect and vegetation not assessed					• See above
<i>Southern River Complex</i>						
Cardinal Drive Bushland* (Bush Forest Site 221)	Vegetation No terrestrial vegetation monitoring transect and vegetation not assessed					• See above
Caversham Airbase Bushland* (Bush Forest Site 290)	Vegetation No terrestrial vegetation monitoring transect and vegetation not assessed					• See above
<i>Tanger Complex</i>						
Hullbrook Nature Reserve* (Bush Forest Site 292)	Vegetation No terrestrial vegetation monitoring transect and vegetation not assessed					• See above
Sawpit Road Bushland* (Bush Forest Site 42)	Vegetation No terrestrial vegetation monitoring transect and vegetation not assessed					• See above
Twin Swamps	Vertebrates					• See above

Sub-group / GDE	Water regime component	Duration of inundation or waterlogging (months/year)	Rate (m/year) and magnitude (m) of decline and risk of impact level (ROI)	Impacts associated with water regime change and/or other disturbances.	Reliability of information
Nature Reserve* (Bush Forever Site 409)	Western Swamp Tortoise may require a high degree of soil moisture during summer to survive activation and inundation during winter/spring.				
Ellenbrook Nature Reserve* (Bush Forever Site 301)	Vertebrates Western Swamp Tortoise may require a high degree of soil moisture during summer to survive activation and inundation during winter/spring.				* See above
Jandakot Herdsman Complex JE17C (Bush Forever Site 391)	Vegetation - 5 year mean and absolute maximum period of inundation (months/year) <i>E. rudis</i> - mean 1.55, absolute 12 (months/year) <i>M. preissiana</i> - mean 0.6, absolute 4.3 (months/year)			<ul style="list-style-type: none"> Decline in health of <i>B. integrata</i> & <i>B. ilicifolia</i>. Decline in number healthy <i>E. rudis</i> (also impacted by insects). Decline in number healthy <i>M. preissiana</i> and <i>M. rhaphiophylla</i>. Increase in number stressed <i>B. attenuata</i> & <i>B. mucronata</i>. Decline in abundance of wetland shrub species. Decline in soil moisture Exotics dominate understorey. 	
Harry Waring Marsupial Reserve* (Bush Forever Site 392)	Vertebrates				<ul style="list-style-type: none"> Habitat type and species present are largely undescribed. EWGs cannot be determined for 'new' terrestrial ecosystems due to the absence of hydrological data.
Bassendean Central & South Complex JE10C			<p>Vegetation Phreatophytic <i>Banksia</i> woodland at 3-6m depth to groundwater. Low ROI - rate <0.1m/year, magnitude <1.0m. Moderate ROI - rate 0.1-0.25m/year, magnitude 1.0-1.5m. High ROI - rate 0.25-0.5m/year, magnitude 1.5-2.25m.</p>	<ul style="list-style-type: none"> Decline in health of <i>Banksia</i> woodland on private property. 	<ul style="list-style-type: none"> Water requirements are approximate as further validation is required. Habitat type and species present are largely undescribed. The hydrology of a terrestrial site is based on water levels as measured at groundwater monitoring bores. This does not represent the variation in topography and its impact on groundwater levels across a site. The spatial area of vegetation represented by each bore is not defined.
BM1			<p>Vegetation Phreatophytic <i>Banksia</i> woodland at 3-6m depth to groundwater. Low ROI - rate <0.1m/year, magnitude <1.0m. Moderate ROI - rate 0.1-0.25m/year, magnitude 1.0-1.5m. High ROI - rate 0.25-0.5m/year, magnitude 1.5-2.25m.</p>	<ul style="list-style-type: none"> Private property vegetation heavily modified. 	* See above

Sub-group / GDE	Water regime component Depth of groundwater (negative value) or surface water (positive value) (m)	Duration of inundation or waterlogging (month/year)	Rate (m/year) and magnitude (m) of decline and risk of impact level (ROI)	Impacts associated with water regime change and/or other disturbances.	Reliability of information
JM1 (Marsh Jandak Site 439)			Vegetation		
JM15 (Bush Forest Site 344)			Vegetation Phreatophytic <i>Banksia</i> woodland at 3-6m depth to groundwater. Low ROI - rate -0.1m/year, magnitude -1.0m. Moderate ROI - rate 0.1-0.25m/year, magnitude 1.0-1.5m. High ROI - rate 0.25-0.5m/year, magnitude 1.5-2.25m.	<ul style="list-style-type: none"> Decline in health of remnant <i>Banksia</i> woodland. 	See above
JM2C (Bush Forest Site 344)			Vegetation Phreatophytic <i>Banksia</i> woodland at 3-6m depth to groundwater. Low ROI - rate -0.1m/year, magnitude -1.0m. Moderate ROI - rate 0.1-0.25m/year, magnitude 1.0-1.5m. High ROI - rate 0.25-0.5m/year, magnitude 1.5-2.25m.	<ul style="list-style-type: none"> Decline in number of healthy <i>M. preissiana</i> and <i>B. decipiens</i>. Loss of <i>B. littoralis</i> from vegetation transect. Decline in number of healthy <i>B. attenuata</i> and <i>B. meczkii</i>. Decline in number of healthy <i>M. rhaphiophylla</i> stems since 1997. 	See above
JM7 (Bush Forest Site 388)			Vegetation Phreatophytic <i>Banksia</i> woodland at 3-6m depth to groundwater. Low ROI - rate -0.1m/year, magnitude -1.0m. Moderate ROI - rate 0.1-0.25m/year, magnitude 1.0-1.5m. High ROI - rate 0.25-0.5m/year, magnitude 1.5-2.25m.	<ul style="list-style-type: none"> <i>E. rudis</i> and <i>M. preissiana</i> impacted by groundwater level decline and insect attack. Recent deaths and varied condition of <i>B. decipiens</i> and <i>B. attenuata</i>. 	See above
JM8 (Bush Forest Site 388)			Vegetation Phreatophytic <i>Banksia</i> woodland at 3-6m depth to groundwater. Low ROI - rate -0.1m/year, magnitude -1.0m. Moderate ROI - rate 0.1-0.25m/year, magnitude 1.0-1.5m. High ROI - rate 0.25-0.5m/year, magnitude 1.5-2.25m.	<ul style="list-style-type: none"> Stress noted in overstorey of large <i>E. rudis</i> and <i>M. preissiana</i> in vicinity. 	See above
JM45 (Bush Forest Site 388)	Vegetation - 5 year mean and absolute maximum period of inundation (months/year) <i>E. rudis</i> - mean 1.55, absolute 12 (months/year) <i>M. preissiana</i> - mean 0.6, absolute 4.4 (months/year)		Vegetation Phreatophytic <i>Banksia</i> woodland at 3-6m depth to groundwater. Low ROI - rate -0.1m/year, magnitude -1.0m. Moderate ROI - rate 0.1-0.25m/year, magnitude 1.0-1.5m. High ROI - rate 0.25-0.5m/year, magnitude 1.5-2.25m.	<ul style="list-style-type: none"> <i>B. decipiens</i>, <i>M. preissiana</i>, <i>E. rudis</i> and <i>B. attenuata</i> show symptoms of drought stress. 	See above
K284	Vegetation - 5 year mean and absolute maximum period of inundation (months/year) <i>E. rudis</i> - mean 1.55, absolute 12 (months/year) <i>M. preissiana</i> - mean 0.6, absolute 4.4 (months/year)		Vegetation Phreatophytic <i>Banksia</i> woodland at 3-6m depth to groundwater. Low ROI - rate -0.1m/year, magnitude -1.0m. Moderate ROI - rate 0.1-0.25m/year, magnitude 1.0-1.5m. High ROI - rate 0.25-0.5m/year, magnitude 1.5-2.25m.		See above

Sub-group / GDE	Water regime component Depth of groundwater (negative value) or surface water (positive value) (m)	Duration of Inundation or waterlogging (month/year)	Rate (m/year) and magnitude (m) of decline and risk of Impact level (ROI)	Impacts associated with water regime change and/or other disturbances.	Reliability of Information
			2.25m.		
JM49			Vegetation Phreatophytic <i>Banksia</i> woodland at 3-6m depth to groundwater. Low ROI - rate <0.1m/year, magnitude <1.0m. Moderate ROI - rate 0.1-0.25m/year, magnitude 1.0-1.5m. High ROI - rate 0.25-0.5m/year, magnitude 1.5-2.25m.	• <i>B. littoralis</i> / <i>M. prostratum</i> woodland, weedy understorey on private property opposite private land 100m west of intact <i>Banksia</i> woodland.	• See above
JM39			Vegetation Phreatophytic <i>Banksia</i> woodland at 3-6m depth to groundwater. Low ROI - rate <0.1m/year, magnitude <1.0m. Moderate ROI - rate 0.1-0.25m/year, magnitude 1.0-1.5m. High ROI - rate 0.25-0.5m/year, magnitude 1.5-2.25m.	• In vicinity of intact <i>Melaleuca</i> woodland.	• See above
North Lake* (Bush Forever Site 244)	Vegetation No terrestrial vegetation monitoring transect and vegetation not assessed.				• Habitat type and species present are largely undescribed. • EWRs cannot be determined for 'new' terrestrial ecosystems due to the absence of hydrological data.
Bibra Lake* (Bush Forever Site 244)	Vegetation No terrestrial vegetation monitoring transect and vegetation not assessed.				• See above
South Lake* (Bush Forever Site 254)	Vegetation No terrestrial vegetation monitoring transect and vegetation not assessed.				• See above
Mandyalep Rd Bushland* (Bush Forever Site 268)	Vegetation No terrestrial vegetation monitoring transect and vegetation not assessed.				• Habitat type and species present are largely undescribed. • EWRs cannot be determined for 'new' terrestrial ecosystems due to the absence of hydrological data.
The Spectacles* (Bush Forever Site 269)	Vegetation No terrestrial vegetation monitoring transect and vegetation not assessed.				• See above
Sandy Lake* (Bush Forever Site 239)	Vegetation No terrestrial vegetation monitoring transect and vegetation not assessed.				• See above
Sicklemore Rd Bushland* (Bush Forever Site 272)	Vegetation No terrestrial vegetation monitoring transect and vegetation not assessed.				• See above
Casuarina Frison Bushland* (Bush Forever Site 273)	Vegetation No terrestrial vegetation monitoring transect and vegetation not assessed.				• See above

Sub-group / GDE	Water regime component Depth of groundwater (negative value) or surface water (positive value) (m)	Duration of inundation or waterlogging (month/year)	Rate (m/year) and magnitude (m) of decline and risk of impact level (ROI)	Impacts associated with water regime change and/or other disturbances.	Reliability of information
Woodi Nature Reserve* (Ibsh Forest Site 247)	Vegetation No terrestrial vegetation monitoring transect and vegetation not assessed				See above
Dangay Dhumland* (Ibsh Forest Site 203)	Vegetation No terrestrial vegetation monitoring transect and vegetation not assessed				See above
Mosberg Nature Reserve* (Ibsh Forest Site 248)					See above
Colichue Central & South Complex JM16 (Ibsh Forest Site 253)			Vegetation Phytosociology <i>Banksia</i> woodland at 3-6m depth in groundwater. Low ROI - rate < 0.1m/year, magnitude < 1.0m. Moderate ROI - rate 0.1-0.25m/year, magnitude 1.0-1.5m. High ROI - rate 0.25-0.5m/year, magnitude 1.5-2.25m		<ul style="list-style-type: none"> Water requirements are approximate as further validation is required. Habitat type and species present are largely undescribed. The hydrology of a terrestrial site is based on water levels as measured at groundwater monitoring boxes. This does not represent the variation in topography and its impact on groundwater levels across a site. The spatial area of vegetation represented by each bore is not defined.
Southern River Complex JM14 (Ibsh Forest Site 289)			Vegetation Phytosociology <i>Banksia</i> woodland at 3-6m depth in groundwater. Low ROI - rate < 0.1m/year, magnitude < 1.0m. Moderate ROI - rate 0.1-0.25m/year, magnitude 1.0-1.5m. High ROI - rate 0.25-0.5m/year, magnitude 1.5-2.25m	<ul style="list-style-type: none"> Evidence of impact: recent deaths of <i>B. attenuata</i> older deaths of <i>B. thefitia</i>, <i>B. attenuata</i> and <i>B. menziesii</i>; drying of <i>B. elegans</i> in understorey. Decline in number healthy <i>M. prevostiana</i>. 	See above
Traser Rd Dhumland* (Ibsh Forest Site 290)	Vegetation No terrestrial vegetation monitoring transect and vegetation not assessed				<ul style="list-style-type: none"> Habitat type and species present are largely undescribed. FWIs cannot be determined for 'new' terrestrial ecosystems due to the absence of hydrological data.
Piara Nature Reserve* (Ibsh Forest Site 262)	Vegetation No terrestrial vegetation monitoring transect and vegetation not assessed				See above
Amley-Keane dampland* (Ibsh Forest Site 242)	Vegetation No terrestrial vegetation monitoring transect and vegetation not assessed				See above

Sub-group / GDE	Water regime component	Duration of inundation or waterlogging (month/year)	Rate (m/year) and magnitude (m) of decline and risk of impact level (ROI)	Impacts associated with water regime change and/or other disturbances.	Reliability of Information
Dhansup* (Bash Forever Site 413)	Vegetation No terrestrial vegetation monitoring transect and vegetation not assessed.				* See above
Karrakata Central & South Complex Yangsbop & Little Rush Lakes* (Bash Forever Site 256)	Vegetation No terrestrial vegetation monitoring transect and vegetation not assessed.				* See above
Ferresdale Lake* (Bash Forever Site 345)	Vegetation No terrestrial vegetation monitoring transect and vegetation not assessed.				* See above
BASE-FLOW SYSTEMS					
Gugina Brook*	Vegetation No vegetation monitoring transect and vegetation not assessed. Vertebrates Fish - needs to be permanently inundated for fish - critical minimum threshold depth for survival not known.	Vertebrates Fish - permanently inundated.	Vertebrates Rate of decline not known - fish are mobile and can probably withstand reasonably rapid natural declines.	<ul style="list-style-type: none"> If allowed to recede to isolated pools in summer there is increased risk of fish species losses if accidental drying occurs or poor water quality causes fish deaths (i.e. catchment-related issues such as eutrophication, clearing, sedimentation etc). 	
Bennett Brook* (139275-1763) & (36028-1763)	Vegetation <i>M. rhaphiophylla</i> and <i>E. rostris</i> Vertebrates Needs to be permanently inundated for fish - however, could recede to isolated permanent pools over summer. Western Minnows migrate upstream to breed in winter. Winter flooding creates extensive swamps for frogs. Macroinvertebrates The known spatial and temporal habitat heterogeneity will be maintained by ensuring the following mix of vegetation assemblages persist: Submergent - requires inundation according to specifications of dominant taxa. Emergent - requires inundation according to specifications of dominant taxa. Littoral - requires inundation according to specifications of dominant taxa.	Vertebrates Permanently inundated for fish - however, could recede to isolated permanent pools over summer.	Vertebrates Rate of decline not known - fish are mobile and can probably withstand reasonably rapid natural declines.	<ul style="list-style-type: none"> If allowed to recede to isolated pools in summer there is increased risk of species losses if accidental drying occurs or poor water quality causes fish deaths (i.e. catchment-related issues such as eutrophication, clearing, sedimentation etc). 	<ul style="list-style-type: none"> No permanent vegetation monitoring transect. Specific site conditions that may influence groundwater dependence are not considered (eg. stratigraphy).
Quin Brook* (347496-2239, 335304-2263, 334546-2272, 332316-2292)	Vegetation 387496-2239 - <i>M. preissiana</i> , <i>M. rhaphiophylla</i> and <i>E. rostris</i> 335304-2263 - <i>M. preissiana</i> , <i>M. rhaphiophylla</i> and <i>B. littoralis</i> 334546-2272 - <i>M. preissiana</i> , <i>M. rhaphiophylla</i> , <i>B. littoralis</i> , <i>E. rostris</i> and <i>A. fasciculata</i> 332316-2292 - <i>M. preissiana</i> , <i>M. rhaphiophylla</i> and <i>A. fasciculata</i> Vertebrates Fish - needs to be permanently inundated for fish - critical	Vertebrates Fish - permanently inundated.	Vertebrates Rate of decline not known - fish are mobile and can probably withstand reasonably rapid natural declines.	<ul style="list-style-type: none"> If allowed to recede to isolated pools in summer there is increased risk of fish species losses if accidental drying occurs or poor water quality causes fish deaths (i.e. catchment-related issues such as eutrophication, clearing, sedimentation etc). Vegetation in excellent to pristine condition despite recent fire and some weed invasion 	

Sub-group /	Water regime component	Depth of groundwater (negative value) or surface water (positive value) (m)	Duration of inundation or waterlogging (months/year)	Rate (m/year) and magnitude (m) of decline and risk of impact level (RDI)	Impacts associated with water regime change and/or other disturbances.	Reliability of information
GDE	Water regime /	depth of groundwater (negative value) or surface water (positive value) (m)	Duration of inundation or waterlogging (months/year)	Rate (m/year) and magnitude (m) of decline and risk of impact level (RDI)	Impacts associated with water regime change and/or other disturbances.	Reliability of information
	Grounds /	depth of groundwater (negative value) or surface water (positive value) (m)	Duration of inundation or waterlogging (months/year)	Rate (m/year) and magnitude (m) of decline and risk of impact level (RDI)	Impacts associated with water regime change and/or other disturbances.	Reliability of information
	Grounds boundary /	depth of groundwater (negative value) or surface water (positive value) (m)	Duration of inundation or waterlogging (months/year)	Rate (m/year) and magnitude (m) of decline and risk of impact level (RDI)	Impacts associated with water regime change and/or other disturbances.	Reliability of information
	Study area /	depth of groundwater (negative value) or surface water (positive value) (m)	Duration of inundation or waterlogging (months/year)	Rate (m/year) and magnitude (m) of decline and risk of impact level (RDI)	Impacts associated with water regime change and/or other disturbances.	Reliability of information
	Riparian /	depth of groundwater (negative value) or surface water (positive value) (m)	Duration of inundation or waterlogging (months/year)	Rate (m/year) and magnitude (m) of decline and risk of impact level (RDI)	Impacts associated with water regime change and/or other disturbances.	Reliability of information
	Channel /	depth of groundwater (negative value) or surface water (positive value) (m)	Duration of inundation or waterlogging (months/year)	Rate (m/year) and magnitude (m) of decline and risk of impact level (RDI)	Impacts associated with water regime change and/or other disturbances.	Reliability of information
	System*	depth of groundwater (negative value) or surface water (positive value) (m)	Duration of inundation or waterlogging (months/year)	Rate (m/year) and magnitude (m) of decline and risk of impact level (RDI)	Impacts associated with water regime change and/or other disturbances.	Reliability of information
CYPAN AND CAVN ECOSYSTEMS	Mesohierarchies	<p>Water quality: Stable flows with no seasonal declines in water levels. Water quality: Stable flows with no seasonal declines. In long low season flows to result in loss of fauna.</p>	<p>Water quality: Stable flows with no seasonal declines. In long low season flows to result in loss of fauna.</p>	<p>Water quality: Stable flows with no seasonal declines. In long low season flows to result in loss of fauna.</p>	<ul style="list-style-type: none"> • Known to have permanent stream once dry. • Level of cave flow or seep: known and known 	
	Mesohierarchies	<p>Water quality: Stable flows with no seasonal declines. Permanent water with no seasonal declines.</p>	<p>Water quality: Stable flows with no seasonal declines. Permanent water with no seasonal declines.</p>	<p>Water quality: Stable flows with no seasonal declines. Permanent water with no seasonal declines.</p>	<ul style="list-style-type: none"> • Permanent deep water readily stabilizing once flow is increased. • No on surface species recorded in 2001 and 2002. • Flashed change scheme is an issue particularly for (K) and temperature, however, primarily (for K) and temperature, however, primarily (for K) and temperature. • Checks are provided from natural groundwater flow - water quality should not be problem (except when contaminants enter the groundwater system of the cave). 	
	Mesohierarchies	<p>Water quality: Stable flows with no seasonal declines. Permanent water with no seasonal declines.</p>	<p>Water quality: Stable flows with no seasonal declines. Permanent water with no seasonal declines.</p>	<p>Water quality: Stable flows with no seasonal declines. Permanent water with no seasonal declines.</p>	<ul style="list-style-type: none"> • Permanent deep water readily stabilizing once flow is increased. • No on surface species recorded in 2001 and 2002. • Flashed change scheme is an issue particularly for (K) and temperature, however, primarily (for K) and temperature. • Checks are provided from natural groundwater flow - water quality should not be problem (except when contaminants enter the groundwater system of the cave). 	
	Mesohierarchies	<p>Water quality: Stable flows with no seasonal declines. Permanent water with no seasonal declines.</p>	<p>Water quality: Stable flows with no seasonal declines. Permanent water with no seasonal declines.</p>	<p>Water quality: Stable flows with no seasonal declines. Permanent water with no seasonal declines.</p>	<ul style="list-style-type: none"> • Permanent deep water readily stabilizing once flow is increased. • No on surface species recorded in 2001 and 2002. • Flashed change scheme is an issue particularly for (K) and temperature, however, primarily (for K) and temperature. • Checks are provided from natural groundwater flow - water quality should not be problem (except when contaminants enter the groundwater system of the cave). 	
CYPAN CAVE	Mesohierarchies	<p>Water quality: Stable flows with no seasonal declines. Permanent water with no seasonal declines.</p>	<p>Water quality: Stable flows with no seasonal declines. Permanent water with no seasonal declines.</p>	<p>Water quality: Stable flows with no seasonal declines. Permanent water with no seasonal declines.</p>	<ul style="list-style-type: none"> • Permanent deep water readily stabilizing once flow is increased. • No on surface species recorded in 2001 and 2002. • Flashed change scheme is an issue particularly for (K) and temperature, however, primarily (for K) and temperature. • Checks are provided from natural groundwater flow - water quality should not be problem (except when contaminants enter the groundwater system of the cave). 	
	Mesohierarchies	<p>Water quality: Stable flows with no seasonal declines. Permanent water with no seasonal declines.</p>	<p>Water quality: Stable flows with no seasonal declines. Permanent water with no seasonal declines.</p>	<p>Water quality: Stable flows with no seasonal declines. Permanent water with no seasonal declines.</p>	<ul style="list-style-type: none"> • Permanent deep water readily stabilizing once flow is increased. • No on surface species recorded in 2001 and 2002. • Flashed change scheme is an issue particularly for (K) and temperature, however, primarily (for K) and temperature. • Checks are provided from natural groundwater flow - water quality should not be problem (except when contaminants enter the groundwater system of the cave). 	

Sub-group /	Water regime component	Duration of inundation or waterlogging (month/year)	Rate (cm/year) and magnitude (m) of decline and risk of impact level (ROI)	Impacts associated with water regime change and/or other differences	Reliability of information
	Depth of groundwater (negative value) or surface				
Chilge Cave (Y227)	Macroturbulence	Periodic flows with no seasonal declines in water levels	Stable flows with no seasonal declines. Drying has been shown to result in loss of fauna.	<ul style="list-style-type: none"> • Large fauna of caves lost due to drying of cave system in 1990. • Planned recharge scheme is an issue particularly for DJ and temperature, however groundwater flows - water quality should not be a problem (except when contaminants enter the groundwater upstream of the caves). 	<ul style="list-style-type: none"> • Level of cave floor or nearby boxes not known.
Chilge Cave (Y230)	Macroturbulence	Periodic flows with no seasonal declines in water levels	Stable flows with no seasonal declines. Drying has been shown to result in loss of fauna.	<ul style="list-style-type: none"> • Water table 5-11cm below surface in January 2002. • Planned recharge scheme is an issue particularly for DJ and temperature, however groundwater flows - water quality should not be a problem (except when contaminants enter the groundwater upstream of the caves). • Strong permanent stream until 1990's now dry. 	<ul style="list-style-type: none"> • Level of cave floor or nearby boxes not known.
Chilge Cave (Y230)	Macroturbulence	Periodic flows with no seasonal declines in water levels	Stable flows with no seasonal declines. Drying has been shown to result in loss of fauna.	<ul style="list-style-type: none"> • Water table 5-11cm below surface in January 2002. • Planned recharge scheme is an issue particularly for DJ and temperature, however groundwater flows - water quality should not be a problem (except when contaminants enter the groundwater upstream of the caves). 	<ul style="list-style-type: none"> • Level of cave floor or nearby boxes not known.
Bombayng Cave (Y209)	Macroturbulence	Periodic flows with no seasonal declines in water levels	Stable flows with no seasonal declines. Drying has been shown to result in loss of fauna.	<ul style="list-style-type: none"> • Permanent stream now dry most of year (groundwater upstream of the caves). 	<ul style="list-style-type: none"> • Level of cave floor or nearby boxes not known.
Twilight Cave (Y2104)	Macroturbulence	Periodic flows with no seasonal declines in water levels	Stable flows with no seasonal declines. Drying has been shown to result in loss of fauna.	<ul style="list-style-type: none"> • Permanent stream that flowed strongly until mid 1990's has diminished. 	<ul style="list-style-type: none"> • Level of cave floor or nearby boxes not known.

Sub-group / GHE	Water regime component Depth of groundwater (negative value) or surface water (positive value) (m)	Duration of inundation or waterlogging (months/year)	Rate (m/year) and magnitude (m) of decline and risk of Impact level (ROI)	Impacts associated with water regime change and/or other disturbances	Reliability of information
Unnamed cave* (YN61)	Macrolinvertebrates Water body is a standing pool of exposed water (presumably extends into floor of cave, with no perceptible flows). Excessive declines in levels are known to expose suspended root mats which then die-off and fauna are lost. Therefore, requires stable water levels. Do not know AHD of bores levels to achieve this. Water quality Stable water quality in terms of pH, DO and temperature, with minimal diel, seasonal or annual variation, showing buffering influence of groundwater. Will be achieved if above EWR for macroinvertebrates is achieved.	Macrolinvertebrates Permanent water with no seasonal declines. Water quality Permanent water with no seasonal declines.	Macrolinvertebrates Permanent water with no seasonal declines. Water quality Permanent water with no seasonal declines.	<ul style="list-style-type: none"> In 1990 had water up to 1m deep with thick sludge, now drying with mud cracking in summer. 	<ul style="list-style-type: none"> Level of cave floor or nearby bores not known.
Cave on Lot 51* (YN555)	Macrolinvertebrates Water body is a standing pool of exposed water (presumably extends into floor of cave, with no perceptible flows). Excessive declines in levels are known to expose suspended root mats which then die-off and fauna are lost. Therefore, requires stable water levels. Do not know AHD of bores levels to achieve this. Water quality Stable water quality in terms of pH, DO and temperature, with minimal diel, seasonal or annual variation, showing buffering influence of groundwater. Will be achieved if above EWR for macroinvertebrates is achieved.	Macrolinvertebrates Permanent water with no seasonal declines. Water quality Permanent water with no seasonal declines.	Macrolinvertebrates Permanent water with no seasonal declines. Water quality Permanent water with no seasonal declines.	<ul style="list-style-type: none"> Solution carving shows cave had been completely filled with water, now shallow. Elevated nitrogen concentration possibly indicating anthropogenic influence on groundwater. 	<ul style="list-style-type: none"> Level of cave floor or nearby bores not known.
Orpheus Cave* (YN256)	Macrolinvertebrates Water body is a standing pool of exposed water (presumably extends into floor of cave, with no perceptible flows). Excessive declines in levels are known to expose suspended root mats which then die-off and fauna are lost. Therefore, requires stable water levels. Do not know AHD of bores levels to achieve this. Water quality Stable water quality in terms of pH, DO and temperature, with minimal diel, seasonal or annual variation, showing buffering influence of groundwater. Will be achieved if above EWR for macroinvertebrates is achieved.	Macrolinvertebrates Permanent water with no seasonal declines. Water quality Permanent water with no seasonal declines.	Macrolinvertebrates Permanent water with no seasonal declines. Water quality Permanent water with no seasonal declines.	<ul style="list-style-type: none"> Lake in bottom of cave now much shallower at winter peak. 	<ul style="list-style-type: none"> Level of cave floor or nearby bores not known.
Jackhammer Cave* (YN438)	Macrolinvertebrates Water body is a standing pool of exposed water (presumably extends into floor of cave, with no perceptible flows). Excessive declines in levels are known to expose suspended root mats which then die-off and fauna are lost. Therefore, requires stable water levels. Do not know AHD of bores levels to achieve this. Water quality Stable water quality in terms of pH, DO and temperature, with minimal diel, seasonal or annual variation, showing buffering influence of groundwater. Will be achieved if above EWR for macroinvertebrates is achieved.	Macrolinvertebrates Permanent water with no seasonal declines. Water quality Permanent water with no seasonal declines.	Macrolinvertebrates Permanent water with no seasonal declines. Water quality Permanent water with no seasonal declines.	<ul style="list-style-type: none"> Contained deep water overlain deep silt and detritus however, levels now 10-20cm below historic water marks on walls. 	<ul style="list-style-type: none"> Level of cave floor or nearby bores not known.

Sub-group / GPE	Water regime component Depth of groundwater (negative value) or surface water (positive value) (m)	Duration of foundation or waterlogging (month/year)	Rate (m/year) and magnitude (m) of decline and risk of impact level (ROI)	Impacts associated with water regime change and/or other disturbances	Reliability of information

ESTUARINE AND NEAR-SHORE MARINE ECOSYSTEMS
 Mangrove Marine
 Pelt
 Lagoon
 Seagrass
 Meadows
 Wetland
 Sand*

2.2 DETAILED EWRs

In this section quantitative EWRs are described for a subset of GDEs for which the required level of information is available. These GDEs include all wetlands, mound springs, terrestrial vegetation sites and caves identified in the 1991/92, 1995 and 1997 reports and 'new' GDEs for which it is now considered appropriate to describe EWRs. Where possible water requirements are described to meet the management objectives described in Task 1. For example, two of the management objectives for Loch McNess; '...minimise the contribution of groundwater decline to... support good populations of waterbirds...' and '...minimise the contribution of groundwater decline to ...support diverse fish species', will be addressed through the determination of water requirements for macroinvertebrates and fish.

The information presented in this section not only describes the water requirements of individual components of GDEs (vegetation, macroinvertebrates etc), but provides comments on the likely degree of dependence of each system. Hatton and Evans (1998) recognised five classes of groundwater dependency on groundwater as follows;

- Ecosystems entirely dependent on groundwater – communities where only slight changes in key groundwater attributes below or above a threshold would result in their demise.
- Ecosystems highly dependent on groundwater – communities where moderate changes in groundwater discharge or water tables would result in a substantial change in their distribution.
- Ecosystems with proportional dependence on groundwater – these ecosystems exhibit a proportional response to changes in groundwater attributes rather than the threshold responses of the more highly dependent ecosystems.
- Ecosystems with limited or opportunistic dependence on groundwater – groundwater appears only to play a significant role in the water balance at the end of the dry season or during extreme drought.
- Ecosystems with no dependence on groundwater – these ecosystems may appear to be groundwater dependent, but are either entirely rainfall fed or dependent only on surface water flows.

To adequately describe the water requirements of an ecosystem the water regime in which it operates should be understood (Evan & Clifton, 2001). To access the current water regime information is also presented on the following;

- Processes for which water is required – consumptive uses, habitat or biophysical processes.
- Source of water used by the ecosystem – groundwater, surface water, soil water or rainfall.

The water requirements of all groundwater dependent ecosystems are described based on the best available information.

WETLANDS

EWRs for wetland vegetation are based on the mean water depths of common wetland species as presented in Table 2. For each species listed at each wetland, the mean minimum water depth (m) is subtracted from the minimum elevation (mAHD) at which that species occurs at the wetland. For example, the mean minimum water depth of *M. rhapsiophylla* is -2.14 m and at Lake Joondalup it occurs from 16.8-19.0 mAHD. Following the appropriate calculation (16.8 – 2.14) the minimum water level required to maintain *M. rhapsiophylla* at Lake Joondalup is 14.66 mAHD. If required, a maximum water level can be determined by adding the mean maximum water (m) of a species to its maximum elevation (mAHD) at a wetland.

Minimum elevations have been physically measured across the permanent vegetation transects at the 13 monitored Gngangara wetlands. However, elevations at the monitored Jandakot wetlands have not been measured and can therefore only be based on the presence of species within transects of known elevation. This approach cannot be applied to wetlands at which there are no vegetation transects; Loch McNess, Pipidiny Swamp, Lake Gngangara, Egerton Springs, Edgecombe Seepage, Lake Forrestdale and Lake Yangebup. There is also insufficient information to describe EWRs for 'new' wetlands (those not previously identified in the 1995, 1997 or 1991/92 reports).

There are a number of limitations and assumptions to this approach:

- Wetland species depth ranges are based on extrapolation of surface and groundwater levels across the length of the monitoring transects rather than actual measured depths to groundwater.
- Vegetation has established under a different water regime to that which currently exists. Without information on age class structure at individual sites it is not possible to determine under which regime tree root zones were set. Older trees may have established 20 years ago, younger individuals 3-5 years ago. Although older trees may have been lost, populations may persist due to recruitment of new plants under new conditions.
- Depth to groundwater contouring for 2003 as provided by WRC was significantly different to that provided by Water Corporation for 2000 and did not appear fully representative of groundwater depths measured at some bores and staff gauges. Discrepancies were also noted between the location of known areas of very shallow groundwater and surface water (eg Gingin Brook) and the levels represented by the contouring. These limitations were also identified by the WRC.
- Assessments of level of groundwater dependence of 'new' wetlands are only as accurate as the groundwater contouring provided.
- A number of wetlands previously considered to be groundwater dependent (Froend et al., 2002) now appear to occur at depths >10m to groundwater which may indicate perched systems or significant drawdown.
- Predicted responses to drawdown do not consider specific site conditions (eg. stratigraphy) or influences of other impacts (eg. fire, dieback).

Description of EWRs for waterbirds and aquatic invertebrates and vertebrates are based chiefly on the permeance, and, depth of surface water required by species either known to or expected to occur at a specific wetland. Depths are often based on those required to inundate emergent macrophytes known to provide habitat or food for various fauna species.

Consideration is also given to the likely degree of groundwater dependence of fauna known to occur at a wetland. With the exception of primarily aquatic species that occur in groundwater dependent wetlands (fish, frogs, turtles), the dependence of fauna upon groundwater is largely indirect. EWRs required to meet faunal needs are therefore difficult to quantify as fauna dependent upon vegetation that itself may or may not be groundwater dependent. These varying levels of groundwater dependence of fauna can be reflected by assigning species to one of four categories as below. The use of categories in this manner applies unnatural constraints across a continuum of dependence, but helps to recognise patterns and identify species of particular significance. This process was carried out for the vertebrate fauna of the study area in what must be recognised as an interpretive and to some extent subjective exercise, based upon available information and personal knowledge of the habitat requirements of each species. The categories were as follows:

1. Low dependence upon groundwater. This was applied to species that occur primarily in upland habitats throughout the year or which show no special preference for groundwater dependent vegetation. Changes to groundwater levels are unlikely to affect such species.
2. Moderate dependence upon groundwater. This was applied to species that make some use of habitats that are themselves moderately dependent upon groundwater, such as vegetation not closely associated with wetlands but in which major components are groundwater dependent. This was also applied to species that make seasonal use of vegetation that is moderately or highly dependent upon groundwater. Changes to groundwater levels would affect these fauna species, at least insofar as the vegetation assemblages upon which they dependent wholly or seasonally are affected. The effect may be for both the vegetation and the fauna to move lower in the landscape.
3. High dependence upon groundwater. This was applied to species that are dependent upon phreatophytic vegetation. Because this vegetation occurs low in the landscape, a lowering of groundwater could cause a reduction in habitat area rather than shift in its position in the landscape. Associated fauna species would therefore decline in abundance or disappear.
4. Very high dependence upon groundwater. This was applied to species that rely on aquatic habitats in wetlands and that are therefore likely to become locally extinct if a fall in the groundwater level leads to the disappearance of surface water in wetlands.

Description of EWRs to maintain sediment processes follow comments made for general EWRs. For those wetlands for which basin bathymetry is available, minimum water levels have been determined. These are based on an assumption that organic sediments will remain saturated/moist if the groundwater level does not drop more than 0.5 m below the ground surface.

Gnangara Mound

Loch McNess

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Undisturbed wetland with largely intact vegetation.
- Good populations of water birds and acts as drought refuge.
- Excellent water quality.
- Very high macroinvertebrate species richness.
- Supports diverse fish species.
- Wide diversity of habitat types.
- Large body of permanent water with very low seasonal variation in water levels.

2. Groundwater dependency analysis.

Although Loch McNess receives rainfall inputs and has a permanent surface water component, Clifton and Evans (2001) described permanent wetlands of the Swan Coastal Plain as entirely dependent on groundwater. It is therefore highly likely that the wetland is entirely groundwater dependent for biophysical processes, habitat and consumptive use.

3. Revised EWRs.

a) Superseded EWRs (mAHD).

Summer absolute minimum - 6.95

b) Water requirements for ecological components of GDE.

- Vegetation.

As there is not a vegetation monitoring transect at Loch McNess, a minimum groundwater level cannot be determined following the methodology outlined above. However, comment can be made on the water depth ranges and period of inundation experienced by wetland species known to occur at the wetland.

Loomes (2000) described the 5 year mean and absolute water depth ranges (m) and duration of inundation (months/year) for the following species;

- *M. raphiophylla* – mean 0.006 to -2.14m, absolute 1.03 to -4.49m; duration of inundation - mean 2.15, absolute 9.4.
- *E. rudis* – mean -0.7 to -3.26m, absolute 1.03 to -6.44m; duration of inundation - mean 1.55, absolute 12.
- *B. littoralis* – mean -0.39 to -1.92m, absolute 0.43 to -3.09m; duration of inundation - mean 0.3, absolute 2.8.
- *B. articulata* – mean 0.28 to -1.22m, absolute 0.81 to -2.59m; duration of inundation - mean 3.26, absolute 12.

Further to this, as the wetland vegetation is in excellent condition, the current water regime may be adequate to maintain vegetation values. Current EWRs are therefore likely to be appropriate.

- Waterbirds.

Loch McNess supports a number of waterbird and wader species known to be highly groundwater dependent. These species generally require permanent surface water with some fluctuation to provide seasonal variation in depth and shoreline. However, as there is little seasonal variation in water depth at Loch McNess, surface water permanence is likely to be of greater importance than shoreline areas to species found at this wetland. Therefore maintenance of the current (2003) water regime should be sufficient to maintain waterbird values at Loch McNess. Current EWRs are therefore likely to be appropriate.

- Macroinvertebrates.

Due to the importance of vegetation assemblages as habitat, vegetation EWRs can be considered a surrogate for macroinvertebrate EWRs. Submergent species, emergent species and littoral vegetation are likely to be important for habitat at Loch McNess. As discussed under vegetation, there is no vegetation at Loch McNess and it is therefore not possible to describe a maximum water level. However, as the vegetation surrounding the basin is in excellent condition, the current (2003) water regime may be adequate to maintain vegetation and therefore macroinvertebrate values. Current EWRs are therefore likely to be appropriate.

- Vertebrates.

Loch McNess supports fish and frog species and Rakali (water rat). All species require permanent water with seasonal fluctuations also important for frogs and Rakali. As there is little seasonal variation in water depth at Loch McNess, surface water permanence is likely to be most important to species found at this wetland. Therefore maintenance of the current (2003) water regime should be sufficient to maintain vertebrate species values at Loch McNess. Current EWRs are therefore likely to be appropriate.

- Sediment processes.

To maintain sediment processes and prevent related changes in water quality, sediments at Loch McNess must remain saturated throughout the summer each year. Therefore maintenance of the current (2003) water regime should be sufficient to maintain sediment processes at Loch McNess. Current EWRs are therefore likely to be appropriate.

Lake Yonderup

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values:

- Largely undisturbed wetland.
- High macroinvertebrate species richness.
- Excellent water quality.
- Vegetation provides range of habitat types.

2. Groundwater dependency analysis.

Although Lake Yonderup receives rainfall inputs and has a permanent surface water component, Clifton and Evans (2001) described permanent wetlands of the Swan Coastal Plain as entirely dependent on groundwater. It is therefore highly likely that the wetland is entirely groundwater dependent for biophysical processes, habitat and consumptive use.

3. Revised EWRs.

a) Superceded EWRs (mAHD).

Summer absolute minimum -5.9.

b) Water requirements for ecological components of GDE.

- Vegetation.

Although there is a vegetation monitoring transect at Lake Yonderup it is located 750m south of the staff gauge and is not influenced by surface water. The minimum water requirements of wetland vegetation at this site are therefore unlikely to be representative of the requirements of vegetation in closer proximity to the wetland basin. However, as the wetland vegetation surrounding the basin is in excellent condition, the current (2003) water regime may be adequate to maintain vegetation values. Current EWRs are therefore likely to be appropriate.

- Macroinvertebrates.

Lake Yonderup supports high macroinvertebrate species richness. Due to the importance of vegetation assemblages as habitat, vegetation EWRs can be considered a surrogate for macroinvertebrate EWRs. Emergent species and littoral vegetation are likely to be of greatest importance for habitat at Lake Yonderup. As discussed under vegetation, there is no vegetation transect near the wetland basin and it

is therefore not possible to describe a maximum water level. However, as the vegetation surrounding the basin is in excellent condition, the current (2003) water regime may be adequate to maintain vegetation and therefore macroinvertebrate values. Current EWRs are therefore likely to be appropriate.

- Vertebrates.

Although there are no ecological values described specifically for vertebrates at Lake Yonderup, it is highly likely that the wetlands supports a similar suite of species to that found at Loch McNess, as the wetlands are in close proximity and of similar geomorphology. Vegetation is noted as providing important habitat, the current (2003) water regime may therefore be adequate to maintain vegetation and therefore vertebrate values. Current EWRs are therefore likely to be appropriate.

- Sediment processes.

To maintain sediment processes and prevent related changes in water quality, sediments at Loch McNess must remain saturated throughout the summer each year. The current (2003) water regime may therefore be adequate to maintain sediment processes. Current EWRs are therefore likely to be appropriate.

Lake Wilgarup

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Rich and unusual vegetation – dense stands of monospecific sedges.

2. Groundwater dependency analysis.

Although Lake Wilgarup receives rainfall inputs, the demise of much of the wetland vegetation in response to groundwater decline indicates that the wetland is entirely dependent on groundwater (Evan & Clifton, 2001) for biophysical processes and consumptive use.

3. Revised EWRs.

a) Superseded EWRs (mAHD).

Preferred minimum peak - 6.1

Absolute minimum peak -5.65

b) Water requirements for ecological components of GDE.

- Vegetation.

The mean water depth ranges of wetland species found across the monitoring transect at Lake Wilgarup are presented in Table 4. Application of the approach to determine the minimum water requirement of wetland species (as described on p.62), indicates that *B. articulata* requires the highest minimum groundwater level at 4.81 mAHD, followed by *B. juncea* at 3.90 mAHD and *M. raphiophylla* at 3.89 mAHD. Therefore to meet the minimum groundwater requirements of all wetland vegetation on the monitoring transect at Lake Wilgarup an autumn minimum of 4.81 mAHD is required. As the bore is situated on the monitoring transect it is representative of the required groundwater levels.

- Sediment processes.

To maintain sediment processes and reduce the likelihood of fire, sediments at Lake Wilgarup must remain saturated throughout the summer each year. The watertable must therefore not drop below the stratigraphic level/layer capable of providing water to surface organics through capillary rise during summer. It is likely that this level is 0.5 m below the ground surface or 5.5 mAHD near the monitoring bore.

Pipidinny Swamp

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Waterbird habitat.
- Supports unique macroinvertebrates.
- Vegetation provides range of habitat types.

2. Groundwater dependency analysis.

Although Pipidinny Swamp receives rainfall inputs and has a permanent surface water component, Clifton and Evans (2001) described permanent wetlands of the Swan Coastal Plain as entirely dependent on groundwater. It is therefore highly likely that the wetland is entirely groundwater dependent for biophysical processes, habitat and consumptive use.

3. Revised EWRs.

a) Superceded EWRs (mAHD).

Preferred minimum peak - 2.7

Absolute minimum peak - 2.4

Summer absolute minimum - 1.6

b) Water requirements for ecological components of GDE.

• Vegetation.

The mean water depth ranges of wetland species found across transects during a one-off assessment at Pipidinny Swamp are presented in Table 4. Application of the approach to determine the minimum water requirement of wetland species (as described on p.62), indicates that *B. articulata* requires the highest minimum groundwater level at 1.38 mAHD, followed by *T. orientalis* at 0.94 mAHD and *M. rhapsiophylla* at 0.65 mAHD. Therefore to meet the minimum groundwater requirements of all wetland vegetation on transects at Pipidinny Swamp an autumn minimum of 1.38 mAHD is required. Current EWRs are therefore likely to be appropriate.

• Waterbirds.

Pipidinny Swamp supports a number of waterbird species known to be highly groundwater dependent. These species require extensive flooding of the wetland in winter/spring. Elevations measured at three of the ponds at Pipidinny Swamp suggest a surface water level of 3.0 mAHD may be required for 2 months of the year in at least 4 out of 6 years to meet the requirements of waterbird species.

• Macroinvertebrates.

Pipidinny Swamp supports unique macroinvertebrates. Due to the importance of vegetation assemblages as habitat, vegetation EWRs can be considered a surrogate for macroinvertebrate EWRs. Emergent species and littoral vegetation are likely to be of greatest importance for habitat at Pipidinny Swamp. To inundate some areas of these vegetation assemblages for 2 months a year, a maximum water level of 3.0 mAHD is required.

• Vertebrates.

Although there are no ecological values described specifically for vertebrates at Pipidinny Swamp, the wetland supports long-necked turtles, which are highly dependent and require near-permanent surface water. A winter/spring maximum of 3.0 mAHD should be adequate to ensure surface water is retained through the summer months.

Lake Nowergup

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Permanent deep-water wetland acting as a drought refuge for waterbirds.
- Supports fish and other vertebrate species.
- Regionally significant for macroinvertebrate species and family richness.
- Areas of sedgeland on eastern shore minimise impact of nutrient enrichment on aquatic fauna.
- Fringing vegetation provides range of habitat types.

2. Groundwater dependency analysis.

Although Lake Nowergup has been artificial maintained since 1989, receives rainfall inputs and has a permanent surface water component, Clifton and Evans (2001) described permanent wetlands of the Swan Coastal Plain as entirely dependent on groundwater. Sudden health declines and deaths of fringing wetland trees (*M. raphiophylla* and *E. rudis*) on the western side of the lake between February and May 2002 coinciding with rapid declines in groundwater levels provides further evidence of total groundwater dependence. Processes of uses for which groundwater is required include consumptive use, habitat and biophysical processes.

3. Revised EWRs.

a) Superseded EWRs (mAHD).

Preferred minimum peak - 17

Absolute minimum peak - 16.8

b) Water requirements for ecological components of GDE.

• Vegetation.

The mean water depth ranges of wetland species found across the monitoring transects at Lake Nowergup are presented in Table 4. Application of the approach to determine the minimum water requirements of wetland species (as described on p.62), indicates that *B. articulata* requires the highest minimum groundwater level at 15.22 mAHD, followed by *M. raphiophylla* at 14.66 mAHD, *E. rudis* at 14.64 mAHD and *T. orientalis* at 14.44 mAHD. Therefore to meet the minimum groundwater requirements of all wetland vegetation on the monitoring transects at Lake Nowergup an autumn minimum of 15.22 mAHD is required. It must be noted that this is a groundwater level and is applicable only to LN2/89 as this bore is in close proximity to the transects. Due to disparities between surface and groundwater levels, the equivalent surface water level at the staff gauge is 16.35 mAHD.

• Waterbirds.

Lake Nowergup supports a number of waterbird and wader species known to be highly groundwater dependent. These species generally require permanent surface water with some fluctuation to provide seasonal variation in depth and shoreline. Winter/spring inundation of fringing vegetation is also important. To inundate an area of *B. articulata* at the southern end of the wetland a surface water level of 16.853 mAHD is required for 2 months of the year in at least 4 out of 6 years. However, to inundate emergent species on the western shore a maximum surface water level of 17.0 mAHD is required. Therefore maintenance of the current (2003) water regime should be sufficient to maintain waterbird values at Lake Nowergup. Current EWRs are therefore likely to be appropriate.

• Macroinvertebrates.

Lake Nowergup supports significant macroinvertebrate assemblages. Requirements are to ensure the maintenance of permanent water in wetland as interannual and seasonal refuge. In order to maintain habitat diversity, spring peak water levels must inundate littoral sedges and fringing vegetation each year. To inundate an area of *B. articulata* at the southern end of the wetland a surface water level of 16.853 mAHD is required for 2 months of the year in at least 4 out of 6 years.

• Vertebrates.

Although long-necked tortoises survive in wetlands that dry for up to 6 months of the year, they are highly dependent and prefer permanent or near permanent surface water. Rakali and fish and frog a species found in Lake Nowergup however, require permanent water. Therefore maintenance of the current (2003) water regime should be sufficient to maintain vertebrate values at Lake Nowergup. Current EWRs are therefore likely to be appropriate.

• Sediment processes.

Organic lacustrine ooze in deeper parts of the lake must be prevented from exposure to drying until more is known about the effects of such drying on ecosystem processes. Recommendations have been made for the mapping of sediments within Lake Nowergup in order to characterise the sediments and their drying potential, and subsequently develop a fire management strategy (Benier & Horwitz, 2003). Water requirements will depend on fire management strategy adopted.

Severe drying and subsequent rewetting will result in acidification of surface and subsurface waters (according to the classification of Lake Nowergup as being at high risk of AASS and PASS within 3 metres of the surface; (Western Australian Planning Commission, 2003)). To prevent acidic surface waters and to prevent an acidic groundwater plume, sediment containing AASS and PASS must remain permanently saturated, until evidence is presented that such consequences will not eventuate.

To protect organic soils at Lake Nowergup, summer/autumn minimum groundwater levels must not drop below 16.353 mAHD (0.5 m below ground surface at the surveyed site).

Lake Joondalup

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Waterbird habitat.
- Diverse range of macrophytes.
- Supports aquatic vertebrates and macroinvertebrates.
- Largely intact fringing vegetation provides range of habitat types.

2. Groundwater dependency analysis.

Although Lake Joondalup receives rainfall and stormwater inputs and has a permanent surface water component, Clifton and Evans (2001) described permanent wetlands of the Swan Coastal Plain as entirely dependent on groundwater. It is therefore highly likely that the wetland is entirely groundwater dependent for biophysical processes, habitat and consumptive use.

3. Revised EWRs.

a) Superseded EWRs (mAHD).

Summer preferred minimum - 16.2

Summer absolute minimum - 15.8

b) Water requirements for ecological components of GDE.

• Vegetation.

The mean water depth ranges of wetland species found across the monitoring transects at Lake Joondalup are presented in Table 4. Application of the approach to determine the minimum water requirement of wetland species (as described on p.62), indicates that *B. articulata* requires the highest minimum groundwater level at 15.88 mAHD, followed by *M. raphiophylla* at 15.86 mAHD, *B. juncea* at 14.75 mAHD and *E. rudis* at 14.74 mAHD. Therefore to meet the minimum groundwater requirements of all wetland vegetation on the monitoring transects at Lake Joondalup an autumn minimum of 15.88 mAHD is required. It must be noted that this is a groundwater level however, the vegetation transect is approximately 2000m NE of bore 8281. As groundwater levels are known to be 2m higher at this bore than surface water levels, it is unlikely that groundwater levels at 8281 will reflect those required by the vegetation in question.

• Waterbirds.

Lake Joondalup supports a number of waterbird and wader species known to be highly groundwater dependent. These species generally require permanent surface water with some fluctuation to provide seasonal variation in depth and shoreline. Surface water current persists in areas along the western shore through summer. Winter/spring inundation of fringing vegetation is also important. To inundate vegetation on the monitoring transects (east, south and north) a water level of 17.0 mAHD is required for 2 months a year in at least 4 out of 6 years.

• Macroinvertebrates.

Lake Joondalup supports macroinvertebrate assemblages. Requirements are to ensure the maintenance of permanent water in the wetland as interannual and seasonal refuge. In order to maintain habitat diversity, spring peak water levels must inundate littoral sedges and fringing vegetation each year. To

inundate areas of vegetation on the monitoring transects (east, south and north) a water level of 17.0 mAHD is required for 2 months a year in at least 4 out of 6 years.

- **Vertebrates.**

Although long-necked tortoises survive in wetlands that dry for up to 6 months of the year, they are highly dependent prefer permanent or near permanent surface water. Rakali and fish and frog species found in Lake Joondalup although also highly groundwater dependent, require permanent water. Therefore maintenance of the current (2003) water regime should be sufficient to maintain vertebrate values at Lake Joondalup. Current EWRs are therefore likely to be appropriate.

- **Sediment processes.**

To maintain sediment processes sediments must remain saturated throughout the summer each year. The water table must therefore not drop below the stratigraphic level/layer capable of providing water to surface organics through capillary rise during summer. To protect organic soils at Lake Joondalup, summer/autumn minimum groundwater levels must not drop more than 0.5 m below ground surface. Organic sediments extend to an elevation of approximately 17.0 mAHD. Therefore to maintain sediment processes across the wetland a minimum of 16.5 mAHD is required.

Lake Goollelal

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Permanent water providing waterbird habitat and drought refuge.
- Supports good populations of native fish species.
- Fringing vegetation provides a range of habitat types.

2. Groundwater dependency analysis.

Although Lake Goollelal receives rainfall inputs and has a permanent surface water component, Clifton and Evans (2001) described permanent wetlands of the Swan Coastal Plain as entirely dependent on groundwater. This is further demonstrated by a high degree of correlation between surface and groundwater levels at Lake Goollelal (Rockwater Pty Ltd., 2003). It is therefore highly likely that the wetland is entirely groundwater dependent for biophysical processes, habitat and consumptive use.

3. Revised EWRs.

a) Superseded EWRs (mAHD).

Summer preferred minimum - 26.2

Summer absolute minimum - 26

b) Water requirements for ecological components of GDE.

- **Vegetation.**

The mean water depth ranges of wetland species found across the monitoring transect at Lake Goollelal are presented in Table 4. Application of the approach to determine the minimum water requirement of wetland species (as described on p.62), indicates that *B. articulata* requires the highest minimum groundwater level at 25.38 mAHD, followed by *M. raphiophylla* at 24.46 mAHD and *E. rudis* at 23.39 mAHD. Therefore to meet the minimum groundwater requirements of all wetland vegetation on the monitoring transect at Lake Goollelal an autumn minimum of 25.38 mAHD is required. Although this represents a substantial decrease from the existing summer minimums, Lake Goollelal has experienced increasing water levels since the 1970's.

- **Waterbirds.**

Lake Goollelal supports a number of waterbird and wader species known to be highly groundwater dependent. These species generally require permanent surface water with some fluctuation to provide seasonal variation in depth and shoreline. Surface water current persists throughout the year. Winter/spring inundation of fringing vegetation is also important. To inundate vegetation on the monitoring transect (west) a water level of 27.1 mAHD is required for 2 months a year in at least 4 out

of 6 years. Under the current (2003) water regime this level is exceeded each year however, the extent of shoreline exposed during summer has declined with increased water levels, thereby reducing the area available for use by wader species.

- Vertebrates.

Rakali and fish and frog species found in Lake Goollelal are highly groundwater dependent and require permanent water. Therefore maintenance of the current (2003) water regime should be sufficient to maintain vertebrate values at Lake Goollelal. Current EWRs are therefore likely to be appropriate.

- Sediment processes.

To maintain sediment processes sediments must remain saturated throughout the summer each year. The water table must therefore not drop below the stratigraphic level/layer capable of providing water to surface organics through capillary rise during summer. To protect organic soils at Lake Goollelal, summer/autumn minimum groundwater levels must not drop more than 0.5 m below ground surface. As the wetland is inundated throughout the year, the current (2003) water regime is adequate to maintain sediment processes.

Lake Jandabup

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Supports diverse sedge and macrophyte vegetation.
- Supports a wide range of waterbirds, especially waders.
- Supports diverse range of macroinvertebrate species.
- Improving water quality following 1997 acidification event.

2. Groundwater dependency analysis.

Although Lake Jandabup has been artificially maintained episodically since 1989, receives rainfall inputs and has a permanent surface water component, Clifton and Evans (2001) described permanent wetlands of the Swan Coastal Plain as entirely dependent on groundwater. Further evidence is provided though the fact that augmentation of surface water levels is required at the time of groundwater level decline (Rockwater Pty Ltd., 2003). It is therefore highly likely that the wetland is entirely groundwater dependent for biophysical processes, habitat and consumptive use.

3. Revised EWRs.

a) Superseded EWRs (mAHD).

Summer absolute minimum - 44.2

b) Water requirements for ecological components of GDE.

- Vegetation.

The mean water depth ranges of wetland species found across the monitoring transect at Lake Jandabup are presented in Table 4. Application of the approach to determine the minimum water requirement of wetland species (as described on p.62), indicates that *A. fascicularis* requires the highest minimum groundwater level at 43.54 mAHD, followed by *M. preissiana* at 43.48 mAHD, *B. articulata* at 42.84 mAHD and *H. angustifolium* at 42.57 mAHD. Therefore to meet the minimum groundwater requirements of all wetland vegetation on the monitoring transect at Lake Jandabup an autumn minimum of 43.54 mAHD is required. It must be noted that this is a groundwater level however, there is no groundwater monitoring bore in proximity of the monitoring transect.

- Waterbirds.

Lake Jandabup supports a number of waterbird and wader species known to be highly groundwater dependent. Flooded emergent species in winter/spring are known to be important for waterbird breeding. To inundate a substantial area of sedges/rushes a peak surface water level of 15.0 mAHD is required. This level should also be adequate to prevent the spread of vegetation into the basin and thereby maintain shallows for use by waders in summer/autumn. The current (2003) water regime appears adequate to maintain waterbird values.

- Macroinvertebrates.

Lake Jandabup supports a diverse range of macroinvertebrate species. Requirements are to ensure the maintenance of permanent water in the wetland as interannual and seasonal refuge. In order to maintain habitat diversity, spring peak water levels must inundate littoral sedges and fringing vegetation each year. To inundate areas of vegetation near the monitoring transect a water level of 15.0 mAHD is required for 2 months a year in at least 4 out of 6 years.

- Sediment processes.

To maintain sediment processes sediments must remain saturated throughout the summer each year. The water table must therefore not drop below the stratigraphic level/layer capable of providing water to surface organics through capillary rise during summer. To address PASS anaerobic sediments need to remain saturated through late summer and early autumn. The current absolute summer minimum of 44.3 mAHD was established to address sediment issues and it remains an appropriate level.

Lake Mariginiup

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Wading bird habitat.
- Supports rich aquatic macroinvertebrates.
- Maintain water quality.

2. Groundwater dependency analysis.

Water levels at Lake Mariginiup have declined in recent years with increasing differences between surface and groundwater levels suggesting perching of rainfall and surface water. However, trends in ground and surface water levels are well correlated indicating hydraulic connectivity (Rockwater Pty Ltd., 2003). Therefore it is likely that biophysical processes, habitat and consumptive use of Lake Mariginiup are highly groundwater dependent.

3. Revised EWRs.

a) Superseded EWRs (mAHD).

Preferred minimum peak - 42.1

Absolute minimum peak - 41.5

b) Water requirements for ecological components of GDE.

- Vegetation.

The mean water depth ranges of wetland species found across the monitoring transect at Lake Mariginiup are presented in Table 4. Application of the approach to determine the minimum water requirement of wetland species (as described on p.62), indicates that *T. orientalis* requires the highest minimum groundwater level at 40.55 mAHD, followed by *E. rudis* at 40.34 mAHD, *B. articulata* at 40.28 mAHD. Therefore to meet the minimum groundwater requirements of all wetland vegetation on the monitoring transect at Lake Mariginiup an autumn minimum of 40.55 mAHD is required. It must be noted that this is a groundwater level, which should be adequately reflected at bore MS10 as it is within close proximity (<100m) of the transect.

- Waterbirds/waders

Wader species found at Lake Mariginiup are thought to be highly groundwater dependent. These species require shallow water in summer and early autumn with high winter levels also required to prevent the spread of vegetation across the basin and reducing the area of open shallows. To inundate a substantial area of sedges/rushes a peak surface water level of 42.1 mAHD is required. This level should also be adequate to prevent the spread of vegetation into the basin and thereby maintain shallows for use by waders in summer/autumn.

- Macroinvertebrates.

Lake Mariginiup supports a diverse range of macroinvertebrate species. In order to maintain habitat diversity, spring peak water levels must inundate littoral sedges and fringing vegetation each year. To inundate a substantial area of sedges/rushes a peak surface water level of 42.1 mAHD is required.

- Sediment processes.

To maintain sediment processes sediments must remain saturated throughout the summer each year. The water table must therefore not drop below the stratigraphic level/layer capable of providing water to surface organics through capillary rise during summer (0.5 m below ground surface). To address PASS anaerobic sediments need to remain saturated through late summer and early autumn. As the staff gauge appears to dry at 41.3 mAHD and the basin of Lake Mariginiup is basically flat, a minimum groundwater level of 40.8 mAHD should be adequate to maintain sediment processes.

Lexia 86

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Supports diverse fringing and wetland vegetation.
- Supports significant invertebrate and vertebrate communities.

2. Groundwater dependency analysis.

Although Lexia 86 receives rainfall inputs, it is thought that surface water levels are an expression of the underlying groundwater (Rockwater Pty Ltd., 2003). Therefore it is likely to be entirely groundwater dependent for biophysical processes, habitat and consumptive use.

3. Revised EWRs.

a) Superceded EWRs (mAHD).

Summer preferred minimum - 47.3

Summer absolute minimum - 47

b) Water requirements for ecological components of GDE.

- Vegetation.

The mean water depth ranges of wetland species found across the monitoring transect at Lexia 86 are presented in Table 4. Application of the approach to determine the minimum water requirement of wetland species (as described on p.62), indicates that *B. articulata* requires the highest minimum groundwater level at 47.09 mAHD, followed by *B. littoralis* at 47.03 mAHD, *P. ellipticum* at 46.66 mAHD, *M. preissiana* at 46.53 mAHD, *A. fascicularis* at 46.07 mAHD and *H. angustifolium* at 45.49 mAHD. Therefore to meet the minimum groundwater requirements of all wetland vegetation on the monitoring transect at Lexia 86 an autumn minimum of 47.09 mAHD is required. It must be noted that this is a groundwater level, which is adequately reflected at bore GNM16 as it is within close proximity (<100m) of the transect.

- Macroinvertebrates.

Lexia 86 supports a significant macroinvertebrate community. Due to the importance of vegetation assemblages as habitat, vegetation EWRs can be considered a surrogate for macroinvertebrate EWRs. Emergent species and littoral vegetation are likely to be of greatest importance for habitat at Lexia 86. To inundate appropriate areas of vegetation for 2 months a year, a maximum water level of 48.5 mAHD is required.

- Vertebrates.

Three highly groundwater dependent frog species occur at Lexia 86. Recruitment of the Moaning Frog, occurred in spring 2003 but not during previous successive years. There were also breeding populations of the Squelching Frog and Guenther's Toadlet. The 2003 autumn peak may therefore be sufficient to induce breeding in these species. This suggests an autumn peak of 48.64 mAHD. Lexia 86 also supports the long-necked tortoise, which requires inundation for at least 6 months of the year. Attaining a peak level of 48.64 mAHD should allow surface water to persist for an adequate length of time.

- Sediment processes.

To maintain sediment processes sediments must remain saturated throughout the summer each year. The water table must therefore not drop below the stratigraphic level/layer capable of providing water to surface organics through capillary rise during summer (0.5 m below ground surface). To address PASS anaerobic sediments need to remain saturated through late summer and early autumn. As the staff gauge appears to dry at 48.31 mAHD and the wetland basin is small and basically flat, a minimum groundwater level of 47.8 mAHD should be adequate to maintain sediment processes and water quality.

Lexia 94

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Supports diverse wetland and fringing vegetation.
- Fringing vegetation provides a range of habitat types.

2. Groundwater dependency analysis.

Clifton and Evans (2001) described damplands of the Swan Coastal Plain as highly groundwater dependent for consumptive use and biophysical processes. Rainfall is also a significant water source and it is thought that there may be some perching at Lexia 94.

3. Revised EWRs.

a) Superseded EWRs (mAHD).

Summer preferred minimum - 45.8

Summer absolute minimum - 45.5

b) Water requirements for ecological components of GDE.

- Vegetation.

The mean water depth ranges of wetland species found across the monitoring transect at Lexia 94 are presented in Table 4. Application of the approach to determine the minimum water requirement of wetland species (as described on p.62), indicates that *P. ellipticum* requires the highest minimum groundwater level at 44.28 mAHD, followed by *A. fascicularis* at 44.24 mAHD, *M. preissiana* at 43.88 mAHD, and *H. angustifolium* at 43.05 mAHD. Therefore to meet the minimum groundwater requirements of all wetland vegetation on the monitoring transect at Lexia 94 an autumn minimum of 44.28 mAHD is required. It must be noted that this is a groundwater level, which should be adequately reflected at bore GNMI7A, 200m S/W of the transect.

- Vertebrates

Frogs occur at Lexia 94 however, as no surface water has been present for a number of years, breeding has not occurred. As the ground elevation at the bore is 47.28 mAHD, a peak level greater than this would be required for 4 months to allow frogs to breed.

Lexia 186

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Fringing and wetland vegetation provides a range of habitat types.

2. Groundwater dependency analysis.

Clifton and Evans (2001) described damplands of the Swan Coastal Plain as highly groundwater dependent for consumptive use and biophysical processes. Rainfall is also a significant water source.

3. Revised EWRs.

a) Superseded EWRs (mAHD).

Summer preferred minimum - 47.5

Summer absolute minimum - 47.2

b) Water requirements for ecological components of GDE.

• Vegetation.

The mean water depth ranges of wetland species found across the monitoring transect at Lexia 186 are presented in Table 4. Application of the approach to determine the minimum water requirement of wetland species (as described on p.62), indicates that *P. ellipticum* requires the highest minimum groundwater level at 47.71 mAHD, followed by *A. fascicularis* at 47.67 mAHD, *M. preissiana* at 47.31 mAHD and *H. angustifolium* at 46.57 mAHD. Therefore to meet the minimum groundwater requirements of all wetland vegetation on the monitoring transect at Lexia 186 an autumn minimum of 47.71 mAHD is required. It must be noted that this is a groundwater level, which is adequately reflected at bore GNM15 as it is within close proximity (<50m) of the transect.

• Vertebrates.

Lexia 186 supports frogs, which generally require approximately 4 months of inundation to breed. The excavated sump at the wetland contained surface water during the winter/autumn 2003. The 2003 peak groundwater level of 48.02 mAHD may therefore reflect an appropriate surface water level in the sump.

• Sediment processes.

To maintain sediment processes sediments must remain saturated throughout the summer each year. The water table must therefore not drop below the stratigraphic level/layer capable of providing water to surface organics through capillary rise during summer (0.5 m below ground surface). To address PASS anaerobic sediments need to remain saturated through late summer and early autumn. The lowest point of the wetland is approximately 48.3 mAHD, therefore a minimum groundwater level of 47.8 mAHD should be adequate to maintain sediment processes.

EPP Wetland 173

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Supports diverse wetland and stream vegetation.
- High vertebrate and macroinvertebrate species richness.
- Supports most northern population of Black-striped minnow (*Galaxiella nigrostriata*).
- Wetland, stream and fringing vegetation provides a range of habitat types.

2. Groundwater dependency analysis.

EPP173 is believed to be a perched wetland, with the water regime relying on rainfall inputs as well as flows from the adjacent springs (Rockwater Pty Ltd., 2003). However, it is still likely that EPP173 is highly groundwater dependent for consumptive use, habitat and biophysical processes.

3. Revised EWRs.

a) Superseded EWRs (mAHD).

Summer absolute minimum - 50.2

b) Water requirements for ecological components of GDE.

• Vegetation.

The mean water depth ranges of wetland species found across the monitoring transect at EPP173 are presented in Table 4. Application of the approach to determine the minimum water requirement of wetland species (as described on p.62), indicates that *P. ellipticum* requires the highest minimum groundwater level at 49.34 mAHD, followed by *B. articulata* at 48.98 mAHD, *A. fascicularis* at 48.79 mAHD, *M. preissiana* at 48.76 mAHD and *H. angustifolium* at 48.02 mAHD. Therefore to meet the minimum groundwater requirements of all wetland vegetation on the monitoring transect at EPP173 an autumn minimum of 49.34 mAHD is required. It must be noted that this is a groundwater level, which is adequately reflected at bore GNM14 as it is within close proximity (<100m) of the transect.

- Macroinvertebrates.

EPP 173 supports a significant macroinvertebrate community. Due to the importance of vegetation assemblages as habitat, vegetation EWRs can be considered a surrogate for macroinvertebrate EWRs. Emergent species and littoral vegetation are likely to be of greatest importance for habitat at EPP 173. To inundate appropriate areas of vegetation for 2 months a year, a maximum water level of 51.1 mAHD is required.

- Vertebrates.

EPP 173 supports high vertebrate species richness. Recruitment of the Moaning Frog occurred in spring 2003 but not during previous successive years. The Quacking Frog was also present at this time, suggesting it requires flooding of areas surrounding the lake including the creek and seepages. The 2003 spring peak may therefore be sufficient to induce breeding in these species. This suggests an spring peak of 51.1 mAHD.

Although there are no known specific water requirements for the Blackstripe Minnow the species can survive in a seasonal wetland, yet needs a high degree of soil moisture during summer to survive aestivation. As it resides in cool water it is important to maintain an adequate depth of water to allow stratification to develop and so provide a cooler layer. It is thought that the species may persist at a maximum surface water level of 50.95 mAHD and minimum groundwater level of 49.41 mAHD however, further research is required to substantiate these levels.

- Sediment processes.

To maintain sediment processes sediments must remain saturated throughout the summer each year. The water table must therefore not drop below the stratigraphic level/layer capable of providing water to surface organics through capillary rise during summer (0.5 m below ground surface). To address PASS anaerobic sediments need to remain saturated through late summer and early autumn. As the staff gauge appears is dry at 50.4 mAHD and the basin of the wetland is small and basically flat, a minimum groundwater level of 49.9 mAHD should be adequate to maintain sediment processes. However, as the wetland may be perched ground and surface water levels are disparate the current minimum surface water level of 50.2 mAHD should be retained.

Dampland 78

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Supports wetland vegetation.

2. Groundwater dependency analysis.

Clifton and Evans (2001) described damplands of the Swan Coastal Plain as highly groundwater dependent for consumptive use and biophysical processes. Rainfall is also a significant water source.

3. Revised EWRs.

- a) Superseded EWRs (mAHD).

Summer preferred minimum - 65.4

Summer absolute minimum - 65.1

b) Water requirements for ecological components of GDE.

- Vegetation.

The mean water depth ranges of wetland species found across the monitoring transect at Dampland 78 are presented in Table 4. Application of the approach to determine the minimum water requirement of wetland species (as described on p.62), indicates that *A. fascicularis* requires the highest minimum groundwater level at 65.44 mAHD, followed by *M. preissiana* at 61.97 mAHD. Therefore to meet the minimum groundwater requirements of all wetland vegetation on the monitoring transect at Dampland 78 an autumn minimum of 65.44 mAHD is required. It must be noted that this is a groundwater level, which may not be adequately reflected at bore GNM31 which is located 50m upslope of the transect.

- Vertebrates

Frogs have been recorded at Dampland 78 but appear unable to breed. As the lowest point of the wetland is approximately 67.0 mAHD water levels are required to exceed this level. However, as the monitoring bore is removed from the basin, it is not possible to determine an appropriate level for the basin.

Lake Gwelup*

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Supports waterbird species and other dependent vertebrates.

2. Groundwater dependency analysis.

Although Lake Gwelup receives rainfall and stormwater inputs and no longer has a permanent surface water component, it has in the past been a permanent wetland. Clifton and Evans (2001) described permanent wetlands of the Swan Coastal Plain as entirely dependent on groundwater. It is therefore highly likely that the wetland is entirely groundwater dependent for biophysical processes, habitat and consumptive use.

3. Revised EWRs.

a) No current EWR.

b) Water requirements for ecological components of GDE.

- Vegetation.

As there is not a vegetation monitoring transect at Lake Gwelup, a minimum groundwater level cannot be determined following the methodology outlined above. However, comment can be made on the water depth ranges and period of inundation experienced by wetland species known to occur at the wetland.

Loomes (2000) described the 5 year mean and absolute water depth ranges (m) and duration of inundation (months/year) for the following species;

- *M. rhapsiphylla*: depth; mean 0.01 to -2.14 m, absolute 1.03 to -4.49 m, duration; mean 2.15 (months/year), absolute 9.4 (months/year).
- *E. rudis*: depth; mean -0.7 to -3.26 m, absolute 1.03 to -6.44 m, duration; mean 1.55 (months/year), absolute 12 (months/year).
- *T. orientalis*: depth; mean 0.74 to -0.95 m, absolute 1.49 to -1.9 m, duration; mean 7.7 (months/year), absolute 12 (months/year).

- Macroinvertebrates.

Due to the importance of vegetation assemblages as habitat, vegetation EWRs can be considered a surrogate for macroinvertebrate EWRs. Emergent species and littoral vegetation are likely to be of greatest importance for habitat at Lake Gwelup.

- Waterbirds

Lake Gwelup may support waterbird and wader species. These species require shallow water in summer and early autumn with high winter levels also required to prevent the spread of vegetation across the basin and reducing the area of open shallows. As the elevation of the staff gauge and ranges of fringing and emergent vegetation are not known, it is not possible to determine an EWR to meet waterbird requirements.

- Sediment processes.

To maintain sediment processes sediments must remain saturated throughout the summer each year. The water table must therefore not drop below the stratigraphic level/layer capable of providing water to surface organics through capillary rise during summer (0.5 m below ground surface).

Big Carine Swamp*

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Supports waterbirds and other dependent vertebrates.

2. Groundwater dependency analysis.

Although Big Carine Swamp receives rainfall inputs, the decline in condition of the wetland vegetation in response to groundwater decline indicates that the wetland is likely to be entirely dependent on groundwater (Evan & Clifton, 2001) for biophysical processes and consumptive use.

3. Revised EWRs.

- a) No current EWR.
- b) Water requirements for ecological components of GDE.

- Vegetation.

As there is not a vegetation monitoring transect at Big Carine Swamp, a minimum groundwater level cannot be determined following the methodology outlined above. However, comment can be made on the water depth ranges and period of inundation experienced by wetland species known to occur at the wetland.

Loomes (2000) described the 5 year mean and absolute water depth ranges (m) and duration of inundation (months/year) for the following species;

- *M. raphiophylla*: depth; mean 0.01 to -2.14 m, absolute 1.03 to -4.49 m, duration; mean 2.15 (months/year), absolute 9.4 (months/year).
- *E. rudis*: depth; mean -0.7 to -3.26 m, absolute 1.03 to -6.44 m, duration; mean 1.55 (months/year), absolute 12 (months/year).
- *T. orientalis*: depth; mean 0.74 to -0.95 m, absolute 1.49 to -1.9 m, duration; mean 7.7 (months/year), absolute 12 (months/year).

- Macroinvertebrates.

Due to the importance of vegetation assemblages as habitat, vegetation EWRs can be considered a surrogate for macroinvertebrate EWRs. Emergent species and littoral vegetation are likely to be of greatest importance for habitat at Big Carine Swamp.

- Waterbirds

Big Carine Swamp may support waterbird and wader species. These species require shallow water in summer and early autumn with high winter levels also required to prevent the spread of vegetation across the basin and reducing the area of open shallows. As the elevation of the staff gauge and ranges of fringing and emergent vegetation are not known, it is not possible to determine an EWR to meet waterbird requirements.

- Sediment processes.

To maintain sediment processes sediments must remain saturated throughout the summer each year. The water table must therefore not drop below the stratigraphic level/layer capable of providing water to surface organics through capillary rise during summer (0.5 m below ground surface).

Lake Muckenburra*

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Supports waterbird species and other dependent vertebrates.
- Supports TEC (SCP07).

2. Groundwater dependency analysis.

The TEC is a species rich vegetation community that occurs on heavy clay soils and is generally inundated from winter to mid-spring. As the wetland is likely to fill following ponding of rainfall and groundwater level rise and vegetation most likely accesses soil water held in the clay during summer, Lake Muckenburra should be considered to be proportionally groundwater dependent.

3. Revised EWRs.

- a) No current EWR. May require installation of staff gauge.
- b) Water requirements for ecological components of GDE.
 - Vegetation.

As there is not a vegetation monitoring transect at Lake Muckenburra and the wetland had not been assessed at the time of writing, no comment can be made on water requirements of wetland species other than the requirement for flooding in winter/spring.

- Macroinvertebrates.

Due to the importance of vegetation assemblages as habitat, vegetation EWRs can be considered a surrogate for macroinvertebrate EWRs. Emergent species and littoral vegetation are likely to be of greatest importance for habitat at Lake Muckenburra.

- Waterbirds.

Lake Muckenburra supports waterbird and wader species. These species require shallow water in summer and early autumn with high winter levels also required to prevent the spread of vegetation across the basin and reducing the area of open shallows. As there is no staff gauge and ranges of fringing and emergent vegetation are not known, it is not possible to determine an EWR to meet waterbird requirements.

- Sediment processes.

To maintain sediment processes sediments must remain saturated throughout the summer each year. The water table must therefore not drop below the stratigraphic level/layer capable of providing water to surface organics through capillary rise during summer (0.5 m below ground surface).

Bambun Lake*

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Supports diverse fish species and other dependent vertebrates.
- Vegetation provides fauna habitat.
- Supports TEC (SCP07 and SCP15).

2. Groundwater dependency analysis.

Bambun Lake supports TEC SCP07, described above for Lake Muckenburra. TEC SCP15 also occurs at the site. This community is described as occurring on alluvial sediments that are inundated for long periods. As the wetland is likely to fill following ponding of rainfall and groundwater level rise and vegetation most likely accesses soil water held in the clay during summer, Bambun Lake should be considered to be proportionally groundwater dependent.

3. Revised EWRs.

- a) No current EWR. May require installation of staff gauge.
- b) Water requirements for ecological components of GDE.
 - Vegetation.

As there is not a vegetation monitoring transect at Bambun Lake, a minimum groundwater level cannot be determined following the methodology outlined above. However, the TECs require winter inundation for flooding in winter/spring.

Comment can also be made on the water depth ranges and period of inundation experienced by wetland species known to occur at the wetland. Loomes (2000) described the 5 year mean and absolute water depth ranges (m) and duration of inundation (months/year) for the following species:

- *M. raphiophylla*: depth; mean 0.01 to -2.14 m, absolute 1.03 to -4.49 m, duration; mean 2.15 (months/year), absolute 9.4 (months/year).
- *E. rudis*: depth; mean -0.7 to -3.26 m, absolute 1.03 to -6.44 m, duration; mean 1.55 (months/year), absolute 12 (months/year).
- *B. articulata*: depth; mean 0.28 to -1.22 m, absolute 0.81 to -2.59 m, duration; mean 3.26 (months/year), absolute 12 (months/year).

- Macroinvertebrates.

Due to the importance of vegetation assemblages as habitat, vegetation EWRs can be considered a surrogate for macroinvertebrate EWRs. Emergent species and littoral vegetation are likely to be of greatest importance for habitat at Bambun Lake.

- Vertebrates.

Permanent surface water is required to support fish species at Bambun Lake.

- Sediment processes.

To maintain sediment processes sediments must remain saturated throughout the summer each year. The water table must therefore not drop below the stratigraphic level/layer capable of providing water to surface organics through capillary rise during summer (0.5 m below ground surface).

Yeal Swamp, Lake Bindiar and Wetlands of Yeal Nature Reserve*

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- System of generally connected damplands situated within large area of high quality bushland within Yeal Nature Reserve.
- Vegetation provides fauna habitat.

2. Groundwater dependency analysis.

Clifton and Evans (2001) described SCP damplands and sumplands with *Melaleuca* and *Banksia* woodlands as proportionally groundwater dependent. Although the depth to groundwater underlying the Yeal wetlands is now >10m, vegetation established under a wetter regime and should still be considered groundwater dependent.

3. Revised EWRs.

- a) No current EWR. May require installation of monitoring bore in close proximity of wetlands.

b) Water requirements for ecological components of GDE.

• Vegetation.

Although a terrestrial vegetation transect was established at Yeal Swamp in 1987, a minimum groundwater level cannot be determined following the methodology outlined above. However, comment can be made on the water depth ranges and period of inundation experienced by wetland species known to occur at the wetland.

Loomes (2000) described the 5 year mean and absolute water depth ranges (m) and duration of inundation (months/year) for the following species;

- *M. preissiana* – mean 0.54 to -2.62m, absolute 1.03 to -5.04m; duration of inundation - mean 2.15, absolute 9.4.
- *B. littoralis* – mean -0.39 to -1.92m, absolute 0.43 to -3.09m; duration of inundation - mean 0.3, absolute 2.8.
- *E. rudis*: depth; mean -0.7 to -3.26 m, absolute 1.03 to -6.44 m, duration; mean 1.55 (months/year), absolute 12 (months/year).

• Vertebrates.

The relationship between groundwater, upland vegetation and terrestrial fauna may be important.

• Sediment processes.

To maintain sediment processes sediments must remain saturated throughout the summer each year. The water table must therefore not drop below the stratigraphic level/layer capable of providing water to surface organics through capillary rise during summer (0.5 m below ground surface).

Edgecombe Seepage

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Supports diverse fauna populations.

2. Groundwater dependency analysis.

Despite seasonal input from rainfall, Clifton and Evans (2001) described mound springs of the Swan Coastal Plain as entirely groundwater dependent for habitat, biophysical processes and consumptive use.

3. Revised EWRs.

a) Superceded EWRs (mAHD).

Summer absolute minimum - 14.35

b) Water requirements for ecological components of GDE.

• Vegetation.

As there is not a vegetation monitoring transect at Edgecombe Seepage, a minimum groundwater level cannot be determined following the methodology outlined above. However, comment can be made on the water depth ranges and period of inundation experienced by wetland species known to occur at the wetland. Loomes (2000) described the 5 year mean and absolute water depth ranges (m) and duration of inundation (months/year) for the following species;

- *M. raphiophylla*: depth; mean 0.01 to -2.14 m, absolute 1.03 to -4.49 m, duration; mean 2.15 (months/year), absolute 9.4 (months/year).
- *E. rudis*: depth; mean -0.7 to -3.26 m, absolute 1.03 to -6.44 m, duration; mean 1.55 (months/year), absolute 12 (months/year).
- *B. articulata*: depth; mean 0.28 to -1.22 m, absolute 0.81 to -2.59 m, duration; mean 3.26 (months/year), absolute 12 (months/year).

• Macroinvertebrates.

Macroinvertebrate assemblages at Edgecombe Seepage require permanently flowing surface water. Therefore sufficient hydrostatic head is required to ensure perennial flow from spring. The volume of flow is not known but it is likely to be a matter of several litres per second at a maximum.

- Sediment processes.

To maintain sediment processes sediments must remain saturated throughout the summer each year. The water table must therefore not drop below the stratigraphic level/layer capable of providing water to surface organics through capillary rise during summer (0.5 m below ground surface).

Egerton Spring

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Supports threatened ecological community (EGO1).
- Supports significant club moss and liverwort species.
- Supports pristine fringing vegetation.
- High conservation as invertebrate habitat.

2. Groundwater dependency analysis.

Despite seasonal input from rainfall, Clifton and Evans (2001) described mound springs of the Swan Coastal Plain as entirely groundwater dependent for habitat, biophysical processes and consumptive use.

3. Revised EWRs.

a) Superseded EWRs (mAHD).

Summer absolute minimum - 39.29

b) Water requirements for ecological components of GDE.

- Vegetation.

As there is not a vegetation monitoring transect at Egerton Springs, a minimum groundwater level cannot be determined following the methodology outlined above. However, comment can be made on the water depth ranges and period of inundation experienced by wetland species known to occur at the wetland.

Loomes (2000) described the 5 year mean and absolute water depth ranges (m) and duration of inundation (months/year) for the following species;

- *M. preissiana* – mean 0.54 to -2.62m, absolute 1.03 to -5.04m; duration of inundation - mean 2.15, absolute 9.4.
- *B. littoralis* – mean -0.39 to -1.92m, absolute 0.43 to -3.09m; duration of inundation - mean 0.3, absolute 2.8.
- *A. fascicularis* – mean -0.35 to -2.26m, absolute 1.03m to -4.6m; duration of inundation – mean 0.66, absolute 2.6.

It is also likely that the club mosses and liverwort species require permanently saturated soil.

- Macroinvertebrates.

Macroinvertebrate assemblages at Egerton Spring require permanently flowing surface water. Therefore sufficient hydrostatic head is required to ensure perennial flow from spring. The volume of flow is not known but it is likely to be a matter of several litres per second at a maximum.

- Sediment processes.

To maintain sediment processes sediments must remain saturated throughout the summer each year. The water table must therefore not drop below the stratigraphic level/layer capable of providing water to surface organics through capillary rise during summer (0.5 m below ground surface).

Kings Spring*

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Supports TEC (organic mound springs).

2. Groundwater dependency analysis.

Despite seasonal input from rainfall, Clifton and Evans (2001) described mound springs of the Swan Coastal Plain as entirely groundwater dependent for habitat, biophysical processes and consumptive use.

3. Revised EWRs.

- a) No current EWR. May require installation of staff gauge or bore in close proximity.
- b) Water requirements for ecological components of GDE.

- Vegetation.

As there is not a vegetation monitoring transect at Kings Spring, a minimum groundwater level cannot be determined following the methodology outlined above. However, comment can be made on the water depth ranges and period of inundation experienced by wetland species known to occur at the wetland.

Loomes (2000) described the 5 year mean and absolute water depth ranges (m) and duration of inundation (months/year) for the following species;

- *M. preissiana* – mean 0.54 to -2.62m, absolute 1.03 to -5.04m; duration of inundation - mean 2.15, absolute 9.4.
- *E. rudis*: depth; mean -0.7 to -3.26 m, absolute 1.03 to -6.44 m, duration; mean 1.55 (months/year), absolute 12 (months/year).

- Macroinvertebrates.

Macroinvertebrate assemblages of Kings Spring may require permanently flowing surface water. Therefore sufficient hydrostatic head is required to ensure perennial flow from spring. The volume of flow is not known but it is likely to be a matter of several litres per second at a maximum.

- Sediment processes.

To maintain sediment processes sediments must remain saturated throughout the summer each year. The water table must therefore not drop below the stratigraphic level/layer capable of providing water to surface organics through capillary rise during summer (0.5 m below ground surface).

Jandakot Mound

Thomsons Lake

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Important habitat for waterbirds (RAMSAR wetland).
- Lake margins support terrestrial bird and other vertebrate species.
- Large area of remnant vegetation associated with the wetland.

2. Groundwater dependency analysis.

Although Thomsons Lake receives rainfall inputs and has a permanent surface water component, Clifton and Evans (2001) described permanent wetlands of the Swan Coastal Plain as entirely dependent on groundwater. This is further demonstrated by a high degree of correlation between surface and groundwater levels (Rockwater Pty Ltd., 2003). It is therefore highly likely that the wetland is entirely groundwater dependent for biophysical processes, habitat and consumptive use.

3. Revised EWRs.

a) Superseded EWRs (mAHD).

Summer preferred minimum - 11.3

Summer absolute minimum - 10.8

b) Water requirements for ecological components of GDE.

• Vegetation.

The mean water depth ranges of wetland species found across the monitoring transects at Thomsons Lake are presented in Table 4. Application of the approach to determine the minimum water requirement of wetland species (as described on p.62), indicates that *B. articulata* requires the highest minimum groundwater level at 11.71 mAHD, followed by *T. orientalis* at 10.82 mAHD, *E. rudis* at 10.24 mAHD, and *B. juncea* at 9.2 mAHD. Therefore to meet the minimum groundwater requirements of all wetland vegetation on the monitoring transects at Thomsons Lake an autumn minimum of 11.71 mAHD is required. It must be noted that this is a groundwater level which appears to be inadequately reflected at bore TM14A (Rockwater Pty Ltd., 2003), located approximately 500m north of transects 2 and 3.

• Waterbirds.

Thomsons Lake is a RAMSAR wetland. Waterbird and wader species require shallow water in summer and early autumn with high winter levels also required to prevent the spread of vegetation across the basin and reducing the area of open water. To inundate a substantial area of *T. orientalis* and *B. articulata* a peak surface water level of 12.8 mAHD is required. This level should also be adequate to prevent the spread of *T. orientalis* into the basin and thereby maintain open water.

• Macroinvertebrates.

Thomsons Lake supports macroinvertebrates. Requirements are to ensure the maintenance of permanent water in wetland as interannual and seasonal refuge. In order to maintain habitat diversity, spring peak water levels must inundate littoral sedges and fringing vegetation each year. To inundate area of *B. articulata* and *T. orientalis* across the wetland a surface water level of 12.8 mAHD is required for 2 months of the year in at least 4 out of 6 years.

• Vertebrates.

Frogs and possibly long-necked tortoises occur at Thomsons Lake. Frogs require 4 months of inundation to breed with tortoises preferring periods of 9 months or more. A peak level of 12.6 mAHD should be adequate to retain surface water for a sufficient period.

• Sediment processes.

To maintain sediment processes sediments must remain saturated throughout the summer each year. The water table must therefore not drop below the stratigraphic level/layer capable of providing water to surface organics through capillary rise during summer (0.5 m below ground surface). To address

PASS anaerobic sediments need to remain saturated through late summer and early autumn. As the staff gauge dries at 11.8 mAHD and the wetland basin is relatively flat a minimum groundwater level of 11.3 should be adequate to maintain sediment processes and water quality not related to run-off inputs.

North Lake

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Supports freshwater sponge species.
- Supports extensive *M. raphiophylla* and *B. articulata* stands.
- Permanent wetland provides summer waterbird refuge (JAMBA/CAMBA species).

2. Groundwater dependency analysis.

Clifton and Evans (2001) described permanent wetlands of the Swan Coastal Plain as entirely groundwater dependent. However, North Lake appears to be perched during periods of low groundwater levels, suggesting it may be only highly dependent (Rockwater Pty Ltd., 2003). North Lake also receives inputs from rainfall however, the volume of surface water entering the lake has decreased in recent years as a result of the diversion of 2 stormwater drains. Uses of groundwater include habitat, biophysical processes and consumption.

3. Revised EWRs.

a) Superceded EWRs (mAHD).

Summer preferred minimum - 13.5

Summer absolute minimum - 12.7

b) Water requirements for ecological components of GDE.

• Vegetation.

The mean water depth ranges of wetland species found across the monitoring transects at North Lake are presented in Table 4. Application of the approach to determine the minimum water requirement of wetland species (as described on p.62), indicates that *B. littoralis* requires the highest minimum groundwater level at 12.68 mAHD, followed by *M. raphiophylla* at 12.06 mAHD, *A. fascicularis* at mAHD, *B. juncea* at 11.35 mAHD and *E. rudis* at 10.94 mAHD. Therefore to meet the minimum groundwater requirements of all wetland vegetation on the monitoring transects at North Lake an autumn minimum of 12.68 mAHD is required. It must be noted that this is a groundwater level, which may not be adequately reflected at the North Lake criteria bore (Rockwater Pty Ltd., 2003), approximately 300m west of transects 1 and 2.

• Waterbirds.

Waterbird species found at North Lake require high winter/spring peaks, retention of deep water in summer/autumn for deep-water species and inundation of fringing vegetation. A peak surface water level of 13.265 mAHD should be sufficient to inundate *Melaleuca* on both side of the wetland. This level should also be adequate to prevent the spread of sedges and exotics into the basin and thereby maintain open water. However, higher peaks up to 14.0 mAHD would be required to maintain deep water throughout summer.

• Macroinvertebrates

The requirements of the freshwater sponge species found at North Lake are unknown. However, it is likely that they require permanent water and a peak of 14.0 mAHD may be sufficient to maintain the population, providing other variables are suitable. This level should also maintain other macroinvertebrate species.

• Vertebrates.

Frogs and possibly long-necked tortoises occur at North Lake. Frogs require 4 months of inundation to breed with tortoises preferring periods of 9 months or more. A peak level of 13.6 mAHD should be adequate to retain surface water for a sufficient period.

- Sediment processes.

To maintain sediment processes sediments must remain saturated throughout the summer each year. The water table must therefore not drop below the stratigraphic level/layer capable of providing water to surface organics through capillary rise during summer (0.5 m below ground surface). To address PASS anaerobic sediments need to remain saturated through late summer and early autumn. To protect organic soils water levels should not drop below 12.765 mAHD.

Banganup Swamp

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Non-avian fauna habitat.
- High conservation value due to diversity and condition of littoral and fringing vegetation.

2. Groundwater dependency analysis.

Clifton and Evans (2001) described sumplands of the Swan Coastal Plain as highly groundwater dependent. However, Rockwater P/L (2003) noted a high correlation between surface and groundwater levels indicating inundation of Banganup Swamp is in direct response to groundwater rise. Banganup Swamp should therefore be regarded as entirely groundwater dependent for habitat, biophysical processes and consumption despite significant seasonal rainfall inputs.

3. Revised EWRs.

a) Superseded EWRs (mAHD).

Summer absolute minimum - 11.25

b) Water requirements for ecological components of GDE.

- Vegetation.

The mean water depth ranges of wetland species found across the monitoring transect at Banganup Swamp are presented in Table 4. Application of the approach to determine the minimum water requirement of wetland species (as described on p.62), indicates that *B. articulata* and *B. littoralis* require the highest minimum groundwater level at 11.48 mAHD, followed by *A. fascicularis* at 10.94 mAHD, *M. preissiana* at 10.58 mAHD, and *E. rudis* at 9.94 mAHD. Therefore to meet the minimum groundwater requirements of all wetland vegetation on the monitoring transect at Banganup Swamp an autumn minimum of 11.48 mAHD is required. It must be noted that this is a groundwater level, which appears to be adequately reflected at Banganup criteria bore LB14 (Rockwater Pty Ltd., 2003), approximately 100m west of the monitoring transect.

- Vertebrates.

Banganup Swamp supports Quenda, a significant mammal species associated with dense vegetation around wetlands. Therefore meeting the EWRs of the fringing vegetation, as described above, should maintain this species.

- Macroinvertebrates.

Banganup Swamp supports macroinvertebrates. In order to maintain habitat diversity, spring peak water levels must inundate littoral sedges and fringing vegetation each year. To inundate areas of *B. articulata* and fringing tree species around the wetland a surface water level of 13.2 mAHD is required for 2 months of the year in at least 4 out of 6 years.

- Sediment processes.

To maintain sediment processes sediments must remain saturated throughout the summer each year. The water table must therefore not drop below the stratigraphic level/layer capable of providing water to surface organics through capillary rise during summer (0.5 m below ground surface). To address PASS anaerobic sediments need to remain saturated through late summer and early autumn. As the staff gauge dries at approximately 12.7 mAHD and the wetland basin is small and relatively flat a minimum groundwater level of 12.2 mAHD should be adequate to maintain sediment processes and water quality not related to run-off inputs.

Bibra Lake

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Supports a diversity of habitats used by wading birds.
- Permanent wetland provides summer refuge for waterbirds.
- Wetland and fringing vegetation provides a range of habitat types.

2. Groundwater dependency analysis.

Clifton and Evans (2001) described permanent wetlands of the Swan Coastal Plain as entirely groundwater dependent. This is further supported by a high correlation between surface and groundwater levels indicating inundation of Bibra Lake is in direct response to groundwater rise (Rockwater Pty Ltd., 2003). Bibra Lake should therefore be regarded as entirely groundwater dependent for habitat, biophysical processes and consumption despite significant seasonal rainfall inputs.

3. Revised EWRs.

a) Superceded EWRs (mAHD).

Summer preferred minimum - 14.2

Summer absolute minimum - 13.6

b) Water requirements for ecological components of GDE.

• Vegetation.

The mean water depth ranges of wetland species found across the monitoring transect at Bibra Lake are presented in Table 4. Application of the approach to determine the minimum water requirement of wetland species (as described on p.62), indicates that *M. preissiana* requires the highest minimum groundwater level at 12.18 mAHD, followed by *E. rudis* at 11.64 mAHD. Therefore to meet the minimum groundwater requirements of all wetland vegetation on the monitoring transect at Bibra Lake an autumn minimum of 12.18 mAHD is required. It must be noted that this is a groundwater level, which may be adequately reflected at bore BM7C, approximately 200m west of the monitoring transect. However this bore has not been monitored since 1999 (Rockwater Pty Ltd., 2003).

• Waterbirds.

Waterbirds and waders require high winter/spring peaks, with the retention of deep water in summer/autumn important for deep-water species and shallows for waders. High winter levels are also required to prevent the spread of vegetation across the basin and reducing the area of open water. A peak level of 14.9 mAHD should be sufficient to inundate areas of vegetation, prevent encroachment into the basin and enable deep water to persist through summer.

• Macroinvertebrates.

Bibra Lake supports macroinvertebrates. In order to maintain habitat diversity, spring peak water levels must inundate littoral sedges and fringing vegetation each year. To inundate areas of fringing tree species around the wetland a surface water level of 14.9 mAHD is required for 2 months of the year in at least 4 out of 6 years.

• Vertebrates.

Bibra Lake supports Quenda, a significant mammal species associated with dense vegetation around wetlands. Therefore meeting the EWRs of the fringing vegetation, as described above, should maintain this species.

• Sediment processes.

To maintain sediment processes sediments must remain saturated throughout the summer each year. The water table must therefore not drop below the stratigraphic level/layer capable of providing water to surface organics through capillary rise during summer (0.5 m below ground surface). To address

PASS anaerobic sediments need to remain saturated through late summer and early autumn. The current absolute minimum of 13.6 mAHD (14.1 mAHD – 0.5 m) should be adequate to maintain sediment processes and water quality not related to run-off inputs.

Yangebup Lake

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Permanent wetland provides summer refuge for waterbirds.
- Supports high number of macroinvertebrate taxa.

2. Groundwater dependency analysis.

Clifton and Evans (2001) described permanent wetlands of the Swan Coastal Plain as entirely groundwater dependent. This is further supported by a high correlation between surface and groundwater levels at Yangebup Lake (Rockwater Pty Ltd., 2003). Although Yangebup Lake should be regarded as entirely groundwater dependent there is some input into the system from nearby disposal ponds and seasonal rainfall. Uses of groundwater at Yangebup Lake include biophysical processes, consumptive use and habitat.

3. Revised EWRs.

a) Superseded EWRs (mAHD).

Summer preferred minimum - 15.5

Summer absolute minimum - 13.8

b) Water requirements for ecological components of GDE.

- Vegetation.

As there is not a vegetation monitoring transect at Yangebup Lake, a minimum groundwater level cannot be determined following the methodology outlined above.

- Waterbirds.

Waterbirds require high winter/spring peaks with the retention of deep water in summer/autumn required for deep-water species. High winter levels are also required to prevent the spread of vegetation across the basin and reducing the area of open water. A peak level of 16.7 mAHD should be sufficient to inundate areas of vegetation, prevent encroachment into the basin and enable deep water to persist through summer.

- Macroinvertebrates.

Yangebup Lake supports macroinvertebrates. In order to maintain habitat diversity, spring peak water levels must inundate littoral sedges each year. To inundate areas of sedges around the wetland a surface water level of 16.2 mAHD is required for 2 months of the year in at least 4 out of 6 years.

- Sediment processes.

To maintain sediment processes sediments must remain saturated throughout the summer each year. The water table must therefore not drop below the stratigraphic level/layer capable of providing water to surface organics through capillary rise during summer (0.5 m below ground surface). To address PASS anaerobic sediments need to remain saturated through late summer and early autumn. A minimum of 14.5 mAHD (15.0 mAHD – 0.5 m) should be adequate to maintain sediment processes and water quality not related to run-off inputs.

Lake Kogolup

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Moderate potential for waterbird breeding.
- High vegetation diversity.
- South Kogolup supports high macroinvertebrate family richness.

2. Groundwater dependency analysis.

Clifton and Evans (2001) described sumplands of the Swan Coastal Plain as highly groundwater dependent. It is believed that Lake Kogolup may be partially perched however, it is not possible to comment on the degree of correlation between ground and surface water levels (Rockwater Pty Ltd., 2003). Groundwater is used for habitat, biophysical processes and consumptive uses.

3. Revised EWRs.

a) Superceded EWRs (mAHD).

Summer preferred minimum - 14

Summer absolute minimum - 13.1

b) Water requirements for ecological components of GDE.

• Vegetation.

The mean water depth ranges of wetland species found across the monitoring transects at Lake Kogolup are presented in Table 4. Application of the approach to determine the minimum water requirement of wetland species (as described on p.62), indicates that at Lake Kogolup North *B. juncea* requires the highest minimum groundwater level at 15.15 mAHD, followed by *M. preissiana* at 14.98 mAHD and *E. rudis* at 14.34 mAHD. Therefore to meet the minimum groundwater requirements of all wetland vegetation on the monitoring transects at Lake Kogolup North an autumn minimum of 15.15 mAHD is required. It must be noted that this is a groundwater level, which is not currently reflected at the Lake Kogolup criteria bore, approximately 1km south of North Kogolup transects 1 and 2.

At Lake Kogolup South *A. fascicularis* has the highest minimum groundwater level requirement of 13.14 mAHD, followed by *E. rudis* at 11.74 mAHD. Therefore to meet the minimum groundwater requirements of all wetland vegetation on the monitoring transect at Lake Kogolup South an autumn minimum of 13.14 mAHD is required.

• Waterbirds.

High winter/spring peaks and extensive shallows are required in spring for waterbirds. A peak level of 15.0 mAHD at Lake Kogolup South should be sufficient to inundate areas of vegetation, prevent encroachment into the basin and enable deep water to persist through summer.

• Macroinvertebrates.

South Kogolup Lake supports macroinvertebrates. In order to maintain habitat diversity, spring peak water levels must inundate littoral sedges and fringing vegetation each year. To inundate areas of sedges around the wetland a surface water level of 15.0 mAHD is required for 2 months of the year in at least 4 out of 6 years.

• Sediment processes.

To maintain sediment processes at Lake Kogolup South sediments must remain saturated throughout the summer each year. The water table must therefore not drop below the stratigraphic level/layer capable of providing water to surface organics through capillary rise during summer (0.5 m below ground surface). To address PASS anaerobic sediments need to remain saturated through late summer and early autumn. A minimum of 14.0 mAHD (14.5 mAHD – 0.5 m) at Lake Kogolup South should be adequate to maintain sediment processes and water quality not related to run-off inputs.

Shirley Balla Swamp

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values:

- Diverse array of vegetation, floristically and in terms of habitat for terrestrial fauna.
- Supports high number of macroinvertebrates.

2. Groundwater dependency analysis.

Clifton and Evans (2001) described sumplands of the Swan Coastal Plain as highly groundwater dependent. Although it is thought that a moderate correlation exists between surface water levels and groundwater levels, Shirley Balla Swamp may be partially perched and therefore influenced by rainfall and surface water (Rockwater Pty Ltd., 2003). Groundwater is used for habitat, biophysical processes and consumptive uses.

3. Revised EWRs.

a) Superseded EWRs (mAHD).

Summer absolute minimum – 25

b) Water requirements for ecological components of GDE.

• Vegetation.

The mean water depth ranges of wetland species found across the monitoring transects at Shirley Balla Swamp are presented in Table 4. Application of the approach to determine the minimum water requirement of wetland species (as described on p.62), indicates that *A. fascicularis* requires the highest minimum groundwater level of 23.84 mAHD, followed by *M. raphiophylla* at 23.66 mAHD, *M. preissiana* at 23.48 mAHD, *H. angustifolium* at 23.17 mAHD and *B. littoralis* at 23.1 mAHD. Therefore to meet the minimum groundwater requirements of all wetland vegetation on the monitoring transects at Shirley Balla Swamp an autumn minimum of 23.84 mAHD is required. It must be noted that this is a groundwater level, which may be adequately reflected at the Shirley Balla Swamp criteria bore, approximately 300m north of transect 1 and 100m east of transect 2.

• Waterbirds.

High winter/spring peaks and extensive shallows are required in spring for waterbirds. A peak surface water level of 25.227 mAHD, reached for 2 months of the year in at least 4 out of 6 years at Shirley Balla Swamp, should be sufficient to inundate an area of sedges in the northern area of the wetland and prevent encroachment into the basin.

• Macroinvertebrates.

Shirley Balla Swamp supports macroinvertebrates. In order to maintain habitat diversity, spring peak water levels must inundate littoral sedges and fringing vegetation each year. To inundate areas of sedges around the wetland a surface water level of 25.227 mAHD is required for 2 months of the year in at least 4 out of 6 years.

• Vertebrates.

To maintain habitat diversity for terrestrial fauna the requirements of wetland vegetation, as described above, should be met.

• Sediment processes.

To maintain sediment processes at Shirley Balla Swamp organic sediments must remain saturated throughout the summer each year. The water table must therefore not drop below the stratigraphic level/layer capable of providing water to surface organics through capillary rise during summer (0.5 m below ground surface). A minimum of 24.77 mAHD (25.27 mAHD – 0.5 m) at Shirley Balla should be adequate to maintain sediment processes and water quality not related to run-off inputs.

Twin Bartram Swamp

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Potential for waterbird breeding.
- Vegetation provides range of habitats.

2. Groundwater dependency analysis.

Clifton and Evans (2001) described sumplands of the Swan Coastal Plain as highly groundwater dependent. However, a high correlation between surface and groundwater levels indicates inundation of Twin Bartram Swamp is in direct response to groundwater rise (Rockwater Pty Ltd., 2003). Twin Bartram Swamp should therefore be regarded as entirely groundwater dependent for consumptive use, habitat and biophysical processes.

3. Revised EWRs.

a) Superceded EWRs (mAHD).

Summer preferred minimum - 22.8

Summer absolute minimum - 22.5

b) Water requirements for ecological components of GDE.

• Vegetation.

The mean water depth ranges of wetland species found across the monitoring transect at Twin Bartram Swamp are presented in Table 4. Application of the approach to determine the minimum water requirement of wetland species (as described on p.62), indicates that *B. littoralis* requires the highest minimum groundwater level at 22.68 mAHD, followed by *T. orientalis* at 22.35 mAHD and *M. rhapsiophylla* at 21.16 mAHD. Therefore to meet the minimum groundwater requirements of all wetland vegetation on the monitoring transect at Twin Bartram Swamp an autumn minimum of 22.68 mAHD is required. It must be noted that this is a groundwater level, which is adequately reflected at the Twin Bartram criteria bore within 10m of the monitoring transect.

• Waterbirds.

High winter/spring surface water levels are required for waterbirds to breed at Twin Bartram Swamp. A peak water level of 24.0 mAHD should be sufficient to inundate vegetation and allow breeding.

• Sediment processes.

To maintain sediment processes at Twin Bartram Swamp organic sediments must remain saturated throughout the summer each year. The water table must therefore not drop below the stratigraphic level/layer capable of providing water to surface organics through capillary rise during summer (0.5 m below ground surface). A minimum of 22.5 mAHD (23.0 mAHD – 0.5 m) at Twin Bartram Swamp should be adequate to maintain sediment processes and water quality not related to run-off inputs.

Beenyup Rd Swamp

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Supports *Melaleuca pauciflora* community.
- Significant due to wetland size, vegetation assemblages and status.
- Non-aquatic vertebrate habitat.

2. Groundwater dependency analysis.

Clifton and Evans (2001) described sumplands of the Swan Coastal Plain as highly groundwater dependent. This is further supported by a moderate correlation between surface and groundwater levels

(Rockwater Pty Ltd., 2003). Groundwater, surface water and rainfall are required for consumptive use, habitat and biophysical processes.

3. Revised EWRs.

a) Superseded EWRs (mAHD).

Summer preferred minimum - 24

Summer absolute minimum - 23.6

b) Water requirements for ecological components of GDE.

- Vegetation.

The mean water depth ranges of wetland species found across the monitoring transect at Beenyp Rd. Swamp are presented in Table 4. Application of the approach to determine the minimum water requirement of wetland species (as described on p.62), indicates that *M. rhapsiophylla* requires the highest minimum groundwater level at 24.0 mAHD, followed by *M. preissiana* at 22.38 mAHD. Therefore to meet the minimum groundwater requirements of all wetland vegetation on the monitoring transect at Beenyp Rd. Swamp an autumn minimum of 23.46 mAHD is required. It must be noted that this is a groundwater level, which may be adequately reflected at the Beenyp Swamp criteria bore, approximately 100m north of the monitoring transect.

In addition to a minimum water level requirement, a higher peak surface water level is required to inundate the basin, thereby reducing the dominance of exotic annuals and possibly rehabilitating *B. articulata*. A peak level of 25.0 mAHD may be sufficient to address these issues.

- Vertebrates.

The vegetation surrounding Beenyp Rd Swamp supports terrestrial vertebrates. The water requirements described above for wetland vegetation should also be sufficient to maintain terrestrial species.

- Sediment processes.

To maintain sediment processes at Beenyp Rd Swamp organic sediments must remain saturated throughout the summer each year. The water table must therefore not drop below the stratigraphic level/layer capable of providing water to surface organics through capillary rise during summer (0.5 m below ground surface). A minimum of 25.5 mAHD (25.0 mAHD – 0.5 m) at Shirley Balla Swamp should be adequate to maintain sediment processes and water quality not related to run-off inputs.

Forrestdale Lake

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Lake margins support terrestrial bird and other vertebrate species.
- Waterbird habitat (RAMSAR wetland).

2. Groundwater dependency analysis.

Clifton and Evans (2001) described sumplands of the Swan Coastal Plain as highly groundwater dependent. However, there is a poor correlation between ground and surface water levels at Lake Forrestdale and a suggestion has been made that the lake acts as a groundwater sink (Rockwater Pty Ltd., 2003). Groundwater, surface water and rainfall are required for consumptive use, habitat and biophysical processes.

3. Revised EWRs.

a) Superseded EWRs (mAHD).

Summer preferred minimum - 21.6

Summer absolute minimum - 21.1

b) Water requirements for ecological components of GDE.

• Vegetation.

As there is not a vegetation monitoring transect at Forrestdale Lake, a minimum groundwater level cannot be determined following the methodology outlined above. However, comment can be made on the water depth ranges and period of inundation experienced by wetland species known to occur at the wetland.

Loomes (2000) described the 5 year mean and absolute water depth ranges (m) and duration of inundation (months/year) for the following species;

- *M. raphiophylla* – mean 0.006 to -2.14m, absolute 1.03 to -4.49m; duration of inundation - mean 2.15, absolute 9.4.
- *E. rudis* – mean -0.7 to -3.26m, absolute 1.03 to -6.44m; duration of inundation - mean 1.55, absolute 12.
- *B. littoralis* – mean -0.39 to -1.92m, absolute 0.43 to -3.09m; duration of inundation - mean 0.3, absolute 2.8.

• Waterbirds.

Forrestdale Lake supports significant waterbird and wader species. High winter/spring peaks are important at this wetland to prevent the spread of vegetation across the basin and retain open shallows on which migratory waders depend in summer and autumn. A peak water level of 23.0 mAHD for 2 months a year in 4 out of 6 years should be sufficient to address these issues at Lake Forrestdale.

• Vertebrates.

Forrestdale Lake supports frog species and terrestrial vertebrate species and possibly long-necked tortoises. Frogs require 4 months of surface water for breeding and long-necked tortoises prefer up to 9 months of inundation. A peak water level of 22.5 mAHD should be sufficient to retain surface water for an adequate period at Lake Forrestdale.

• Sediment processes.

To maintain sediment processes at Lake Forrestdale organic sediments must remain saturated throughout the summer each year. The water table must therefore not drop below the stratigraphic level/layer capable of providing water to surface organics through capillary rise during summer (0.5 m below ground surface). A minimum of 22.0 mAHD (22.5 mAHD – 0.5 m) should be adequate to maintain sediment processes and water quality not related to run-off inputs.

Mather Reserve Swamp*

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Supports non-aquatic fauna.
- Supports waterbirds.

2. Groundwater dependency analysis.

Clifton and Evans (2001) described sumplands of the Swan Coastal Plain as highly groundwater dependent. Groundwater, surface water and rainfall are required for consumptive use, habitat and biophysical processes.

3. Revised EWRs.

- a) No current EWR.
- b) Water requirements for ecological components of GDE.

• Vegetation.

As there is not a vegetation monitoring transect at Mather Reserve and the wetland had not been assessed at the time of writing, no comment can be made on water requirements of wetland species.

- Waterbirds.

High winter/spring water levels are required to support waterbirds, which may require up to 6 months of surface water for breeding. A peak level of 26.0 mAHD may be sufficient for 2 months a year in 4 out of 6 years may be sufficient to meet these requirements.

- Vertebrates.

Bushland surrounding Mather Reserve Swamp supports Quenda, a significant mammal species associated with dense vegetation around wetlands. Therefore meeting the EWRs of the fringing vegetation, should maintain this species.

- Sediment processes.

To maintain sediment processes at Mather Reserve Swamp organic sediments must remain saturated throughout the summer each year. The water table must therefore not drop below the stratigraphic level/layer capable of providing water to surface organics through capillary rise during summer (0.5 m below ground surface). As the staff gauge appears to dry at 25.03 mAHD, a minimum level of 24.53 mAHD should be adequate to maintain sediment processes and water quality not related to run-off inputs.

Specacles North*

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Supports aquatic and non-aquatic vertebrates.
- Vegetation provides range of habitats.

2. Groundwater dependency analysis.

Clifton and Evans (2001) described sumplands of the Swan Coastal Plain as highly groundwater dependent. Groundwater, surface water and rainfall are required for consumptive use, habitat and biophysical processes.

3. Revised EWRs.

- a) No current EWR.
- b) Water requirements for ecological components of GDE.

- Vegetation.

As there is not a vegetation monitoring transect at Spectacles North and the wetland had not been assessed at the time of writing, no comment can be made on water requirements of wetland species.

- Waterbirds.

The Spectacles North supports waterbirds. Inundation of fringing *Melaleuca* is important for waterbird breeding. As the range of *Melaleuca* at this wetland is unknown, is not possible to determine a peak surface water level.

- Vertebrates.

Bushland surrounding the Spectacles North supports Quenda, a significant mammal species associated with dense vegetation around wetlands. Therefore meeting the EWRs of the fringing vegetation, should maintain this species.

- Sediment processes.

To maintain sediment processes at Spectacles North organic sediments must remain saturated throughout the summer each year. The water table must therefore not drop below the stratigraphic level/layer capable of providing water to surface organics through capillary rise during summer (0.5 m below ground surface).

Harrisdale Swamp*

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Supports non-aquatic vertebrates.

2. Groundwater dependency analysis.

Clifton and Evans (2001) described sumplands of the Swan Coastal Plain as highly groundwater dependent. Groundwater, surface water and rainfall are required for consumptive use, habitat and biophysical processes.

3. Revised EWRs.

- a) No current EWR.
- b) Water requirements for ecological components of GDE.

- Vegetation.

As there is not a vegetation monitoring transect at Harrisdale Swamp and the wetland had not been assessed at the time of writing, no comment can be made on water requirements of wetland species.

- Vertebrates.

Bushland surrounding Harrisdale Swamp supports Quenda, a significant mammal species associated with dense vegetation around wetlands. Therefore meeting the EWRs of the fringing vegetation, should maintain this species.

- Sediment processes.

To maintain sediment processes at Harrisdale Swamp organic sediments must remain saturated throughout the summer each year. The water table must therefore not drop below the stratigraphic level/layer capable of providing water to surface organics through capillary rise during summer (0.5 m below ground surface).

TERRESTRIAL ECOSYSTEMS

The description of EWRs for phreatophytic terrestrial vegetation is based on the depth to groundwater category at each 'criteria' groundwater bore (0-3 m, 3-6 m etc). Recent studies have determined drawdown thresholds for vegetation of each depth category (Froend & Zencich, 2001). Thresholds are described as rate (m/year) and magnitude (m) of drawdown and the associated risk of impact (low, moderate, high, severe) (Tables 4 and 5). Water requirements of terrestrial vegetation in the 0-3m category have been based on drawdown thresholds determined for wetland vegetation. This is acceptable as most terrestrial sites in this depth category support tree species associated with wetlands (eg *M. preissiana*, *E. rudis*). In the absence of water depths ranges for terrestrial species (as is available for wetland species) this information provides the basis for describing EWRs for terrestrial vegetation. However, as drawdown has already occurred at many sites, it is not appropriate to apply drawdown thresholds to current (2004) groundwater levels. As impacts of drawdown are generally cumulative, consideration must also be given to recent changes in groundwater levels. The Autumn 2001 minimum generally represents the water level at the start of the most recent drying cycle (2000-2004). Use of the 2001 minimum groundwater level as a baseline for setting EWRs, therefore considers the cumulative impacts of recent and future declines in groundwater levels.

To maintain each terrestrial ecosystem at a low level of risk from drawdown, the maximum permissible magnitude of drawdown (m) is subtracted from the 2001 autumn minimum (mAHD). The maximum permissible rate of drawdown is then applied to the 2001 minimum to determine the year at which the minimum groundwater level can be reached. For example, at MT3S *Banksia* woodland occurs at 6-10m depth to groundwater. It is at low risk of impact from a total drawdown of 1.25m at a rate of 0.1m/year. A decrease of 1.25m from the autumn 2001 minimum of 44.137mAHD results in an EWR of 42.887mAHD. However, as the 2004 minimum of 44.067mAHD already represents a decline of 0.07m, levels can only fall a further 1.18m before a breach occurs. As the rate of decline required to maintain a low risk of impact is 0.1m/year, it is further stipulated that the EWR cannot be breached prior to 2016.

There are a number of assumptions and limitations to this approach;

- Water requirements are approximate as further validation is required.
- Phreatophytic classes (0-3m etc) are based on quantitative studies of two *Banksia* species and have not considered requirements of other phreatophytic vegetation.
- Habitat type and species present are largely undescribed.
- Vegetation has established under a different water regime to that which currently exists. Without information on age class structure at individual sites it is not possible to determine under which regime tree root zones were set. Older trees may have established 20 years ago, younger individuals 3-5 years ago. Although older trees may have been lost, populations may persist due to recruitment of new plants under new conditions.
- The hydrology of a terrestrial site is based on water levels as measured at groundwater monitoring bores. This does not represent the variation in topography and its impact on groundwater levels across a site.
- The spatial area of vegetation represented by each bore is not defined.
- Depth to groundwater contouring for 2003 as provided by WRC was significantly different to that provided by Water Corporation for 2000 and did not appear fully representative of groundwater depths measured at some bores. Discrepancies were also noted between the location of known areas of very shallow groundwater and surface water (eg Gingin Brook) and the levels represented by the contouring. These limitations were also identified by the WRC.
- EWRs cannot be determined for 'new' terrestrial ecosystems due to the absence of hydrological data.

Gnangara Mound

PM24

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Regionally significant bushland/wetland linkage.
- Bush Forever Site 382.
- Supports one of remaining examples of Pinjar vegetation complex in area.
- Area supports non-aquatic fauna.
- Supports phreatophytic vegetation at 0-3m to groundwater.

2. Groundwater dependency analysis.

Clifton and Evans (2001) described sumplands of the Swan Coastal Plain as highly groundwater dependent. Groundwater and rainfall are required for consumptive use and biophysical processes.

3. Revised EWRs.

c) Superceded EWRs (mAHD).

Summer absolute minimum – 40.5

d) Water requirements for ecological components of GDE.

• Vegetation.

As vegetation at PM24 is in the 0-3m category, occurs in the basin of Lake Pinjar and is dominated by the wetland species *E. rudis* and *M. preissiana*, a minimum groundwater level should not be determined following the methodology outlined above for terrestrial vegetation. However, the approach applied to determine wetland vegetation water requirements is appropriate. Application of this approach indicates that *M. preissiana* requires the highest minimum groundwater level of 40.96 mAHD with *E. rudis* requiring 39.9 mAHD.

• Vertebrates.

Bushland surrounding Lake Pinjar supports Quenda, a significant mammal species associated with dense vegetation around wetlands. Meeting the water requirements of the fringing vegetation, should maintain this species.

MT3S

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Undisturbed phreatophytic vegetation.
- Bush Forever Site 324.
- *Banksia* woodland 6-10m depth to groundwater.

2. Groundwater dependency analysis.

Clifton and Evans (2001) described *Banksia* woodlands of south-western WA as opportunistically dependent on groundwater. Zencich (2003) also described *Banksia* woodland at 6-10m depth to groundwater as opportunistically dependent. This ecosystem would also rely on rainfall and soil water for biophysical processes and habitat.

3. Revised EWRs.

a) Superceded EWRs (mAHD).

Summer preferred minimum – 21.6.

Summer absolute minimum – 21.1.

b) Water requirements for ecological components of GDE.

• Vegetation.

It is currently thought that *Banksia* woodland in the 6-10m depth to groundwater category is at low risk of impact from a total drawdown of 1.25m at a rate of 0.1m/year. A decrease of 1.25m from the autumn 2001 minimum of 44.137mAHD results in an EWR of 42.887mAHD. However, as the 2004 minimum of 44.067mAHD already represents a decline of 0.07m, levels can only fall a further 1.18m before a breach occurs. As the rate of decline required to maintain a low of risk of impact is 0.1m/year, it is further stipulated that the EWR cannot be breached prior to 2016.

MM18

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Undisturbed phreatophytic vegetation.
- Bush Forever Site 304.
- *Banksia* woodland 3-6m depth to groundwater.
- Area supports non-aquatic fauna.

2. Groundwater dependency analysis.

Although Clifton and Evans (2001) described *Banksia* woodlands of south-western WA as opportunistically dependent on groundwater, further research by Zencich (2003) determined *Banksia* woodland at 3-6m depth to groundwater was proportionally dependent. This ecosystem would also rely on rainfall and soil water for biophysical processes and habitat.

3) Revised EWRs.

a) Superseded EWRs (mAHD).

Summer absolute minimum – 38.6

b) Water requirements for ecological components of GDE.

• Vegetation.

It is currently thought that *Banksia* woodland in the 3-6m depth to groundwater category is at low risk of impact from a total drawdown of 1.0m at a rate of 0.1m/year. A decrease of 1m from the autumn 2001 minimum of 39.18mAHD results in an EWR of 38.18mAHD. However, as the 2004 minimum of 38.5mAHD already represents a decline of 0.68m, levels can only fall a further 0.32m before a breach occurs. As the rate of decline required to maintain a low of risk of impact is 0.1m/year, it is further stipulated that the EWR cannot be breached prior to 2007.

• Vertebrates.

The area supports significant mammal and reptile species. Meeting the water requirements of *Banksia* woodland, should maintain these species.

MM53

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Undisturbed phreatophytic vegetation.
- Bush Forever Site 304.
- *Banksia* woodland 3-6m depth to groundwater.
- Area supports non-aquatic fauna.

2. Groundwater dependency analysis.

Although Clifton and Evans (2001) described *Banksia* woodlands of south-western WA as opportunistically dependent on groundwater, further research by Zencich (2003) determined *Banksia* woodland at 3-6m depth to groundwater was proportionally dependent. This ecosystem would also rely on rainfall and soil water for biophysical processes and habitat.

3. Revised EWRs.

a) Superseded EWRs (mAHD).

Summer absolute minimum – 33.3

c) Water requirements for ecological components of GDE.

• Vegetation.

It is currently thought that *Banksia* woodland in the 3-6m depth to groundwater category is at low risk of impact from a total drawdown of 1.0m at a rate of 0.1m/year. A decrease of 1m from the autumn 2001 minimum of 33.37mAHD results in an EWR of 32.37mAHD. However, as the 2004 minimum of 33.26mAHD already represents a decline of 0.11m, levels can only fall a further 0.89m before a breach occurs. As the rate of decline required to maintain a low of risk of impact is 0.1m/year, it is further stipulated that the EWR cannot be breached prior to 2013.

• Vertebrates.

The area supports significant mammal and reptile species. Meeting the water requirements of *Banksia* woodland, should maintain these species.

MM59B

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Disturbed phreatophytic vegetation.
- Bush Foreer Site 304.
- *Banksia* woodland 3-6m depth to groundwater.
- Area supports non-aquatic fauna.

2. Groundwater dependency analysis.

Although Clifton and Evans (2001) described *Banksia* woodlands of south-western WA as opportunistically dependent on groundwater, further research by Zencich (2003) determined *Banksia* woodland at 3-6m depth to groundwater was proportionally dependent. This ecosystem would also rely on rainfall and soil water for biophysical processes and habitat.

3. Revised EWRs.

a) Superseded EWRs (mAHD).

Summer absolute minimum – 36.3

b) Water requirements for ecological components of GDE.

• Vegetation.

It is currently thought that *Banksia* woodland in the 3-6m depth to groundwater category is at low risk of impact from a total drawdown of 1.0m at a rate of 0.1m/year. A decrease of 1m from the autumn 2001 minimum of 36.196mAHD results in an EWR of 35.196mAHD. However, as the 2004 minimum of 36.016mAHD already represents a decline of 0.18m, levels can only fall a further 0.82m before a breach occurs. As the rate of decline required to maintain a low of risk of impact is 0.1m/year, it is further stipulated that the EWR cannot be breached prior to 2013.

• Vertebrates.

The area supports significant mammal and reptile species. Meeting the water requirements of *Banksia* woodland, should maintain these species.

MM55B

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Disturbed phreatophytic vegetation.
- Bush Forever Site 304.
- *Melaleuca* woodland 0-3m depth to groundwater.

2. Groundwater dependency analysis.

Clifton and Evans (2001) described sumplands of the Swan Coastal Plain as highly groundwater dependent. Groundwater and rainfall are required for consumptive use and biophysical processes.

3. Revised EWRs.

a) Superseded EWRs (mAHD).

Summer absolute minimum – 29.5

b) Water requirements for ecological components of GDE.

- Vegetation.

As vegetation at MM55B is in the 0-3m category and is dominated by the wetland species *M. preissiana*, a minimum groundwater level should not be determined following the methodology outlined above for terrestrial vegetation. However, the approach applied to determine wetland vegetation water requirements is appropriate. Application of this approach indicates that *M. preissiana* requires a minimum groundwater level of 29.38 mAHD.

MM16

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Undisturbed phreatophytic vegetation.
- Bush Forever Site 196.
- *Banksia* woodland 3-6m depth to groundwater.
- Area supports TEC SCP 20a (Telstra01-08).
- Area supports non-aquatic fauna.

2. Groundwater dependency analysis.

Although Clifton and Evans (2001) described *Banksia* woodlands of south-western WA as opportunistically dependent on groundwater, further research by Zencich (2003) determined *Banksia* woodland at 3-6m depth to groundwater was proportionally dependent. This ecosystem would also rely on rainfall and soil water for biophysical processes and habitat.

3. Revised EWRs.

a) Superseded EWRs (mAHD).

Summer absolute minimum – 38.8

b) Water requirements for ecological components of GDE.

- Vegetation.

It is currently thought that *Banksia* woodland in the 3-6m depth to groundwater category is at low risk of impact from a total drawdown of 1.0m at a rate of 0.1m/year. A decrease of 1m from the autumn 2001 minimum of 38.8mAHD results in an EWR of 37.8mAHD. However, as the 2004 minimum of

38.8m AHD already represents a decline of 0m, levels can only fall a further 1.0m before a breach occurs. As the rate of decline required to maintain a low of risk of impact is 0.1m/year, it is further stipulated that the EWR cannot be breached prior to 2014.

- Vertebrates.

The area supports significant mammal species. Meeting the water requirements of *Banksia* woodland, should maintain these species.

PM9

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Disturbed phreatophytic vegetation.
- Bush Forever Site 380.
- *Banksia* woodland 6-10m depth to groundwater.
- Area supports non-aquatic fauna.
- Regionally significant contiguous bushland linkage.

2. Groundwater dependency analysis.

Clifton and Evans (2001) described *Banksia* woodlands of south-western WA as opportunistically dependent on groundwater. This ecosystem would also rely on rainfall and soil water for biophysical processes and habitat.

3. Revised EWRs.

- a) Superseded EWRs (m AHD)

Summer absolute minimum – 56.3

- b) Water requirements for ecological components of GDE.

- Vegetation.

It is currently thought that *Banksia* woodland in the 6-10m depth to groundwater category is at low risk of impact from a total drawdown of 1.25m at a rate of 0.1m/year. A decrease of 1.25m from the autumn 2001 minimum of 57.04m AHD results in an EWR of 55.79m AHD. However, as the 2004 minimum of 56.63m AHD already represents a decline of 0.41m, levels can only fall a further 0.84m before a breach occurs. As the rate of decline required to maintain a low of risk of impact is 0.1m/year, it is further stipulated that the EWR cannot be breached prior to 2013.

- Vertebrates.

The area supports significant mammal species. Meeting the water requirements of *Banksia* woodland, should maintain these species.

WMI

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Undisturbed phreatophytic vegetation.
- Bush Forever Site 398.
- *Banksia* woodland 3-6m depth to groundwater.

2. Groundwater dependency analysis.

Although Clifton and Evans (2001) described *Banksia* woodlands of south-western WA as opportunistically dependent on groundwater, further research by Zencich (2003) determined *Banksia* woodland at 3-6m depth to groundwater was proportionally dependent. This ecosystem would also rely on rainfall and soil water for biophysical processes and habitat.

3. Revised EWRs.

a) Superseded EWRs (mAHD).

Summer absolute minimum – 55.7

b) Water requirements for ecological components of GDE.

- Vegetation.

It is currently thought that *Banksia* woodland in the 3-6m depth to groundwater category is at low risk of impact from a total drawdown of 1.0m at a rate of 0.1m/year. A decrease of 1m from the autumn 2001 minimum of 55.7mAHD results in an EWR of 56.7mAHD. However, as the 2004 minimum of 55.435mAHD already represents a decline of 0.265m, levels can only fall a further 0.735m before a breach occurs. As the rate of decline required to maintain a low of risk of impact is 0.1m/year, it is further stipulated that the EWR cannot be breached prior to 2012.

WM2

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Undisturbed phreatophytic vegetation.
- Bush Forever Site 399.
- *Banksia* woodland 3-6m depth to groundwater.
- Regionally significant area of bushland.
- Area supports non-aquatic fauna.

2. Groundwater dependency analysis.

Although Clifton and Evans (2001) described *Banksia* woodlands of south-western WA as opportunistically dependent on groundwater, further research by Zencich (2003) determined *Banksia* woodland at 3-6m depth to groundwater was proportionally dependent. This ecosystem would also rely on rainfall and soil water for biophysical processes and habitat.

3. Revised EWRs.

a) Superseded EWRs (mAHD).

Summer absolute minimum – 66.5

b) Water requirements for ecological components of GDE.

- Vegetation.

It is currently thought that *Banksia* woodland in the 3-6m depth to groundwater category is at low risk of impact from a total drawdown of 1.0m at a rate of 0.1m/year. A decrease of 1m from the autumn 2001 minimum of 67.495mAHD results in an EWR of 66.495mAHD. However, as the 2004 minimum of 67.325mAHD already represents a decline of 0.17m, levels can only fall a further 0.83m before a breach occurs. As the rate of decline required to maintain a low of risk of impact is 0.1m/year, it is further stipulated that the EWR cannot be breached prior to 2013.

- Vertebrates.

The area supports significant mammal and reptile species. Meeting the water requirements of *Banksia* woodland, should maintain these species.

WM8

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Undisturbed phreatophytic vegetation.
- Bush Forever Site 399.
- *Banksia* woodland 3-6m depth to groundwater.
- Regionally significant area of bushland.
- Area supports non-aquatic fauna.

2. Groundwater dependency analysis.

Although Clifton and Evans (2001) described *Banksia* woodlands of south-western WA as opportunistically dependent on groundwater, further research by Zencich (2003) determined *Banksia* woodland at 3-6m depth to groundwater was proportionally dependent. This ecosystem would also rely on rainfall and soil water for biophysical processes and habitat.

3. Revised EWRs.

- a) Superseded EWRs (mAHD).

Summer absolute minimum – 64.8

- b) Water requirements for ecological components of GDE.

- Vegetation.

It is currently thought that *Banksia* woodland in the 3-6m depth to groundwater category is at low risk of impact from a total drawdown of 1.0m at a rate of 0.1m/year. A decrease of 1m from the autumn 2001 minimum of 65.517mAHD results in an EWR of 64.517mAHD. However, as the 2004 minimum of 65.567mAHD represents an increase of 0.05m, levels can fall a further 1.05m before a breach occurs. As the rate of decline required to maintain a low of risk of impact is 0.1m/year, it is further stipulated that the EWR cannot be breached prior to 2015.

- Vertebrates.

The area supports significant mammal and reptile species. Meeting the water requirements of *Banksia* woodland, should maintain these species.

NR6C

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Undisturbed phreatophytic vegetation.
- Bush Forever Site 399.
- *Banksia* woodland 3-6m depth to groundwater.
- Regionally significant area of bushland.
- Area supports non-aquatic fauna.

2. Groundwater dependency analysis.

Although Clifton and Evans (2001) described *Banksia* woodlands of south-western WA as opportunistically dependent on groundwater, further research by Zencich (2003) determined *Banksia* woodland at 3-6m depth to groundwater was proportionally dependent. This ecosystem would also rely on rainfall and soil water for biophysical processes and habitat.

3. Revised EWRs.

- a) Superseded EWRs (mAHD).

Summer absolute minimum – 58.5

- b) Water requirements for ecological components of GDE.

- Vegetation.

It is currently thought that *Banksia* woodland in the 3-6m depth to groundwater category is at low risk of impact from a total drawdown of 1.0m at a rate of 0.1m/year. A decrease of 1m from the autumn 2001 minimum of 59.635mAHD results in an EWR of 58.635mAHD. However, as the 2004 minimum of 59.395mAHD already represents a decline of 0.24m, levels can only fall a further 0.76m before a breach occurs. As the rate of decline required to maintain a low of risk of impact is 0.1m/year, it is further stipulated that the EWR cannot be breached prior to 2012.

- Vertebrates.

The area supports significant mammal and reptile species. Meeting the water requirements of *Banksia* woodland, should maintain these species.

NR11C

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Undisturbed phreatophytic vegetation.
- Bush Forever Site 399.
- *Banksia* woodland 3-6m depth to groundwater.
- Regionally significant area of bushland.
- Area supports non-aquatic fauna.

2. Groundwater dependency analysis.

Although Clifton and Evans (2001) described *Banksia* woodlands of south-western WA as opportunistically dependent on groundwater, further research by Zencich (2003) determined *Banksia* woodland at 3-6m depth to groundwater was proportionally dependent. This ecosystem would also rely on rainfall and soil water for biophysical processes and habitat.

3. Revised EWRs.

a) Superseded EWRs (mAHD).

Summer absolute minimum – 55.0

b) Water requirements for ecological components of GDE.

- Vegetation.

It is currently thought that *Banksia* woodland in the 3-6m depth to groundwater category is at low risk of impact from a total drawdown of 1.0m at a rate of 0.1m/year. A decrease of 1m from the autumn 2001 minimum of 55.521mAHD results in an EWR of 54.521mAHD. However, as the 2004 minimum of 55.601mAHD represents an increase of 0.08m, levels can fall a further 1.08m before a breach occurs. As the rate of decline required to maintain a low of risk of impact is 0.1m/year, it is further stipulated that the EWR cannot be breached prior to 2015.

- Vertebrates.

The area supports significant mammal and reptile species. Meeting the water requirements of *Banksia* woodland, should maintain these species.

L30C

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Undisturbed phreatophytic vegetation.
- Bush Forever Site 399.
- *Banksia* woodland 3-6m depth to groundwater.
- Regionally significant area of bushland.
- Area supports non-aquatic fauna

2. Groundwater dependency analysis.

Although Clifton and Evans (2001) described *Banksia* woodlands of south-western WA as opportunistically dependent on groundwater, further research by Zencich (2003) determined *Banksia* woodland at 3-6m depth to groundwater was proportionally dependent. This ecosystem would also rely on rainfall and soil water for biophysical processes and habitat.

3. Revised EWRs.

a) Superseded EWRs (mAHD).

Summer absolute minimum – 47.2

b) Water requirements for ecological components of GDE.

• Vegetation.

It is currently thought that *Banksia* woodland in the 3-6m depth to groundwater category is at low risk of impact from a total drawdown of 1.0m at a rate of 0.1m/year. A decrease of 1m from the autumn 2001 minimum of 48.594mAHD results in an EWR of 47.594mAHD. However, as the 2004 minimum of 48.474mAHD already represents a decline of 0.12m, levels can only fall a further 0.88m before a breach occurs. As the rate of decline required to maintain a low of risk of impact is 0.1m/year, it is further stipulated that the EWR cannot be breached prior to 2013.

• Vertebrates.

The area supports significant mammal and reptile species. Meeting the water requirements of *Banksia* woodland, should maintain these species.

L110C

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Undisturbed phreatophytic vegetation.
- *Banksia* woodland 6-10m depth to groundwater.
- Regionally significant area of bushland.
- Area supports non-aquatic fauna.

2. Groundwater dependency analysis.

Clifton and Evans (2001) described *Banksia* woodlands of south-western WA as opportunistically dependent on groundwater. This ecosystem would also rely on rainfall and soil water for biophysical processes and habitat.

3. Revised EWRs.

a) Superseded EWRs (mAHD).

Summer absolute minimum – 55.7

b) Water requirements for ecological components of GDE.

• Vegetation.

It is currently thought that *Banksia* woodland in the 6-10m depth to groundwater category is at low risk of impact from a total drawdown of 1.25m at a rate of 0.1m/year. A decrease of 1.25m from the autumn 2001 minimum of 58.062mAHD results in an EWR of 57.062mAHD. However, as the 2004 minimum of 57.842mAHD already represents a decline of 0.22m, levels can only fall a further 1.03m before a breach occurs. As the rate of decline required to maintain a low of risk of impact is 0.1m/year, it is further stipulated that the EWR cannot be breached prior to 2015.

• Vertebrates.

The area supports significant mammal and reptile species. Meeting the water requirements of *Banksia* woodland, should maintain these species.

L220C

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Undisturbed phreatophytic vegetation.
- Bush Forever Site 399.
- *Banksia* woodland 3-6m depth to groundwater.
- Regionally significant area of bushland.
- Area supports non-aquatic fauna.

2. Groundwater dependency analysis.

Although Clifton and Evans (2001) described *Banksia* woodlands of south-western WA as opportunistically dependent on groundwater, further research by Zencich (2003) determined *Banksia* woodland at 3-6m depth to groundwater was proportionally dependent. This ecosystem would also rely on rainfall and soil water for biophysical processes and habitat.

3. Revised EWRs.

a) Superseded EWRs (mAHD).

Summer absolute minimum – 52.2

b) Water requirements for ecological components of GDE.

• Vegetation.

It is currently thought that *Banksia* woodland in the 3-6m depth to groundwater category is at low risk of impact from a total drawdown of 1.0m at a rate of 0.1m/year. A decrease of 1m from the autumn 2001 minimum of 53.041mAHD results in an EWR of 52.041mAHD. However, as the 2004 minimum of 52.881mAHD already represents a decline of 0.16m, levels can only fall a further 0.84m before a breach occurs. As the rate of decline required to maintain a low of risk of impact is 0.1m/year, it is further stipulated that the EWR cannot be breached prior to 2013.

• Vertebrates.

The area supports significant mammal and reptile species. Meeting the water requirements of *Banksia* woodland, should maintain these species.

MM12

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Undisturbed phreatophytic vegetation.
- Bush Forever Site 192.
- *Banksia* woodland 3-6m depth to groundwater.
- Area supports non-aquatic fauna.

2. Groundwater dependency analysis.

Although Clifton and Evans (2001) described *Banksia* woodlands of south-western WA as opportunistically dependent on groundwater, further research by Zencich (2003) determined *Banksia* woodland at 3-6m depth to groundwater was proportionally dependent. This ecosystem would also rely on rainfall and soil water for biophysical processes and habitat.

3. Revised EWRs.

- a) Superceded EWRs (mAHD).

Summer absolute minimum – 42.0

- b) Water requirements for ecological components of GDE.

- Vegetation.

It is currently thought that *Banksia* woodland in the 3-6m depth to groundwater category is at low risk of impact from a total drawdown of 1.0m at a rate of 0.1m/year. A decrease of 1m from the autumn 2001 minimum of 43.240mAHD results in an EWR of 42.240mAHD. However, as the 2004 minimum of 42.77mAHD already represents a decline of 0.47m, levels can only fall a further 0.53m before a breach occurs. As the rate of decline required to maintain a low of risk of impact is 0.1m/year, it is further stipulated that the EWR cannot be breached prior to 2010.

- Vertebrates.

The area supports significant mammal species. Meeting the water requirements of *Banksia* woodland, should maintain these species.

Ridges*

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Supports non-aquatic fauna.
- Supports TEC (SCP26a).
- Bush Forever Site 381.
- *Banksia* woodland 6-10m depth to groundwater.
- Representative of terrestrial vegetation with respect to structure and composition.

2. Groundwater dependency analysis.

Clifton and Evans (2001) described *Banksia* woodlands of south-western WA as opportunistically dependent on groundwater. This ecosystem would also rely on rainfall and soil water for biophysical processes and habitat.

3. Revised EWRs.

- a) No current EWR. Groundwater monitoring bore GNM11A may be most representative of the groundwater levels in the area.

- b) Water requirements for ecological components of GDE.

- Vegetation.

It is currently thought that *Banksia* woodland in the 6-10m depth to groundwater category is at low risk of impact from a total drawdown of 1.25m at a rate of 0.1m/year.

- Vertebrates.

The area supports significant mammal and reptile species. Meeting the water requirements of *Banksia* woodland, should maintain these species.

Rosella Rd Bushland (north)*

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Area supports non-aquatic fauna.
- *Banksia* woodland at 3-6m and 6-10m depth to groundwater.
- Bush Forever Site 380.

2. Groundwater dependency analysis.

Although Clifton and Evans (2001) described *Banksia* woodlands of south-western WA as opportunistically dependent on groundwater, further research by Zencich (2003) determined *Banksia* woodland at 3-6m depth to groundwater was proportionally dependent. *Banksia* woodland at 6-10 m is likely to be opportunistically dependent. This ecosystem would also rely on rainfall and soil water for biophysical processes and habitat.

3. Revised EWRs.

- a) No current EWR. Not known which groundwater monitoring bore if any, would be most representative of the area.
- b) Water requirements for ecological components of GDE.
 - Vegetation.

It is currently thought that *Banksia* woodland in the 3-6m depth to groundwater category is at low risk of impact from a total drawdown of 1.0m at a rate of 0.1m/year. *Banksia* woodland in the 6-10m depth to groundwater category is at low risk of impact from a total drawdown of 1.25m at a rate of 0.1m/year.

- Vertebrates.

The area supports significant mammal and reptile species. Meeting the water requirements of *Banksia* woodland, should maintain these species.

Muchea Air Weapons Range*

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Supports non-aquatic fauna.
- *Banksia* woodland at 6-10m depth to groundwater..
- Representative of terrestrial vegetation with respect to structure and composition.
- Bush Forever Site 462.

2. Groundwater dependency analysis.

Clifton and Evans (2001) described *Banksia* woodlands of south-western WA as opportunistically dependent on groundwater. This ecosystem would also rely on rainfall and soil water for biophysical processes and habitat.

3. Revised EWRs.

- a) No current EWR. Not known which groundwater bore would be most representative of groundwater levels in the area.
- b) Water requirements for ecological components of GDE.

- Vegetation.

It is currently thought that *Banksia* woodland in the 6-10m depth to groundwater category is at low risk of impact from a total drawdown of 1.25m at a rate of 0.1m/year.

- Vertebrates.

The area supports significant mammal and reptile species. Meeting the water requirements of *Banksia* woodland, should maintain these species.

Jandakot**JE17C**

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- *Eucalyptus rudis*/*Melaleuca preissiana* woodland occurring in area 0-3m to groundwater.
- Bush Forever Site 391.
- Reserve supports non-aquatic fauna.
- Reserve supports priority flora.

2. Groundwater dependency analysis.

Clifton and Evans (2001) described sumplands of the Swan Coastal Plain as highly groundwater dependent. Groundwater and rainfall are required for consumptive use and biophysical processes.

3. Revised EWRs.

a) Superceded EWRs (mAHD).

Summer preferred minimum – 16.8

Summer absolute minimum – 16.3

b) Water requirements for ecological components of GDE.

• Vegetation.

As vegetation at JE17C is in the 0-3m category and is dominated by the wetland species *E. rudis* and *M. preissiana*, a minimum groundwater level should not be determined following the methodology outlined above for terrestrial vegetation. However, the approach applied to determine wetland vegetation water requirements is appropriate. Application of this approach indicates that *M. preissiana* requires the highest minimum groundwater level of 16.347 mAHD with *E. rudis* requiring 15.707 mAHD.

• Vertebrates.

The area supports significant mammal species. Meeting the water requirements of *Banksia* woodland, should maintain these species.

JE10C

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- *Banksia* woodland occurring in area 3-6m to groundwater.
- Bush Forever Site 344.
- Representative of terrestrial vegetation with respect to structure, composition and fauna habitat.

2. Groundwater dependency analysis.

Although Clifton and Evans (2001) described *Banksia* woodlands of south-western WA as opportunistically dependent on groundwater, further research by Zencich (2003) determined *Banksia* woodland at 3-6m depth to groundwater was proportionally dependent. This ecosystem would also rely on rainfall and soil water for biophysical processes and habitat.

3. Revised EWRs.

a) Superceded EWRs (mAHD).

Summer preferred minimum – 21.8

Summer absolute minimum – 21.3

b) Water requirements for ecological components of GDE.

- Vegetation.

It is currently thought that *Banksia* woodland in the 3-6m depth to groundwater category is at low risk of impact from a total drawdown of 1.0m at a rate of 0.1m/year. A decrease of 1m from the autumn 2001 minimum of 23.075mAHD results in an EWR of 22.075mAHD. However, as the 2004 minimum of 23.825mAHD represents an increase of 0.75m, levels can fall a further 1.75m before a breach occurs. As the rate of decline required to maintain a low of risk of impact is 0.1m/year, it is further stipulated that the EWR cannot be breached prior to 2022.

JM19

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- *Banksia* woodland occurring in area 6-10m to groundwater.
- Bush Forever Site 390.
- Representative of terrestrial vegetation with respect to structure, composition and fauna habitat.

2. Groundwater dependency analysis.

Clifton and Evans (2001) described *Banksia* woodlands of south-western WA as opportunistically dependent on groundwater. Zencich (2003) also described *Banksia* woodland at 6-10m depth to groundwater as opportunistically dependent. This ecosystem would also rely on rainfall and soil water for biophysical processes and habitat.

3. Revised EWRs.

a) Superseded EWRs (mAHD).

Summer preferred minimum – 25.26

Summer absolute minimum – 24.76

b) Water requirements for ecological components of GDE.

- Vegetation.

It is currently thought that *Banksia* woodland in the 6-10m depth to groundwater category is at low risk of impact from a total drawdown of 1.25m at a rate of 0.1m/year. A decrease of 1.25m from the autumn 2001 minimum of 25.08mAHD results in an EWR of 23.83mAHD. However, as the 2004 minimum of 24.9mAHD represents a decline of 0.18m, levels can only fall a further 1.07m before a breach occurs. As the rate of decline required to maintain a low of risk of impact is 0.1m/year, it is further stipulated that the EWR cannot be breached prior to 2015.

JM31

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- *Banksia* woodland occurring in area 3-6m to groundwater.
- Bush Forever Site 344.
- Representative of terrestrial vegetation with respect to structure, composition and fauna habitat.

2. Groundwater dependency analysis.

Although Clifton and Evans (2001) described *Banksia* woodlands of south-western WA as opportunistically dependent on groundwater, further research by Zencich (2003) determined *Banksia* woodland at 3-6m depth to groundwater was proportionally dependent. This ecosystem would also rely on rainfall and soil water for biophysical processes and habitat.

3. Revised EWRs.

c) Superseded EWRs (mAHD).

Summer preferred minimum - 24.05

Summer absolute minimum – 23.55

d) Water requirements for ecological components of GDE.

- Vegetation.

It is currently thought that *Banksia* woodland in the 3-6m depth to groundwater category is at low risk of impact from a total drawdown of 1.0m at a rate of 0.1m/year. A decrease of 1m from the autumn 2001 minimum of 25.01mAHD results in an EWR of 24.01mAHD. However, as the 2004 minimum of 24.9mAHD already represents a decline of 0.11m, levels can only fall a further 0.89m before a breach occurs. As the rate of decline required to maintain a low of risk of impact is 0.1m/year, it is further stipulated that the EWR cannot be breached prior to 2013.

- Vertebrates.

The area supports significant mammal species. Meeting the water requirements of *Banksia* woodland, should maintain these species.

JM35

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- *Banksia* woodland occurring in area 3-6m to groundwater.

2. Groundwater dependency analysis.

Although Clifton and Evans (2001) described *Banksia* woodlands of south-western WA as opportunistically dependent on groundwater, further research by Zencich (2003) determined *Banksia* woodland at 3-6m depth to groundwater was proportionally dependent. This ecosystem would also rely on rainfall and soil water for biophysical processes and habitat.

3. Revised EWRs.

a) Superseded EWRs (mAHD).

Summer preferred minimum – 21.25

Summer absolute minimum – 20.75

b) Water requirements for ecological components of GDE.

- Vegetation.

It is currently thought that *Banksia* woodland in the 3-6m depth to groundwater category is at low risk of impact from a total drawdown of 1.0m at a rate of 0.1m/year. A decrease of 1m from the autumn 2001 minimum of 23.44mAHD results in an EWR of 22.44mAHD. However, as the 2004 minimum of 23.41mAHD already represents a decline of 0.03m, levels can only fall a further 0.97m before a breach occurs. As the rate of decline required to maintain a low of risk of impact is 0.1m/year, it is further stipulated that the EWR cannot be breached prior to 2014.

JE4C

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Mixed *Melaleuca sp./Banksia* woodland occurring in area 3-6m to groundwater.
- Bush Forever Site 344.
- Important bird breeding area protected under JAMBA/CAMBA.

2. Groundwater dependency analysis.

Clifton and Evans (2001) described *Melaleuca/Banksia* woodlands of south-western WA as proportionally dependent on groundwater. This ecosystem would also rely on rainfall and soil water for biophysical processes and habitat.

3. Revised EWRs.

a) Superseded EWRs (mAHD).

Summer preferred minimum – 24.0

Summer absolute minimum – 23.5

b) Water requirements for ecological components of GDE.

- Vegetation.

It is currently thought that *Banksia* woodland in the 3-6m depth to groundwater category is at low risk of impact from a total drawdown of 1.0m at a rate of 0.1m/year. A decrease of 1m from the autumn 2001 minimum of 24.098mAHD results in an EWR of 23.098mAHD. However, as the 2004 minimum of 24.158mAHD already represents a decline of 0.06m, levels can only fall a further 0.94m before a breach occurs. As the rate of decline required to maintain a low of risk of impact is 0.1m/year, it is further stipulated that the EWR cannot be breached prior to 2014.

- Vertebrates.

The area supports significant mammal species. Meeting the water requirements of *Banksia* woodland, should maintain these species.

JM7

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- *M. preissiana/E. rudis/Banksia* woodland occurring in area 3-6m to groundwater.
- Bush Forever Site 388.
- Area supports non-aquatic fauna.
- No current record of rare orchid species.

2. Groundwater dependency analysis.

Clifton and Evans (2001) described *Melaleuca/Banksia* woodlands of south-western WA as proportionally dependent on groundwater. This ecosystem would also rely on rainfall and soil water for biophysical processes and habitat.

3. Revised EWRs.

a) Superseded EWRs (mAHD).

Summer preferred minimum – 23.17

Summer absolute minimum – 22.67

b) Water requirements for ecological components of GDE.

- Vegetation.

It is currently thought that *Banksia* woodland in the 3-6m depth to groundwater category is at low risk of impact from a total drawdown of 1.0m at a rate of 0.1m/year. A decrease of 1m from the autumn 2001 minimum of 23.061mAHD results in an EWR of 22.061mAHD. However, as the 2004 minimum of 22.791mAHD already represents a decline of 0.27m, levels can only fall a further 0.73m before a breach occurs. As the rate of decline required to maintain a low of risk of impact is 0.1m/year, it is further stipulated that the EWR cannot be breached prior to 2012.

- Vertebrates.

The area supports significant mammal and reptile species. Meeting the water requirements of *Banksia* woodland, should maintain these species.

JM8

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- *Banksia* woodland occurring in area 3-6m to groundwater.
- Bush Forever Site 388.
- Area supports non-aquatic fauna.
- Supports rare orchid species.

2. Groundwater dependency analysis.

Although Clifton and Evans (2001) described *Banksia* woodlands of south-western WA as opportunistically dependent on groundwater, further research by Zencich (2003) determined *Banksia* woodland at 3-6m depth to groundwater was proportionally dependent. This ecosystem would also rely on rainfall and soil water for biophysical processes and habitat.

3. Revised EWRs.

a) Superceded EWRs (mAHD).

Summer preferred minimum – 24.43

Summer absolute minimum – 23.93

b) Water requirements for ecological components of GDE.

• Vegetation.

It is currently thought that *Banksia* woodland in the 3-6m depth to groundwater category is at low risk of impact from a total drawdown of 1.0m at a rate of 0.1m/year. A decrease of 1m from the autumn 2001 minimum of 24.38mAHD results in an EWR of 23.38mAHD. However, as the 2004 minimum of 24.36mAHD already represents a decline of 0.02m, levels can only fall a further 0.98m before a breach occurs. As the rate of decline required to maintain a low of risk of impact is 0.1m/year, it is further stipulated that the EWR cannot be breached prior to 2014.

• Vertebrates.

The area supports significant mammal and reptile species. Meeting the water requirements of *Banksia* woodland, should maintain these species.

JM45

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Mixed *Banksia*/*E. rudis* / *M. preissiana* woodland occurring in area 3-6m to groundwater.
- No current record of rare orchid species.

2. Groundwater dependency analysis.

Clifton and Evans (2001) described *Melaleuca/Banksia* woodlands of south-western WA as proportionally dependent on groundwater. This ecosystem would also rely on rainfall and soil water for biophysical processes and habitat.

3. Revised EWRs.

a) Superceded EWRs (mAHD).

Summer preferred minimum – 24.02

Summer absolute minimum – 23.52

b) Water requirements for ecological components of GDE.

• Vegetation.

It is currently thought that mixed *Banksia/ E. rudis / M. preissiana* woodland in the 3-6m depth to groundwater category is at low risk of impact from a total drawdown of 1.0m at a rate of 0.1m/year. A decrease of 1m from the autumn 2001 minimum of 23.711mAHD results in an EWR of 22.711mAHD. However, as the 2004 minimum of 23.431mAHD already represents a decline of 0.28m, levels can only fall a further 0.72m before a breach occurs. As the rate of decline required to maintain a low of risk of impact is 0.1m/year, it is further stipulated that the EWR cannot be breached prior to 2012.

8284

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Mixed *Banksia/ E. rudis / M. preissiana* woodland occurring in area 3-6m to groundwater.

2. Groundwater dependency analysis.

Clifton and Evans (2001) described *Melaleuca/Banksia* woodlands of south-western WA as proportionally dependent on groundwater. This ecosystem would also rely on rainfall and soil water for biophysical processes and habitat.

3. Revised EWRs.

a) Superseded EWRs (mAHD).

Summer preferred minimum – 24.82

Summer absolute minimum – 23.32

b) Water requirements for ecological components of GDE.

• Vegetation.

It is currently thought that *Banksia* woodland in the 3-6m depth to groundwater category is at low risk of impact from a total drawdown of 1.0m at a rate of 0.1m/year. A decrease of 1m from the autumn 2001 minimum of 25.345mAHD results in an EWR of 24.345mAHD. However, as the 2004 minimum of 25.125mAHD already represents a decline of 0.22m, levels can only fall a further 0.78m before a breach occurs. As the rate of decline required to maintain a low of risk of impact is 0.1m/year, it is further stipulated that the EWR cannot be breached prior to 2012.

JM49

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- *Melaleuca/Banksia* woodland occurring in area 3-6m to groundwater.

2. Groundwater dependency analysis.

Clifton and Evans (2001) described sumplands of the Swan Coastal Plain as highly groundwater dependent. Groundwater and rainfall are required for consumptive use and biophysical processes.

3. Revised EWRs.

a) Superseded EWRs (mAHD).

Summer preferred minimum – 22.34

Summer absolute minimum – 21.84

b) Water requirements for ecological components of GDE.

• Vegetation.

It is currently thought that *Banksia* woodland in the 3-6m depth to groundwater category is at low risk of impact from a total drawdown of 1.0m at a rate of 0.1m/year. A decrease of 1m from the autumn 2001 minimum of 23.091mAHD results in an EWR of 22.091mAHD. However, as the 2004 minimum of 23.251mAHD already represents a decline of 0.16m, levels can only fall a further 0.84m before a breach occurs. As the rate of decline required to maintain a low of risk of impact is 0.1m/year, it is further stipulated that the EWR cannot be breached prior to 2013.

JM39

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- *Banksia* woodland occurring in area 3-6m to groundwater.

2. Groundwater dependency analysis.

Although Clifton and Evans (2001) described *Banksia* woodlands of south-western WA as opportunistically dependent on groundwater, further research by Zencich (2003) determined *Banksia* woodland at 3-6m depth to groundwater was proportionally dependent. This ecosystem would also rely on rainfall and soil water for biophysical processes and habitat.

3. Revised EWRs.

a) Superseded EWRs (mAHD).

Summer preferred minimum – 21.2

Summer absolute minimum – 20.7

b) Water requirements for ecological components of GDE.

• Vegetation.

It is currently thought that *Banksia* woodland in the 3-6m depth to groundwater category is at low risk of impact from a total drawdown of 1.0m at a rate of 0.1m/year. A decrease of 1m from the autumn 2001 minimum of 21.597mAHD results in an EWR of 20.597mAHD. However, as the 2004 minimum of 21.827mAHD represents an increase of 0.23m, levels can only fall a further 1.23m before a breach occurs. As the rate of decline required to maintain a low of risk of impact is 0.1m/year, it is further stipulated that the EWR cannot be breached prior to 2017.

JM16

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- *Banksia* woodland occurring in area 3-6m to groundwater.
- Bush Forever Site 253.
- Area supports non-avian fauna.

2. Groundwater dependency analysis.

Although Clifton and Evans (2001) described *Banksia* woodlands of south-western WA as opportunistically dependent on groundwater, further research by Zencich (2003) determined *Banksia* woodland at 3-6m depth to groundwater was proportionally dependent. This ecosystem would also rely on rainfall and soil water for biophysical processes and habitat.

3. Revised EWRs.

a) Superceded EWRs (mAHD).

Summer preferred minimum – 23.9

Summer absolute minimum – 23.4

b) Water requirements for ecological components of GDE.

- Vegetation.

It is currently thought that *Banksia* woodland in the 3-6m depth to groundwater category is at low risk of impact from a total drawdown of 1.0m at a rate of 0.1m/year. A decrease of 1m from the autumn 2001 minimum of 24.59mAHD results in an EWR of 23.59mAHD. However, as the 2004 minimum of 24.3mAHD already represents a decline of 0.29m, levels can only fall a further 0.71m before a breach occurs. As the rate of decline required to maintain a low of risk of impact is 0.1m/year, it is further stipulated that the EWR cannot be breached prior to 2012.

- Vertebrates.

The area supports significant mammal species. Meeting the water requirements of *Banksia* woodland, should maintain these species.

JM14

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- *Banksia* woodland occurring in area 3-6m to groundwater.
- Bush Forever Site 389.
- Representative of terrestrial vegetation with respect to structure, composition and fauna habitat.

2. Groundwater dependency analysis.

Although Clifton and Evans (2001) described *Banksia* woodlands of south-western WA as opportunistically dependent on groundwater, further research by Zencich (2003) determined *Banksia* woodland at 3-6m depth to groundwater was proportionally dependent. This ecosystem would also rely on rainfall and soil water for biophysical processes and habitat.

3. Revised EWRs.

a) Superceded EWRs (mAHD).

Summer preferred minimum – 23.39

Summer absolute minimum – 23.89

b) Water requirements for ecological components of GDE.

- Vegetation.

It is currently thought that *Banksia* woodland in the 3-6m depth to groundwater category is at low risk of impact from a total drawdown of 1.0m at a rate of 0.1m/year. A decrease of 1m from the autumn 2001 minimum of 24.71mAHD results in an EWR of 23.71mAHD. However, as the 2004 minimum of 24.59mAHD already represents a decline of 0.12m, levels can only fall a further 0.88m before a breach occurs. As the rate of decline required to maintain a low of risk of impact is 0.1m/year, it is further stipulated that the EWR cannot be breached prior to 2013.

- Vertebrates.

The area supports fauna. Meeting the water requirements of *Banksia* woodland, should maintain these species.

Anstey/Keane Bushland*

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Bush Forever Site 342.
- *Melaleuca/Banksia* woodland 3-6m to groundwater.

2. Groundwater dependency analysis.

Although Clifton and Evans (2001) described *Banksia* woodlands of south-western WA as opportunistically dependent on groundwater, further research by Zencich (2003) determined *Banksia* woodland at 0-3m depth to groundwater was proportionally dependent. This ecosystem would also rely on rainfall and soil water for biophysical processes and habitat.

3. Revised EWRs.

- a) No current EWR. Not known which groundwater bore would be most representative of groundwater levels in the area.
- b) Water requirements for ecological components of GDE.
 - Vegetation.

It is currently thought that *Banksia* woodland in the 3-6m depth to groundwater category is at low risk of impact from a total drawdown of 1.0m at a rate of 0.1m/year.

BASE-FLOW SYSTEMS

There are neither staff gauges nor groundwater monitoring bores in the vicinity of the base-flow systems discussed in this study. There is also insufficient knowledge of vegetation and faunal community structure and their water requirements to allow comment on possible flow requirements of these ecosystems. However, comments can be made on general requirements of vegetation, vertebrates, macroinvertebrates and sediments following the same principles applied to wetlands.

Bennett Brook*

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Supports diverse fish species and other dependent aquatic vertebrates and invertebrates.

2. Groundwater dependency analysis.

Clifton and Evans (2001) described base-flow dependent ecosystems of south-western WA as proportionally dependent on groundwater. This ecosystem would also rely on rainfall and surface water for biophysical processes and habitat.

3. Revised EWRs.

- a) No current EWR. Not known which groundwater monitoring bore would be most representative of groundwater levels in the area. May also require installation of a staff gauge.
- b) Water requirements for ecological components of GDE.

- Vegetation.

As there is not a vegetation monitoring transect at Bennett Brook, a minimum groundwater level cannot be determined following the methodology outlined above. Although wetland and vegetation condition had not been assessed at the time of writing, *M. raphiophylla* and *E. rudis* occur at Mussel Pool. Comment can therefore be made on the water depth ranges and period of inundation experienced by these wetland species.

Loomes (Loomes, 2000) described the 5 year mean and absolute water depth ranges (m) and duration of inundation (months/year) for the following species;

- *M. raphiophylla*; mean 0.006 to -2.14m, absolute 1.03 to -4.49m; duration of inundation - mean 2.15, absolute 9.4(months/year).
- *E. rudis*; mean -0.7 to -3.26m, absolute 1.03 to -6.44m; duration of inundation - mean 1.55, absolute 12 (months/year).

- Macroinvertebrates.

Due to the importance of vegetation assemblages as habitat, vegetation EWRs can be considered a surrogate for macroinvertebrate EWRs. Emergent species and littoral vegetation are likely to be of greatest importance for habitat at Bennet Brook.

- Vertebrates.

Bennett Brook supports a diverse assemblage of fish species. Fish require permanent inundation however, can survive in isolated permanent pools over summer. Frogs require 4 months of inundation to breed.

- Sediment processes.

To maintain sediment processes at Lake Forrestdale organic sediments must remain saturated throughout the summer each year. The water table must therefore not drop below the stratigraphic level/layer capable of providing water to surface organics through capillary rise during summer (0.5 m below ground surface).

Quin Brook*

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Supports dependent vertebrates.
- Near pristine vegetation provides fauna habitat.

2. Groundwater dependency analysis.

Clifton and Evans (2001) described base-flow dependent ecosystems of south-western WA as proportionally dependent on groundwater. This ecosystem would also rely on rainfall and surface water for biophysical processes and habitat.

3. Revised EWRs.

- a) No current EWR. Not known which groundwater monitoring bore would be most representative of groundwater levels in the area. May also require installation of a staff gauge.
- b) Water requirements for ecological components of GDE.

- Vegetation.

As there is not a vegetation monitoring transect at Quin Brook, a minimum groundwater level cannot be determined following the methodology outlined above. However, comment can be made on the water depth ranges and period of inundation experienced by wetland species known to occur at the wetland.

Loomes (Loomes, 2000) described the 5 year mean and absolute water depth ranges (m) and duration of inundation (months/year) for the following species;

- *M. rhapsiophylla*; mean 0.006 to -2.14m, absolute 1.03 to -4.49m; duration of inundation - mean 2.15, absolute 9.4(months/year).
- *E. rudis*; mean -0.7 to -3.26m, absolute 1.03 to -6.44m; duration of inundation - mean 1.55, absolute 12 (months/year).
- *B. littoralis*; mean -0.39 to -1.92m, absolute 0.43 to -3.09m; duration of inundation - mean 0.3, absolute 2.8 (months/year).
- *M. preissiana*; mean -0.54 to -2.62m, absolute 1.03 to -5.04m; duration of inundation - mean 0.6, absolute 4.4 (months/year).

- Macroinvertebrates.

Due to the importance of vegetation assemblages as habitat, vegetation EWRs can be considered a surrogate for macroinvertebrate EWRs. Emergent species and littoral vegetation are likely to be of greatest importance for habitat at Quin Brook.

- Vertebrates.

Quin Brook may support fish species. Fish require permanent inundation however, can survive in isolated permanent pools over summer. It is likely that frogs also occur at Quin Brook. Frog species require 4 months of inundation to breed. The relationship between groundwater and upland vegetation may also be important for terrestrial fauna.

- Sediment processes.

To maintain sediment processes at Lake Forrestdale organic sediments must remain saturated throughout the summer each year. The water table must therefore not drop below the stratigraphic level/layer capable of providing water to surface organics through capillary rise during summer (0.5 m below ground surface).

AQUIFER AND CAVE ECOSYSTEMS

The proximity of bores to each of the caves is not known and therefore the relationship between bore water levels and the elevation (mAHD) of the caves is unknown. Until the location of the bores is known relative to the caves, it is not possible to determine the point at which water levels in the bores will fall below the floor of the specific caves. The elevation (mAHD) of the caves vary from 11.316 (Boomerang Cave) to 6.186 (Water Cave). Bores YN3, YN4 and YN5 are in the vicinity and water levels in these bores vary from 12 to 8 mAHD. However, from plots of water levels in these bores it can be seen that groundwater levels in all bores are declining, and minimum summer levels would be below the floor of some of the caves but not others – depending upon which bore was used against which cave.

It is already known that streams in some caves now run dry in summer. For example, Cabaret, Boomerang and Carpark Caves all cease flowing in summer, and have done so for the last few years. In fact, groundwater levels have declined to such an extent that streams in Cabaret and Boomerang no longer flow in winter either. This suggests that groundwater levels have fallen below the AHD of these caves for the whole year.

In general terms, if the current trends of declining maximum winter and minimum summer groundwater levels continue, then flows to these caves will not return. Also, caves which contain pools of water which currently are present throughout the year (i.e. Water Cave, Orpheus Cave, cave YN555 on Lot 51) may start to dry. For example, water levels in Water Cave drop by several cms each summer, although the pool is still permanent. However, this seasonal decline in Water Cave either reflects a reduced hydrostatic head in summer, or else that minimum summer groundwater level is starting to drop below the floor of this cave. A further decline in groundwater level of 50 – 70 cm would see Water Cave dry in summer.

Before the effects of these continuing trends may be more accurately determined, the relationship of water levels in monitoring bores to the AHD of the caves must be established by determining the exact proximity of each bore to each cave. However, as the cave floor level (mAHD) has been measured at Water Cave, Carpark Cave, Boomerang Cave and Cabaret Cave, an interim EWR that allows each cave to be inundated to a minimum dept of 0.2 m can be described.

Crystal Cave (YN1)

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Cave streams and pools support unique aquatic fauna.

2. Groundwater dependency analysis.

Clifton and Evans (2001) described karstic ecosystems as entirely dependent on groundwater for biophysical processes and habitat.

3. Revised EWRs.

- a. No current EWR. Not known which groundwater monitoring bore would be most representative of groundwater levels in the area.
- b. Water requirements for ecological components of GDE.

- Macroinvertebrates

Ancient cavernicoles most critical in terms thresholds – require perennial and stable flows to provide approx 2 – 3 cms depth in streams on cave floor with deeper pools of up to 10 – 20 cms. Therefore, maintain groundwater depth and hydrostatic head to maintain these flows. Do not know AHD of bores/levels to achieve this.

- Water quality

Stable water quality in terms of pH, DO and temperature, with minimal diel, seasonal or annual variation, showing buffering influence of groundwater. Will be achieved if above EWR for macroinvertebrates is achieved.

Water Cave (YN11)

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Cave pool and streams support unique fauna (cave root mat TEC).

2. Groundwater dependency analysis.

Clifton and Evans (2001) described karstic ecosystems as entirely dependent on groundwater for biophysical processes and habitat.

3. Revised EWRs.

- a) No current EWR. Not known which groundwater monitoring bore would be most representative of groundwater levels in the area. May also require installation of a staff gauge.
- b) Water requirements for ecological components of GDE.

- Macroinvertebrates

Water body is a standing pool of exposed water (presumably extends into floor of cave, with no perceptible flows). Excessive declines in levels are known to expose suspended root mats which then die-off and fauna are lost. Therefore, requires stable water levels. A spring minimum water level of 6.386 mAHD (6.186 mAHD + 0.2 m) may be adequate to meet these requirements.

- Water quality

Stable water quality in terms of pH, DO and temperature, with minimal diel, seasonal or annual variation, showing buffering influence of groundwater. Will be achieved if above EWR for macroinvertebrates is achieved.

Carpark Cave (YN18)

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Cave pool and streams support unique fauna (cave root mat TEC).

2. Groundwater dependency analysis.

Clifton and Evans (2001) described karstic ecosystems as entirely dependent on groundwater for biophysical processes and habitat.

3. Revised EWRs.

- a) No current EWR. Not known which groundwater monitoring bore would be most representative of groundwater levels in the area. May also require installation of a staff gauge.
- b) Water requirements for ecological components of GDE.

- **Macroinvertebrates**

Ancient cavernicoles most critical in terms thresholds – require perennial and stable flows to provide approx 2-3 cms depth in streams on cave floor with deeper pools of up to 10-20 cms. Therefore, maintain groundwater depth and hydrostatic head to maintain these flows. A spring minimum water level of 7.86 mAHD (7.66 mAHD + 0.2 m) may be adequate to meet these requirements.

- **Water quality**

Stable water quality in terms of pH, DO and temperature, with minimal diel, seasonal or annual variation, showing buffering influence of groundwater. Will be achieved if above EWR for macroinvertebrates is achieved.

Gilgie Cave (YN27)

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Cave pool and streams support unique fauna (cave root mat TEC).

2. Groundwater dependency analysis.

Clifton and Evans (2001) described base-flow dependent ecosystems of south-western WA as proportionally dependent on groundwater. This ecosystem would also rely on rainfall and surface water for biophysical processes and habitat.

3. Revised EWRs.

- a) No current EWR. Not known which groundwater monitoring bore would be most representative of groundwater levels in the area. May also require installation of a staff gauge.
- b) Water requirements for ecological components of GDE.

- **Macroinvertebrates**

Ancient cavernicoles most critical in terms thresholds – require perennial and stable flows to provide approx 2-3 cms depth in streams on cave floor with deeper pools of up to 10-20 cms. Therefore, maintain groundwater depth and hydrostatic head to maintain these flows. Do not know AHD of bores/levels to achieve this.

- **Water quality**

Stable water quality in terms of pH, DO and temperature, with minimal diel, seasonal or annual variation, showing buffering influence of groundwater. Will be achieved if above EWR for macroinvertebrates is achieved.

Cabaret Cave (YN30)

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Cave pool and streams support unique fauna (cave root mat TEC).

2. Groundwater dependency analysis.

Clifton and Evans (2001) described karstic ecosystems as entirely dependent on groundwater for biophysical processes and habitat.

3. Revised EWRs.

- a) No current EWR. Not known which groundwater monitoring bore would be most representative of groundwater levels in the area. May also require installation of a staff gauge.

b) Water requirements for ecological components of GDE.

- Macroinvertebrates

Ancient cavernicoles most critical in terms thresholds – require perennial and stable flows to provide approx 2-3 cms depth in streams on cave floor with deeper pools of up to 10-20 cms. Therefore, maintain groundwater depth and hydrostatic head to maintain these flows. A spring minimum water level of 11.375 mAHD (11.175 mAHD + 0.2 m) may be adequate to meet these requirements.

- Water quality

Stable water quality in terms of pH, DO and temperature, with minimal diel, seasonal or annual variation, showing buffering influence of groundwater. Will be achieved if above EWR for macroinvertebrates is achieved.

Boomerang Cave (YN99)

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Cave pool and streams support unique fauna (cave root mat TEC).

2. Groundwater dependency analysis.

Clifton and Evans (2001) described karstic ecosystems as entirely dependent on groundwater for biophysical processes and habitat.

3. Revised EWRs.

- a) No current EWR. Not known which groundwater monitoring bore would be most representative of groundwater levels in the area.

- b) Water requirements for ecological components of GDE.

- Macroinvertebrates

Ancient cavernicoles most critical in terms thresholds – require perennial and stable flows to provide approx 2-3 cms depth in streams on cave floor with deeper pools of up to 10-20 cms. Therefore, maintain groundwater depth and hydrostatic head to maintain these flows. A spring minimum water level of 11.516 mAHD (11.316 mAHD + 0.2 m) may be adequate to meet these requirements.

- Water quality

Stable water quality in terms of pH, DO and temperature, with minimal diel, seasonal or annual variation, showing buffering influence of groundwater. Will be achieved if above EWR for macroinvertebrates is achieved.

Twilight Cave (YN194)

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Cave pool and streams support unique fauna (cave root mat TEC).

2. Groundwater dependency analysis.

Clifton and Evans (2001) described karstic ecosystems as entirely dependent on groundwater for biophysical processes and habitat.

3. Revised EWRs.

- a) No current EWR. Not known which groundwater monitoring bore would be most representative of groundwater levels in the area.
- b) Water requirements for ecological components of GDE.
 - **Macroinvertebrates**
Ancient cavernicoles most critical in terms thresholds – require perennial and stable flows to provide approx 2-3 cms depth in streams on cave floor with deeper pools of up to 10-20 cms. Therefore, maintain groundwater depth and hydrostatic head to maintain these flows. Do not know AHD of bores/levels to achieve this.
 - **Water quality**
Stable water quality in terms of pH, DO and temperature, with minimal diel, seasonal or annual variation, showing buffering influence of groundwater. Will be achieved if above EWR for macroinvertebrates is achieved.

YN61*

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Cave pool and streams support unique fauna.

2. Groundwater dependency analysis.

Clifton and Evans (2001) described karstic ecosystems as entirely dependent on groundwater for biophysical processes and habitat.

3. Revised EWRs.

- a) No current EWR. Not known which groundwater monitoring bore would be most representative of groundwater levels in the area.
- b) Water requirements for ecological components of GDE.

- **Macroinvertebrates**
Water body is a standing pool of exposed water (presumably extends into floor of cave, with no perceptible flows). Excessive declines in levels are known to expose suspended root mats which then die-off and fauna are lost. Therefore, requires stable water levels. Do not know AHD of bores/levels to achieve this.
- **Water quality**
Stable water quality in terms of pH, DO and temperature, with minimal diel, seasonal or annual variation, showing buffering influence of groundwater. Will be achieved if above EWR for macroinvertebrates is achieved.

YN555*

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Cave pool and streams support unique fauna.

2. Groundwater dependency analysis.

Clifton and Evans (2001) described karstic ecosystems as entirely dependent on groundwater for biophysical processes and habitat.

3. Revised EWRs.

- a) No current EWR. Not known which groundwater monitoring bore would be most representative of groundwater levels in the area.
- b) Water requirements for ecological components of GDE.
- **Macroinvertebrates**
Water body is a standing pool of exposed water (presumably extends into floor of cave, with no perceptible flows). Excessive declines in levels are known to expose suspended root mats which then die-off and fauna are lost. Therefore, requires stable water levels. Do not know AHD of bores/levels to achieve this.
- **Water quality**
Stable water quality in terms of pH, DO and temperature, with minimal diel, seasonal or annual variation, showing buffering influence of groundwater. Will be achieved if above EWR for macroinvertebrates is achieved.

Orpheus Cave (YN256)*

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Cave pool and streams support unique fauna.

2. Groundwater dependency analysis.

Clifton and Evans (2001) described karstic ecosystems as entirely dependent on groundwater for biophysical processes and habitat.

3. Revised EWRs.

- a) No current EWR. Not known which groundwater monitoring bore would be most representative of groundwater levels in the area.
- b) Water requirements for ecological components of GDE.
- **Macroinvertebrates**
Water body is a standing pool of exposed water (presumably extends into floor of cave, with no perceptible flows). Excessive declines in levels are known to expose suspended root mats which then die-off and fauna are lost. Therefore, requires stable water levels. Do not know AHD of bores/levels to achieve this.
- **Water quality**
Stable water quality in terms of pH, DO and temperature, with minimal diel, seasonal or annual variation, showing buffering influence of groundwater. Will be achieved if above EWR for macroinvertebrates is achieved.

Jackhammer Cave (YN438)*

1. Revised ecological management objectives.

Recognising the cumulative impacts of abstraction history and long-term climatic and land use change, minimise the contribution of groundwater abstraction to progressive decline in the following ecological values;

- Cave pool and stream support unique fauna..

2. Groundwater dependency analysis.

Clifton and Evans (2001) described karstic ecosystems as entirely dependent on groundwater for biophysical processes and habitat.

3. Revised EWRs.

- a) No current EWR. Not known which groundwater monitoring bore would be most representative of groundwater levels in the area.
- b) Water requirements for ecological components of GDE.

- **Macroinvertebrates**

Water body is a standing pool of exposed water (presumably extends into floor of cave, with no perceptable flows). Excessive declines in levels are known to expose suspended root mats which then die-off and fauna are lost. Therefore, requires stable water levels. Do not know AHD of bores/levels to achieve this.

- **Water quality**

Stable water quality in terms of pH, DO and temperature, with minimal diel, seasonal or annual variation, showing buffering influence of groundwater. Will be achieved if above EWR for macroinvertebrates is achieved.

ESTUARINE AND NEAR-SHORE MARINE ECOSYSTEMS

Despite increasing interest in the importance of groundwater discharge to near-shore marine and estuarine ecosystems a great number of questions regarding the nature and degree of dependence remain unanswered. It is therefore not possible to describe EWRs for these ecosystems.

SECTION 3 – SUSCEPTIBILITY, RISK OF IMPACT AND POSSIBLE RESPONSE OF GDES TO DRAWDOWN

In this section comment is made on the likely response to water level changes predicted over 2, 5 and 10 year intervals (2003-05, 2003-08 and 2003-13) modelled under PRAMS 3.0. To achieve this, a GDE's susceptibility to groundwater decline is determined using a matrix of conservation values, current ecological condition, historic water level decline and current depth to groundwater.

SUSCEPTIBILITY

As part of the EWR process there is a need to identify areas of highest susceptibility to impact from water level change, to determine those GDEs that should be afforded the highest level of protection. This can be achieved through consideration of conservation value, current water levels and historic groundwater level change.

The susceptibility of a GDE to future water regime changes is directly influenced by historic water level changes and current depth to groundwater. These factors are considered important as it is unlikely for any ecosystem to evolve in the presence of groundwater without having some reliance on it. It is further suggested that if the availability of groundwater is reduced or its quality altered, these ecosystems would respond in some way regardless of their degree of dependence. If a GDE has experienced historic declines in groundwater levels it may be more susceptible to further declines than other systems. Conversely, historic groundwater rises may buffer future declines.

Conservation values require special consideration when determining the level of protection afforded to GDEs. It is difficult to apply a standard approach to the rating of conservation values for GDEs, especially when trying to differentiate between the importance of international, national and regional conservation classifications. For example, a highly modified wetland may be recognised as an internationally important water-bird habitat under the Ramsar Convention but little regional significance due to its altered nature, whereas a wetlands supporting a vegetation community that is unusual within a specific region, may have regional conservation values, but be of little international importance. Existing impacts may include clearing for urban or agricultural uses, fire, invasion by exotics (flora and/or fauna), dieback, water pollution, climatic changes and vehicular or human traffic.

Rating of susceptibility for use in the matrix should be based on the premise that the most vulnerable GDEs are those in areas of shallow groundwater that are already under pressure (stress, impact etc) from historic drawdown. Current depth to groundwater for wetlands (including base-flow systems) and terrestrial vegetation can be rated based on phreatophytic vegetation categories (0-3m, 3-6m, 6-10m and >10m) (Froend & Zencich, 2001), with the shallowest depths the most susceptible. Depths can be based on modelling or actual water depths from monitoring bores and/or surface water levels.

Long-term hydrological data from groundwater monitoring bores allows assessment of past water regimes. These data can provide comprehensive information on mean groundwater depths, seasonal and long-term changes in groundwater levels (magnitude), duration and rate of water level rise and/or decline and the seasonality of peak and low levels. Of most significance to ecosystem integrity are the mean annual depth to groundwater and magnitude, rate and duration of decline (or rise).

Rapid rates of declines over a short period will generally have had a more noticeable impact than low-rate, longer-term declines (>20 years), as ecosystem components cannot adapt to changes or migrate to more suitable habitats quickly enough. For example, phreatophytic *Banksias* have the capacity to grow new roots and to respond to drawdown by 'following' the water table down. However, this would likely be effective only where water tables changes are gradual (Zencich & Froend, 2001) and of a low magnitude.

In the current project susceptibility was determined for individual wetlands (including base-flow systems), areas of terrestrial vegetation at criteria bore sites, cave systems and a group of associated wetlands (Yeal Swamp) using conservation values, current depths to groundwater (autumn minimum 2003) and the historic water level changes (1992-2003, 1995-2003 or 1997-2003).

Wetlands

The first stage in determining level of susceptibility was to give all wetlands a conservation value. Conservation value is scored between 1-4 (highest value to lowest value), based on categories as described below (Table 5) (Froend & Loomes, 2004).

Table 5: Conservation value scores of wetlands.

Conservation value category	Score
Ecosystem with international, national or regional conservation values (legislated) that has little evidence of alteration from surrounding land-use practices.	1
Ecosystem with international, national or regional conservation values (legislated) that has evidence of low to moderate impacts from surrounding land-use practices.	2
Ecosystem that has not been assessed for conservation values or is poorly understood, and that has evidence of low to moderate impacts from surrounding land-use.	3
Ecosystem with no recognised conservation values that has been moderately to severely degraded by surrounding land-use patterns	4

The second stage in determining level of susceptibility was to consider the current (autumn minimum 2003) depth to groundwater, using hydrodata from the Water and Rivers Commission (Water and Rivers Commission (WIN), 2003). The scores for current depth to groundwater are those outlined by Froend, Loomes & Zencich (2002). Wetlands in areas of >10m to groundwater scored 4, those at 6-10m scored 3, 3-6m scored 2 and 0-3m scored 1 (Table 6).

Table 6: Wetland and terrestrial vegetation depth to groundwater scores.

Depth to groundwater (2003) category	Score
>10m	4
6-10m	3
3-6m	2
0-3m	1

The third stage was to determine the historic groundwater level change from WRC hydrodata (Water and Rivers Commission (WIN), 2003) using the scoring system outlined by Welker Environmental Consultancy (2002). Changes in water levels (surface and/or groundwater) score from 1-5 (high, moderate, low & no change or increase) depending on depth to groundwater category and the degree of water level change (Table 7). Wetlands at <10m depth to groundwater scored a 5. The periods examined for historic groundwater change were 1992-2003 for Jandakot Mound wetlands, 1995-2003 for Gngangara Mound wetlands and 1997-2003 for East Gngangara Mound wetlands. The categories used in Table 7 were based on autumn minimum levels from the earliest year during the period (ie. 1992, 1995 or 1997) (most wetlands did not change category during the period).

Table 7: Historic groundwater level change of wetlands.

Wetland Category	No change or increase (4)	Low (3)	Moderate (2)	High (1)
0-3m	-	<0.25m	0.25 to 0.5m	>0.5m
3-6m	-	<0.75m	0.75-1m	>1m
6-10m	-	<1.25m	1.25-1.5	>1.5m
>10m (5)	-	-	-	-

The final stage was to determine the susceptibility score. This was achieved by adding the scores for conservation value, current depth to groundwater and historic groundwater level change together with lower numbers representing the highest susceptibility.

For example at Loch McNess the conservation value was 1 (high) and the current depth to groundwater was 0-3m, scoring 1. The historic groundwater level change score of 3 (low) was derived by using the 1995

wetland category of 0-3m and the groundwater change between 1995 and 2003 of 0.1m which is less than 0.25m therefore leading to a score of 3. These scores added result in a susceptibility score of 5.

Terrestrial Ecosystems

As with individual wetlands the first stage in determining level of susceptibility was to give all terrestrial vegetation a conservation value. Conservation value is scored between 1-4 (highest value to lowest value) and is based on categories as described below (Table 8) (Froend & Loomes, 2004).

Table 8: Conservation value scores of terrestrial vegetation.

Conservation value category	Score
Ecosystem with international, national or regional conservational values (legislated) that has little evidence of alteration from surrounding land-use practices eg. Bush Forever sites, sites with Threatened Ecological Communities, JAMBA or CAMBA, in good condition.	1
Ecosystem with international, national or regional conservational values (legislated) that has evidence of low to moderate impacts from surrounding land-use practices eg. Bush Forever sites, sites with Threatened Ecological Communities, JAMBA or CAMBA, with low to moderate impacts.	2
Ecosystem that has not been assessed for conservation values or is poorly understood, and that has evidence of low to moderate impacts from surrounding land-use eg. sites that have low to moderate impacts but are not Bush Forever.	3
Ecosystem with no recognised conservation values that has been moderately to severely degraded by surrounding land-use patterns.	4

The second stage was to determine the current depth to groundwater (autumn minimum 2003) using hydrographs from the WRC. The scores for current depth to groundwater are those outlined by Froend *et al.* (2002). Terrestrial vegetation in areas of >10m to groundwater scored 4, those at 6-10m scored 3, 3-6m scored 2 and 0-3m scored 1 (Table 6).

The third stage was to determine the historic groundwater level change from WRC hydrodata using the scoring system outlined by Froend & Zencich (2001). The change in groundwater scored 1-5 (high to low) depending on the depth to groundwater category and the level of change in groundwater (Figure 1). The periods examined for historic groundwater level change were 1992-2003 for Jandakot Mound terrestrial criteria sites, 1995-2003 for Gngangara Mound criteria sites and 1997-2003 for East Gngangara Mound criteria sites. The categories used in Figure 1 were based on autumn minimum levels from the earliest year during the period (ie. 1992, 1995 or 1997).

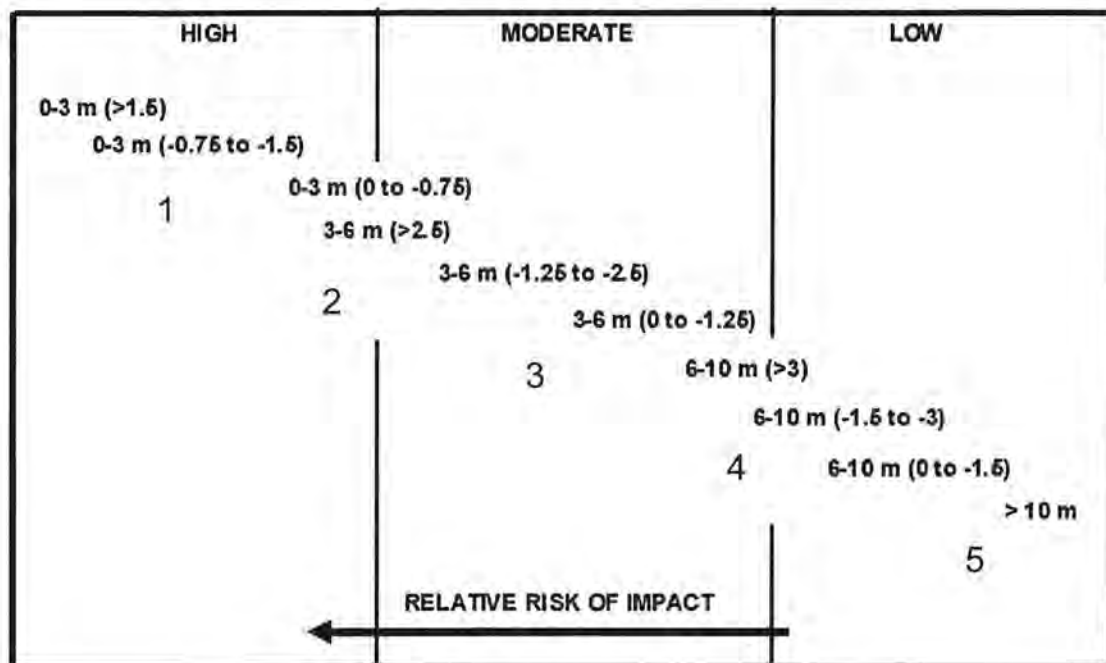


Figure 1: Historic Groundwater Level Change for Terrestrial Vegetation.

The final stage was to determine the susceptibility score. This was achieved by adding the scores for conservation value, current depth to groundwater and historic groundwater level change.

Cave and Aquifer Ecosystems

As with wetlands and terrestrial vegetation the first stage in determining level of susceptibility was to give all cave systems a conservation value. Due to the relic nature of these ecosystems they were all afforded the highest conservation value of 1. As most caves either currently contain surface water or have only dried in the recent past, all were regarded as falling in the 0-3 m depth to groundwater category. These ecosystems are recognized as totally dependent on groundwater and therefore any drawdown will, at best result in reductions in key elements of ecosystem integrity, at worst, in complete collapse of the entire ecosystem. Therefore any historic groundwater decline (recorded at the nearest monitoring bore) scored a 1. Finally, a susceptibility score was determined by adding the scores for conservation value, current depth to groundwater and historic groundwater level change.

RISK OF IMPACT

In the next step GDE susceptibility was related to proposed (modelled) changes in groundwater levels to describe the risk of impact to GDEs. Risk of impact is expressed as low (4), moderate (3), high (2) or severe (1).

Predicted water regime changes are most often the product of groundwater modelling. This ideally quantifies the spatial and temporal distribution of water level changes across a study area. This project used predicted changes at 2, 5 and 10 year intervals (2003-2005, 2003-2008 and 2003-2013) based on PRAMS 3.0. The scenario used the following components to generate results for April/May minimums (R. Vogwill, DoE, pers. comm., March 2004);

- Climate – rainfall at short-term average.
- Private Abstraction – at 100% of allocation.
- Public Abstraction – Water Corporation pumping at 135GL/yr.
- Landuse – areas from the Future Perth Plan designated for urbanisation, urbanised in 15 years.
- Pines – thinned as per LVL.

The current calibration of PRAMS is such that there are areas of 'intractable error' that are associated with (R. Vogwill, DoE, pers. comm., March 2004);

- Areas in which that the current conceptual model of the Superficial Aquifer is inadequate, often corresponding with areas of heterogeneity and the presence of impeding layers.
- Areas in which there is a large degree of uncertainty in the allocation database regarding either location or quantity of abstraction.

Unfortunately many of these areas are also those with the highest impacts, large amounts of wetlands and distinct ecological values.

Susceptibility value and predicted rates and magnitude values were combined to categorise the risk of impact (ROI). As each GDE type can exhibit a different level of groundwater dependency, different responses to the same changes in water regime may arise.

Wetlands

Future water level changes were determined using predicted modelling scenarios (PRAMS 3.0). These were presented as a series of three maps (2003-2005, 2003-2008 and 2003-2013) depicting predicted changes in groundwater levels (Department of Environment, 2003, 2004). The predicted changes scored 1-5 (severe to no change and/or increase) depending on the rate (m/yr) and magnitude of drawdown (m) (Figure 2). To achieve the final scores for risk of impact the scores for susceptibility and predicted change in groundwater levels were added for each prediction period.

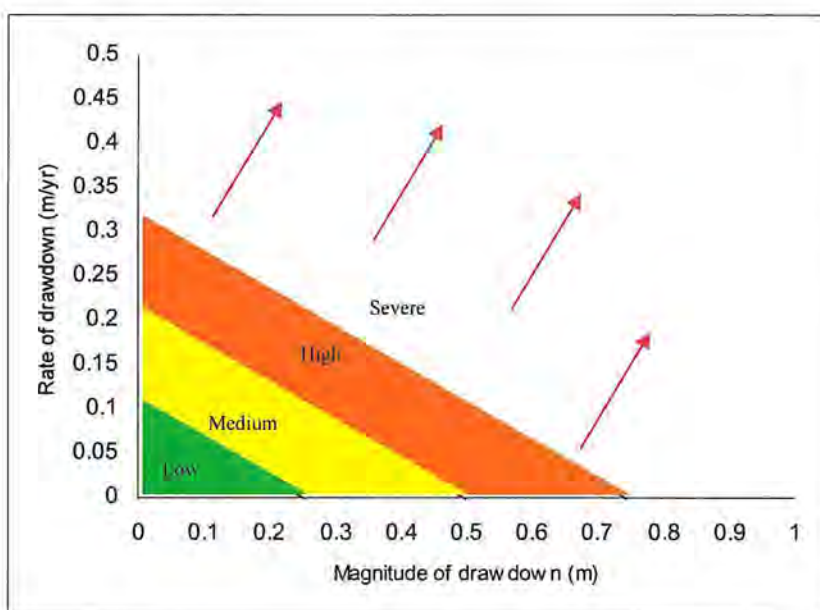


Figure 2: Risk of impact categories for wetland ecosystems based on rate and magnitude of groundwater drawdown.

Continuing with the example for Loch McNess the predicted change in groundwater levels for 2003-2005 was derived by using the predicted change in groundwater between 0.75-1.0m on the west side of the lake and the rate of drawdown (magnitude/year = $0.75/2=0.375$), therefore giving Loch McNess a score of 1 (severe). This step was repeated for all prediction periods. To achieve the final scores for risk of impact the scores for susceptibility (5) and predicted change in groundwater levels (2003-2005 = 1) were added for each prediction period. Therefore the final impact score for Loch McNess for the period 2003-2005 was 6.

Terrestrial Vegetation

Future groundwater level changes were determined using predicted modelling scenarios (PRAMS 3.0). These were presented as three maps (2003-2005, 2003-2008 and 2003-2013) depicting predicted changes in groundwater levels (Department of Environment, 2003, 2004). The predicted changes scored 1-5 (severe to no change and/or increase) depending on magnitude and rate of drawdown using the appropriate depth to groundwater category (Table 5) according to Figures 3, 4 & 5. To achieve the final scores for risk of impact

the scores for susceptibility and predicted change in groundwater levels were added for each prediction period.

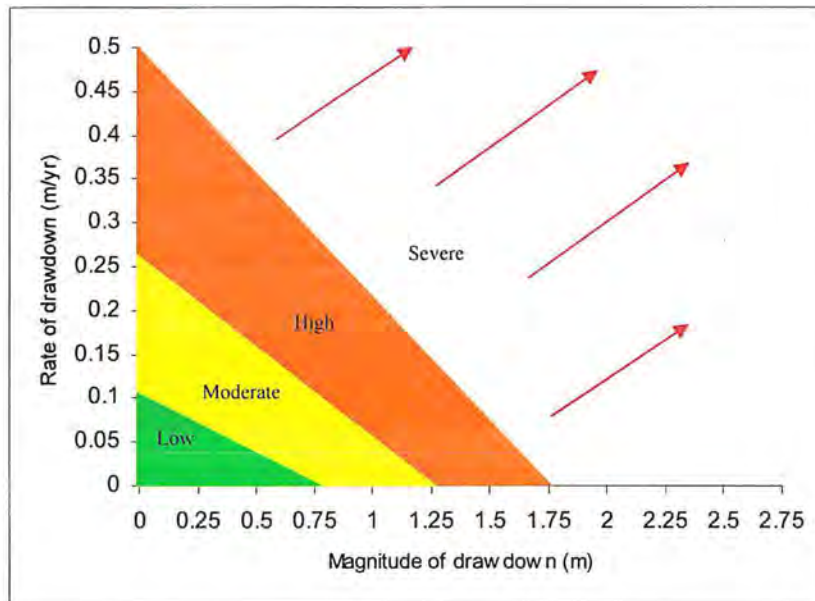


Figure 3: Risk of impact categories for phreatophytic vegetation in the 0-3m depth to groundwater grouping based on rate and magnitude of groundwater drawdown.

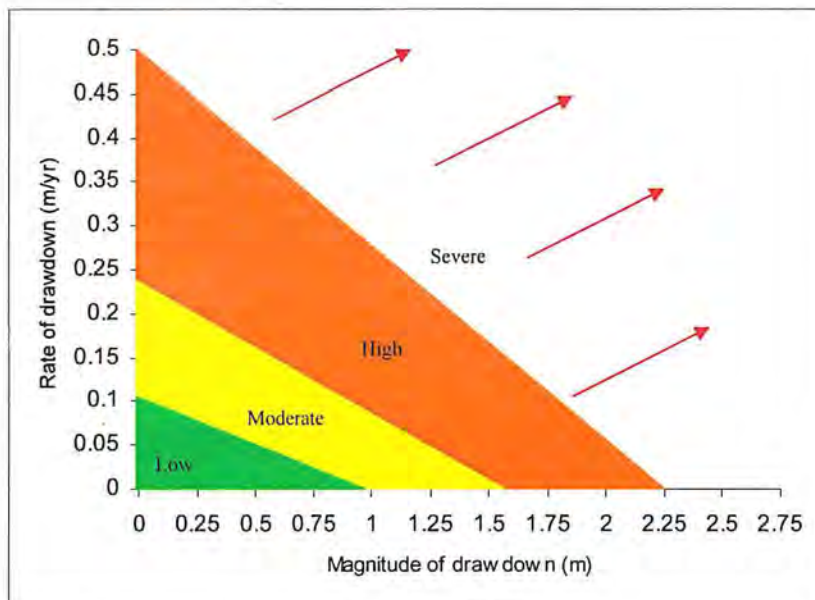


Figure 4: Risk of impact categories for phreatophytic vegetation in the 3-6m depth to groundwater grouping based on rate and magnitude of groundwater drawdown.

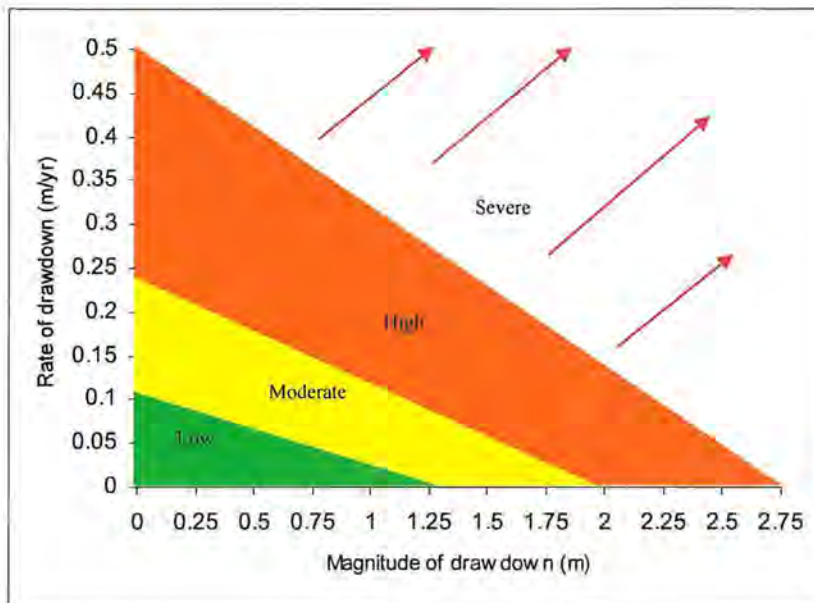


Figure 5: Risk of impact categories for phreatophytic vegetation in the 6-10m depth to groundwater grouping based on rate and magnitude of groundwater drawdown.

Cave and Aquifer Ecosystems

Future groundwater level changes were determined using predicted modelling scenarios (PRAMS 3.0). These were presented as three maps (2003-2005, 2003-2008 and 2003-2013) depicting predicted changes in groundwater levels (Department of Environment, 2003, 2004). These ecosystems are recognized as totally dependent on groundwater and therefore any drawdown will, at best result in reductions in key elements of ecosystem integrity, at worst, in complete collapse of the entire ecosystem. Therefore any predicted groundwater decline (recorded at the nearest monitoring bore) scored a 1. To achieve the final scores for risk of impact the scores for susceptibility and predicted change in groundwater levels were added for each prediction period.

LEVEL OF POSSIBLE RESPONSE TO DRAWDOWN

In this step the level of possible response of GDEs to predicted drawdown are rated based on the risk of impact score (Table 9). Scores from 4-6 are rated as a severe response, 7-9 as significant, 10-12 as moderate and 13-15 as not significant.

Tables 10-15 were adapted from Perth's Coastal Waters - Environmental Values and Objectives (Environmental Protection Authority, 2000) and describe the type of response that may occur in key elements of ecosystem integrity for each type of GDE at each level of response. Ecosystem integrity is defined as "... the ability to support and maintain a balanced, integrative, adaptive community of organisms having a species composition, diversity and functional organisation comparable to that of natural habitat of the region" (Karr, 1991).

Table 9: Matrix of conservation values, current depth to groundwater, historic groundwater level change and predicted groundwater level change to determine susceptibility, risk of impact and possible level of response of GDEs to drawdown.

Sub-group / GDE	Conservation value	Current (min 2003) depth to groundwater score	Historic water level change score	Susceptibility (conservation + current depth + historic)	Predicted groundwater level change score			Risk of impact			Level of possible impact		
					2003-05	2003-08	2003-13	2003-05	2003-08	2003-2013	2003-05	2005-08	2005-13
WETLANDS													
<i>Gngangara</i>													
<i>Herdman Complex</i>													
Loch McNess	1	1	3	5	1	1	1	6	6	6	Severe	Severe	Severe
Lake Yonderup	1	1	3	5	1	1	1	6	6	6	Severe	Severe	Severe
Lake Wilgarup	2	1	1	4	1	1	1	5	5	5	Severe	Severe	Severe
Pipjinnv Swamp	1	1	4	6	1	1	1	7	7	7	Significant	Significant	Significant
Coogee Springs	4	1	1	6	1	1	1	7	7	7	Significant	Significant	Significant
Lake Nowergup	1	1	2	4	1	1	1	5	5	5	Severe	Severe	Severe
Lake Joondalup	1	1	2	4	1	1	1	5	5	5	Severe	Severe	Severe
Lake Goollelal	2	1	3	6	1	1	1	7	7	7	Significant	Significant	Significant
Carrabooda Lake * (37849650146)	2	1	1	4	1	1	1	5	5	5	Severe	Severe	Severe
Lake Neerabup* (38205649442)	2	1	1	4	1	1	1	5	5	5	Severe	Severe	Severe
Lake Gwelup* (38561647226)	2	1	2	5	1	1	1	6	6	6	Severe	Severe	Severe
Beensup Swamp* (38625648247)	1	1	3	5	1	1	1	6	6	6	Significant	Significant	Significant
Big Carine Swamp* (38506647515)	2	1	1	4	1	1	1	5	5	5	Severe	Severe	Severe
Careniup Swamp* (38595647569)	4	1	1	6	1	1	1	7	7	7	Significant	Significant	Significant
Wallubeniup Swamp* (38696648190)	1	1	3	5	1	1	1	6	6	6	Severe	Severe	Severe
Badgerup Lake* (39028648351)	2	3	3	8	1	1	1	9	9	9	Significant	Significant	Significant
Little Badgerup Lake* (39037648274)	2	2	3	7	1	1	1	8	8	8	Significant	Significant	Significant

Sub-group / GDE	Conservation value	Current (min 2003) depth to groundwater score	Historic water level change score	Susceptibility (conservation + current depth + historic)	Predicted groundwater level change score			Risk of Impact			Level of possible Impact		
					2003-05	2003-08	2003-13	2003-05	2003-08	2003-2013	2003-05	2005-08	2005-13
Sumpland (38348649057)*	2	1	3	6	1	1	1	7	7	7	Severe	Severe	Severe
Lake Karrynyup* (38517647354)	3	1	1	5	1	1	1	6	6	6	Severe	Severe	Severe
<i>Pinjar Complex</i>													
Lake Mariginiup	2	2	2	6	1	1	1	7	7	7	Significant	Significant	Significant
Lake Jandabup	1	1	4	6	1	1	1	7	7	7	Significant	Significant	Significant
Lake Pinjar*	2	2	2	6	1	1	1	7	7	7	Significant	Significant	Significant
Little Mariginiup* (38830649035)	4	2	1	7	1	1	1	8	8	8	Significant	Significant	Significant
Hawkins Rd Swamp* (39120648926)	2	3	3	8	1	1	1	9	9	9	Significant	Significant	Significant
Lake Adams* (38844649190)	3	2	3	8	1	1	1	9	9	9	Significant	Significant	Significant
Little Adams Swamp* (38955649226)	3	4	5	12	1	1	1	13	13	13	Not sig.	Not sig.	Not sig.
Damp/land (39012649008)*	3	4	5	12	1	1	1	13	13	13	Not sig.	Not sig.	Not sig.
<i>Karrakatta Central & South Complex</i>													
Little Emu Swamp* (39360647560)	2	3	3	8	1	1	1	9	9	9	Significant	Significant	Significant
<i>Bassendean Central & South Complex</i>													
Lake Gngara	4	1	3	8	1	1	1	9	9	9	Significant	Significant	Significant
Ridges* (sumpland)	1	2	1	4	1	1	1	5	5	5	Severe	Severe	Severe
<i>Bassendean North Transition Complex - North</i>													
11 Damp/lands*													
38613651757	1	4	5	10	2	1	1	12	11	11	Moderate	Moderate	Moderate
38368651780	1	4	5	10	2	1	1	12	11	11	Moderate	Moderate	Moderate
38636651749	1	4	5	10	2	1	1	12	11	11	Moderate	Moderate	Moderate
38669651758	2	4	5	11	2	1	1	13	12	12	Not sig.	Moderate	Moderate
38731651919	2	4	5	11	2	1	1	13	12	12	Not sig.	Moderate	Moderate
38798652311	1	4	5	10	2	1	1	12	11	11	Moderate	Moderate	Moderate
38825652147	1	2	2	5	1	1	1	6	6	6	Severe	Severe	Severe
38875652172	1	2	2	5	1	1	1	6	6	6	Severe	Severe	Severe
38861652407	1	4	5	10	2	1	1	12	11	11	Moderate	Moderate	Moderate
	2	2	2	6	1	1	1	7	7	7	Significant	Significant	Significant

Sub-group / GDE	Conservation value	Current (min 2003) depth to groundwater score	Historic water level change score	Susceptibility (conservation + current depth + historic)	Predicted groundwater level change score			Risk of impact			Level of possible impact		
					2003-05	2003-08	2003-13	2003-05	2003-08	2003-2013	2003-05	2005-08	2005-13
38919652275 38933652030	2	4	3	11	2	1	1	13	12	12	Not sig.	Moderate	Moderate
<i>Bassendean North Complex - Yeal Swamp</i>													
Yeal Swamp* (38267651751)	1	4	1	6	1	1	1	7	7	7	Significant	Significant	Significant
Bindjar Lake* (38181651941)	2	4	1	7	1	1	1	8	8	8	Significant	Significant	Significant
Dampland (38488651846)*	1	4	1	6	1	1	1	7	7	7	Significant	Significant	Significant
2 Damplands* 38340651762 38337651800	1 1	4 4	1 1	6 6	1 1	1 1	1 1	7 7	7 7	7 7	Significant Significant	Significant Significant	Significant Significant
<i>Bassendean North Complex - Yeal West</i>													
Dampland (38821652464)*	1	2	2	5	1	1	1	6	6	6	Severe	Severe	Severe
2 Damplands* 38144652776 38174652305	1 2	3 1	3 1	7 4	1 1	1 1	1 1	8 5	8 5	8 5	Significant Severe	Significant Severe	Significant Severe
Sumpland (38551652525)*	1	1	1	3	1	1	1	4	4	4	Severe	Severe	Severe
Tangleloc Swamp* (37607652972)	1	4	5	10	1	1	1	11	11	11	Moderate	Moderate	Moderate
62 damplands* 37917652461 37948652434 37987652796 37981652582 37987652446 38030652677 38009652550 38024652295 38026652641 38039652524 38033652611 38036652738 38046652635	2 2 1 1 2 2 1 2 1 2 1 1 1 1	3 5 4 2 2 2 1 2 1 1 1 4 2 1	3 3 2 5 2 3 1 3 1 3 3 5 3 2	8 8 7 8 6 7 3 6 4 6 6 10 6 5	1 1 1 1 1 1 1 1 1 1 1 1 1 1	1 1 1 1 1 1 1 1 1 1 1 1 1 1	1 1 1 1 1 1 1 1 1 1 1 1 1 1	9 9 8 9 7 8 4 7 6 7 5 7 11 7 6	9 9 8 9 7 8 4 7 6 7 5 7 11 7 6	9 9 8 9 7 8 4 7 6 7 5 7 11 7 6	Significant Significant Significant Significant Significant Significant Severe Significant Severe Significant Severe Moderate Significant Severe	Significant Significant Significant Significant Significant Significant Severe Significant Severe Significant Severe Moderate Significant Severe	Significant Significant Significant Significant Significant Significant Severe Significant Severe Significant Severe Moderate Significant Severe

Sub-group / GDE	Conservation value	Current (min 2003) depth to groundwater score	Historic water level change score	Susceptibility (conservation + current depth + historic)	Predicted groundwater level change score			Risk of impact			Level of possible impact		
					2003-05	2003-08	2003-13	2003-05	2003-08	2003-2013	2003-05	2005-08	2005-13
38058652554	2	3	3	8	1	1	1	9	9	9	Significant	Significant	Significant
38083652724	2	1	1	4	1	1	1	5	5	5	Severe	Severe	Severe
38078652433	2	2	3	7	1	1	1	8	8	8	Significant	Significant	Significant
38090652633	1	2	1	4	1	1	1	5	5	5	Severe	Severe	Severe
38082652192	1	2	1	4	1	1	1	5	5	5	Severe	Severe	Severe
38088652250	2	1	1	4	1	1	1	5	5	5	Severe	Severe	Severe
38097652471	2	2	3	7	1	1	1	8	8	8	Significant	Significant	Significant
38139652681	2	1	1	4	1	1	1	5	5	5	Severe	Severe	Severe
38122652574	2	2	3	7	1	1	1	8	8	8	Significant	Significant	Significant
38147652733	1	2	3	6	1	1	1	7	7	7	Significant	Significant	Significant
38151652708	2	1	1	4	1	1	1	5	5	5	Severe	Severe	Severe
38168652666	2	2	3	7	1	1	1	8	8	8	Significant	Significant	Significant
38162652573	1	1	1	3	1	1	1	4	4	4	Severe	Severe	Severe
38167652757	1	2	3	6	1	1	1	7	7	7	Significant	Significant	Significant
38182652512	2	1	1	4	1	1	1	5	5	5	Severe	Severe	Severe
38226652757	1	2	3	6	1	1	1	7	7	7	Significant	Significant	Significant
38220652466	2	1	1	4	1	1	1	5	5	5	Severe	Severe	Severe
38230652721	2	1	3	6	1	1	1	7	7	7	Significant	Significant	Significant
38231652411	2	1	1	4	1	1	1	5	5	5	Severe	Severe	Severe
38245652664	2	1	3	6	1	1	1	7	7	7	Significant	Significant	Significant
38252652683	2	1	1	4	1	1	1	5	5	5	Severe	Severe	Severe
38266652435	2	1	1	4	1	1	1	5	5	5	Severe	Severe	Severe
38280652700	2	1	3	6	1	1	1	7	7	7	Significant	Significant	Significant
38285652373	2	1	3	6	1	1	1	7	7	7	Significant	Significant	Significant
38289652487	2	1	1	4	1	1	1	5	5	5	Severe	Severe	Severe
38287652725	2	1	1	4	1	1	1	5	5	5	Severe	Severe	Severe
38310652767	2	1	1	4	1	1	1	5	5	5	Severe	Severe	Severe
38309652440	1	1	1	3	1	1	1	4	4	4	Severe	Severe	Severe
38317652442	2	1	3	6	1	1	1	7	7	7	Significant	Significant	Significant
38336652318	2	1	1	4	1	1	1	5	5	5	Severe	Severe	Severe
38342652392	1	1	1	3	1	1	1	4	4	4	Severe	Severe	Severe
38394652578	2	1	1	4	1	1	1	5	5	5	Severe	Severe	Severe
38386652685	1	1	1	3	1	1	1	4	4	4	Severe	Severe	Severe
38361652523	2	1	1	4	1	1	1	5	5	5	Severe	Severe	Severe
38381652418	2	1	1	4	1	1	1	5	5	5	Severe	Severe	Severe
38416652349	1	2	1	4	1	1	1	5	5	5	Severe	Severe	Severe
38456652718	1	2	2	5	1	1	1	6	6	6	Severe	Severe	Severe

Sub-group / GDE	Conservation value	Current (min 2003) depth to groundwater score	Historic water level change score	Susceptibility (conservation + current depth + historic)	Predicted groundwater level change score			Risk of Impact			Level of possible impact		
					2003-05	2003-08	2003-13	2003-05	2003-08	2003-2013	2003-05	2005-08	2005-13
38415652188	2	2	1	5	1	1	1	6	6	6	Severe	Severe	Severe
38456652444	1	2	2	5	1	1	1	6	6	6	Severe	Severe	Severe
38480652351	2	3	3	8	1	1	1	9	9	9	Significant	Significant	Significant
38532652185	1	2	1	4	1	1	1	5	5	5	Severe	Severe	Severe
38533652305	1	3	3	7	1	1	1	8	8	8	Significant	Significant	Significant
38560652228	1	4	5	10	1	1	1	11	11	11	Moderate	Moderate	Moderate
38580652413	2	4	5	10	1	1	1	11	11	11	Moderate	Moderate	Moderate
38587652096	2	2	1	5	1	1	1	6	6	6	Severe	Severe	Severe
38585652194	2	1	2	5	1	1	1	6	6	6	Severe	Severe	Severe
38589652128	1	1	3	5	1	1	1	6	6	6	Severe	Severe	Severe
38642652041	1	2	3	5	1	1	1	6	6	6	Severe	Severe	Severe
38651652093	2	2	3	7	1	1	1	8	8	8	Significant	Significant	Significant
38732652377	1	1	3	5	1	1	1	6	6	6	Severe	Severe	Severe
38420652687													
38389652800													
38764652463													
38997652088													
38334652752													
Deepwater Lagoon* (38881652828)	3	1	2	6	1	1	1	7	7	7	Significant	Significant	Significant
Dampland (37797652988)*	2	4	5	11	1	1	1	12	12	12	Moderate	Moderate	Moderate
2 sumplands*													
37852653007	2	4	5	11	1	1	1	12	12	12	Moderate	Moderate	Moderate
37879652973	1	4	5	10	1	1	1	11	11	11	Moderate	Moderate	Moderate
<i>Bassenden North Complex - Tick Flat</i>													
Tick Flat* (37632652620)	2	4	5	11	1	1	1	12	12	12	Moderate	Moderate	Moderate
4 Damplands*													
37668652593	2	4	5	11	1	1	1	12	12	12	Moderate	Moderate	Moderate
37577652591	1	4	5	10	1	1	1	11	11	11	Moderate	Moderate	Moderate
37588652556	2	4	5	11	1	1	1	12	12	12	Moderate	Moderate	Moderate
37593652546	2	4	5	11	1	1	1	12	12	12	Moderate	Moderate	Moderate
<i>Bassenden North Complex - Yeal East</i>													
Lake Mukenburra* (38405653196)	1	1	3	5	1	2	1	6	7	6	Severe	Significant	Severe

Sub-group / GDE	Conservation value	Current (min 2003) depth to groundwater score	Historic water level change score	Susceptibility (conservation + current depth + historic)	Predicted groundwater level change score			Risk of impact			Level of possible impact			
					2003-05	2003-08	2003-13	2003-05	2003-08	2003-2013	2003-05	2005-08	2005-13	
17 Damplands*														
38821652464	1	2	2	5	1	1	1	6	6	6	Severe	Severe	Severe	
38829652308	2	2	2	6	1	1	1	7	7	7	Significant	Significant	Significant	
38831651988	1	4	5	10	1	2	1	11	12	11	Moderate	Moderate	Moderate	
38898652368	1	2	2	5	1	1	1	6	6	6	Severe	Severe	Severe	
38861652005	1	4	5	10	1	2	1	11	12	11	Moderate	Moderate	Moderate	
38913652246	2	2	2	6	1	1	1	7	7	7	Significant	Significant	Significant	
38913652012	1	4	5	10	1	2	1	11	11	11	Moderate	Moderate	Moderate	
38919652275	3	2	2	7	1	1	1	8	8	8	Significant	Significant	Significant	
38933652030	3	2	2	7	1	1	1	8	8	8	Significant	Significant	Significant	
38951652330	1	2	2	5	1	1	1	6	6	6	Severe	Severe	Severe	
38973652008	2	4	5	11	1	2	1	12	13	12	Moderate	Not sig.	Moderate	
39008652386	1	3	3	7	1	2	1	8	9	8	Significant	Significant	Significant	
39008652298	1	3	3	7	1	2	1	8	9	8	Significant	Significant	Significant	
39026652224	1	3	3	7	1	2	1	8	9	8	Significant	Significant	Significant	
39045652254	1	3	3	7	1	2	1	8	9	8	Significant	Significant	Significant	
39058652235	2	3	3	8	1	2	1	9	10	9	Significant	Moderate	Significant	
38685652685	1	2	1	4	1	1	1	5	5	5	Severe	Severe	Severe	
2 Sumplands*														
38570652790	1	2	1	4	1	1	1	5	5	5	Severe	Severe	Severe	
38606652771	1	2	1	4	1	1	1	5	5	5	Severe	Severe	Severe	
Sumpland (38773652686)*	3	2	2	8	1	1	1	9	9	9	Significant	Significant	Significant	
Floodplain (39108652522)*	3	2	2	8	1	1	1	9	9	9	Significant	Significant	Significant	
Sumpland (38828652623)*	3	2	2	7	1	1	1	8	8	8	Significant	Significant	Significant	
<i>Bassendean North Complex - Lexia</i>														
Lexia 86	1	1	3	5	4	4	3	9	9	8	Significant	Significant	Significant	
Lexia 186	1	1	2	4	4	4	3	8	8	7	Significant	Significant	Significant	
Lexia 94	1	1	3	5	4	4	3	9	9	8	Significant	Significant	Significant	
4 sumplands*														
40141648670	1	2	3	6	2	3	2	8	9	8	Significant	Significant	Significant	
40132648626	1	2	3	6	2	3	2	8	9	8	Significant	Significant	Significant	
40149648594	1	2	3	6	2	3	2	8	9	8	Significant	Significant	Significant	
40163648635	1	2	3	6	2	3	2	8	9	8	Significant	Significant	Significant	
Dampland (40135648601)*	1	3	3	7	3	5	5	10	12	12	Moderate	Moderate	Moderate	

Sub-group / GDE	Conservation value	Current (min 2003) depth to groundwater score	Historic water level change score	Susceptibility (conservation + current depth + historic)	Predicted groundwater level change score			Risk of impact			Level of possible impact			
					2003-05	2003-08	2003-13	2003-05	2003-08	2003-2013	2003-05	2005-08	2005-13	
2 Sump/lands*														
40156648685	1	3	3	7	3	5	4	10	12	11	Moderate	Moderate	Moderate	
40238648707	1	3	3	7	3	5	4	10	12	11	Moderate	Moderate	Moderate	
Dampland (40203648567)*	1	3	3	7	3	5	4	10	12	11	Moderate	Moderate	Moderate	
Sump/land (40256648635)*	1	4	5	10	5	5	5	15	15	15	Not sig.	Not sig.	Not sig.	
2 Sump/land (40292643721, 40148648729)*	1 2	4 3	5 3	10 8	3 3	5 5	5 4	13 11	15 13	15 12	Moderate	Not sig.	Moderate	
2 Damplands*														
40297648659	1	4	5	10	5	5	5	15	15	15	Not sig.	Not sig.	Not sig.	
40346648651	1	4	5	10	5	5	5	15	15	15	Not sig.	Not sig.	Not sig.	
Sump/land (40140648683)*	1	2	3	6	2	5	3	8	11	9	Significant	Moderate	Significant	
Dampland (40272648506)*	1	4	5	10	5	5	5	15	15	15	Not sig.	Not sig.	Not sig.	
Kings Spring (The Maze)*	1	2	5	8	2	2	1	10	10	9	Significant	Significant	Significant	
<i>Bassendean North Complex - Melaleuca Park</i>														
EPP Weiland 173	1	1	3	5	3	3	2	8	8	7	Significant	Significant	Significant	
Dampland 78	2	2	3	7	1	1	1	8	8	8	Significant	Significant	Significant	
Dampland (39496649584)*	1	2	3	6	2	2	1	8	8	7	Significant	Significant	Significant	
25 damplands*														
39455649394	1	1	3	5	1	1	1	6	6	6	Severe	Severe	Severe	
39464649585	2	2	3	7	5	5	1	12	12	8	Moderate	Moderate	Significant	
39478649638	2	2	3	7	5	5	5	12	12	12	Moderate	Moderate	Moderate	
39498649656	2	2	3	7	1	1	1	8	8	8	Significant	Significant	Significant	
39507649695	1	3	3	7	2	3	1	9	10	8	Significant	Moderate	Significant	
39513649527	2	2	3	7	1	1	1	8	8	8	Significant	Significant	Significant	
39514649463	2	1	3	6	1	1	1	7	7	7	Significant	Significant	Significant	
39527649600	2	2	3	7	1	1	1	8	8	8	Significant	Significant	Significant	
39547649649	2	1	3	6	1	1	1	7	7	7	Significant	Significant	Significant	
39541649417	2	1	3	6	1	1	1	7	7	7	Significant	Significant	Significant	
39565649347	2	2	3	7	1	1	1	8	8	8	Significant	Significant	Significant	
39550649619	3	1	3	7	1	1	1	8	8	8	Significant	Significant	Significant	

Sub-group / GDE	Conservation value	Current (min 2003) depth to groundwater score	Historic water level change score	Susceptibility (conservation + current depth + historic)	Predicted groundwater level change score			Risk of impact			Level of possible impact			
					2003-05	2003-08	2003-13	2003-05	2003-08	2003-2013	2003-05	2005-08	2005-13	
30559649393														
39572649792	2	3	3	8	1	1	1	9	9	9	Significant	Significant	Significant	
39616649454	2	1	3	6	1	1	1	7	7	7	Significant	Significant	Significant	
39627649484	1	1	3	5	1	1	1	6	6	6	Severe	Severe	Severe	
39647649353	2	1	3	6	1	1	1	7	7	7	Significant	Significant	Significant	
39712649551	2	1	3	6	1	1	1	7	7	7	Significant	Significant	Significant	
39876649518	2	2	3	7	1	1	1	8	8	8	Significant	Significant	Significant	
39876649518	2	1	3	6	1	1	1	7	7	7	Significant	Significant	Significant	
39906649362	2	1	3	6	1	1	1	7	7	7	Significant	Significant	Significant	
39592649232	2	1	3	6	1	1	1	7	7	7	Significant	Significant	Significant	
39685649249	2	1	3	6	1	1	1	7	7	7	Significant	Significant	Significant	
39660649160	2	1	3	6	1	1	1	7	7	7	Significant	Significant	Significant	
39813649148	1	1	3	5	1	1	1	6	6	6	Significant	Severe	Severe	
39881649161														
Dampland (39183649754)*	2	4	1	7	5	5	4	12	12	11	Moderate	Moderate	Moderate	
6 damplands*														
39421649304	2	1	3	6	1	1	1	7	7	7	Significant	Significant	Significant	
39442649618	2	2	3	7	5	2	1	12	9	8	Moderate	Significant	Significant	
39443649445	2	1	3	6	5	1	1	11	7	7	Moderate	Significant	Significant	
39433649770	2	4	5	11	3	3	1	14	14	12	Not sig.	Not sig.	Moderate	
39510659739	2	3	3	8	3	3	1	11	11	9	Moderate	Moderate	Significant	
39575649169	3	1	3	7	1	1	1	8	8	8	Significant	Significant	Significant	
Sumpland (39969949158)*	1	4	3	8	1	1	1	9	9	9	Significant	Significant	Significant	
6 sumplands*														
39556649708	1	3	3	7	2	1	1	9	8	8	Significant	Significant	Significant	
39554649527	2	1	3	6	2	2	1	8	8	8	Significant	Significant	Severe	
39582649556	2	1	2	5	2	2	1	7	7	6	Significant	Significant	Severe	
39576649679	2	2	3	7	1	1	1	8	8	8	Significant	Significant	Significant	
39610649565	1	1	3	5	1	1	1	6	6	6	Severe	Severe	Severe	
39653649561	2	1	3	7	1	1	1	8	8	8	Significant	Significant	Significant	
Sumpland (39920649456)*	1	4	3	8	1	1	1	9	9	9	Significant	Significant	Significant	
<i>Bassendean North Complex – East Pinjar</i>														
Edgecombe Seepage and Lake Yakine	1	1	2	4	5	5	5	9	9	9	Significant	Significant	Significant	

Sub-group / GDE	Conservation value	Current (min 2003) depth to groundwater score	Historic water level change score	Susceptibility (conservation + current depth + historic)	Predicted groundwater level change score			Risk of impact			Level of possible impact		
					2003-05	2003-08	2003-13	2003-05	2003-08	2003-2013	2003-05	2005-08	2005-13
Egerton Seepage	1	1	3	5	5	5	5	10	10	10	Moderate	Moderate	Moderate
<i>Funga Complex</i>													
Bambun Lake* (39435652283)	1	3	2	6	2	4	3	8	10	9	Significant	Moderate	Significant
Lake Nambung* (39421652168)	2	1	3	6	1	3	1	7	9	7	Significant	Significant	Significant
Lake Mungala* (39482652119)	2	1	3	6	1	3	1	7	10	7	Significant	Moderate	Significant
Springs on Lot 11 Archibald St., Muchea			3										
Spring sites 3s, 3b, 3r, 4 3ps, 5pd, 5d, 6 & 7.			3										
<i>Jandakot</i>													
<i>Herdman Complex</i>													
Thomsons Lake	1	1	1	3	1/3	1/2	1	4/6	4/5	4	Severe	Severe	Severe
North Lake	1	1	1	3	1/3	1/2	1	4/6	4/5	4	Severe	Severe	Severe
Banganup Swamp	1	1	1	3	1	1/2	1/2	4	4/5	4/5	Severe	Severe	Severe
Bibra Lake	1	1	1	3	1	2/3	1	4	5/6	4	Severe	Severe	Severe
Yangebup Lake	2	1	1	4	1	1/2	1/2	5	7/8	5/6	Severe	Significant	Severe
Kogolup Lake	2	1	1	4	1	2/3	1/2	5	6/7	5/6	Severe	Sig/severe	Severe
Little Rush Lake*													
Spectacles North* (39041643485)	1	1	1	3	2	1	2	5	4	5	Severe	Severe	Severe
East Swamp*													
Hope Rd Lake*													
<i>Bassendean Central & South Complex</i>													
Shirley Balla Swamp	1	1	1	3	3	1	1	6	4	4	Severe	Severe	Severe
Twin Bartram	2	1	4	7	3	2	2	10	9	9	Moderate	Significant	Significant
Beenvup Rd Swamp	2	1	1	4	3	1	1	7	5	5	Significant	Severe	Severe
Mather Reserve* (39361644253)	1	1	2	4	3	1	3	7	5	7	Significant	Severe	Significant
Copolup Lake*													
Branch St Swamp*													
Forest-Tapper Swamp*													

Sub-group / GDE	Conservation value	Current (min 2003) depth to groundwater score	Historic water level change score	Susceptibility (conservation + current depth + historic)	Predicted groundwater level change score			Risk of Impact			Level of possible impact			
					2003-05	2003-08	2003-13	2003-05	2003-08	2003-2013	2003-05	2005-08	2005-13	
Solomon Rd Swamp*														
Mandogalup (Wattleup) Lake*														
<i>Karrakatta Central & South Complex</i>														
Forrestdale Lake	1	1	2	4	1	3/5	5/2	5	7/9	9/6	Severe	Significant	Sig./severe	
<i>Southern River Complex</i>														
Harrisdale Swamp* (39867644655)	1	1	2	4	3	3	3	7	7	7	Significant	Significant	Significant	
Lake Balanup*														
TERRESTRIAL ECOSYSTEMS														
<i>Gngangara</i>														
<i>Herdsmen Complex</i>														
PM24	1	1	2	4	3	3	3	7	7	7	Significant	Significant	Significant	
Badgerup Lake & Adjacent Bushland, Wanneroo*														
Yellagonga Regional Park, Wanneroo / Woodvale*														
<i>Pinjar Complex</i>														
MT35	1	3	5	9	2	1	1	11	10	10	Moderate	Moderate	Moderate	
JB5	3	2	3	8	1	1	1	9	9	9	Significant	Significant	Significant	
Numbat Road Bushland, Manjimup*														
Little Coogee Flat, Pinjar														
<i>Bassendean Central & South Complex</i>														
MM18	1	2	3	6	5	5	5	11	11	11	Moderate	Moderate	Moderate	
MM53	1	2	5	8	5	5	5	13	13	13	Not sig.	Not sig.	Not sig.	
MM59B	1	2	3	6	3	4	4	9	10	10	Significant	Moderate	Moderate	
MM55B	2	1	5	8	2	4	4	10	12	12	Moderate	Moderate	Moderate	
MM49B	2	2	5	9	2	4	5	11	13	14	Moderate	Not sig.	Not sig.	
MM16	1	2	5	8	1	1	1	9	9	9	Significant	Significant	Significant	

Sub-group / GDE	Conservation value	Current (min 2003) depth to groundwater score	Historic water level change score	Susceptibility (conservation + current depth + historic)	Predicted groundwater level change score			Risk of impact			Level of possible impact		
					2003-05	2003-08	2003-13	2003-05	2003-08	2003-2013	2003-05	2005-08	2005-13
Gngangara Lake & adjacent Bushland, Gngangara*													
<i>Bassendean North</i>													
PM9	2	3	4	9	2	3	2	11	12	11	Moderate	Moderate	Moderate
WM1	1	2	3	6	5	5	4	11	11	10	Moderate	Moderate	Moderate
WM2	1	2	3	6	3	2	1	9	8	7	Significant	Significant	Significant
WM6	2	3	5	10	5	4	3	15	14	13	Not sig.	Not sig.	Not sig.
WM8	1	2	3	6	1	1	1	7	7	7	Significant	Significant	Significant
NR6C	1	2	3	6	1	1	1	7	7	7	Significant	Significant	Significant
NR11C	1	2	3	6	1	1	1	7	7	7	Significant	Significant	Significant
L30	1	2	3	6	2	4	3	8	10	9	Significant	Moderate	Moderate
L110C	2	3	5	10	5	4	3	15	14	13	Not sig.	Not sig.	Not sig.
L220C	1	2	3	6	4	3	3	10	9	9	Moderate	Significant	Significant
MM12	1	2	3	6	2	2	3	8	8	9	Significant	Significant	Significant
State Forest 65 – Gngangara Plantation Bushland*													
Rosella Rd Bushland* 3-6m	1	2	3	6	3	2	2	9	8	8	Significant	Significant	Significant
Rosella Rd Bushland* 6-10m	1	3	4	8	4	3	3	12	11	11	Moderate	Moderate	Moderate
Della Road South Bushland, Bullsbrook*													
Wabling Management Priority Area*													
Yeal Nature Reserve*													
Tangletoe*													
Kirby Road Bushland, Bullsbrook*													
Mueha Air Weapons Range Bushland*	1	3	4	8	4	3	4	12	11	12	Moderate	Moderate	Moderate
<i>Bassendean North Transition Complex</i>													
Hawkins Road Bushland, Jandabup*													
<i>Cottesloe Central & South Complex</i>													

Sub-group / GDE	Conservation value	Current (min 2003) depth to groundwater score	Historic water level change score	Susceptibility (conservation + current depth + historic)	Predicted groundwater level change score			Risk of impact			Level of possible impact		
					2003-05	2003-08	2003-13	2003-05	2003-08	2003-2013	2003-05	2005-08	2005-13
Wilbinga-Caraban Bushland*													
Yanchep National Park *													
<i>Cottesloe North / Cottesloe Central & South Complex</i>													
Ridges & adjacent Bushland – Yanchep*	1	2	1	4	1	1	1	5	5	5	Severe	Severe	Severe
State Forest 65 – Pinjar Plantation South Bushland, Nowergup / Yanchep / Neerabup*													
Neerabup National Park, Lake Nowergup Nature Reserve *													
Garden Park Bushland, Wanneroo*													
High Road Bushland, Wanneroo*													
Errina Road Bushland*													
Lake Gwelup Reserve*													
Decourcey Way Bushland, Marangaroo*													
Landsdale Road Bushland, Landsdale*													
Koondoola Regional Bushland*													
<i>Southern River Complex</i>													
Cardinal Drive Bushland, Ellenbrook*													
Caversham Airbase Bushland, West Swan*													

Sub-group / GDE	Conservation value	Current (min 2003) depth to groundwater score	Historic water level change score	Susceptibility (conservation + current depth + historic)	Predicted groundwater level change score			Risk of impact			Level of possible impact		
					2003-05	2003-08	2003-13	2003-05	2003-08	2003-2013	2003-05	2005-08	2005-13
<i>Yanga Complex</i>													
Ellenbrook, Upper Swan*													
Bullsbrook Nature Reserve*													
Sawpit Road Bushland*													
Twin Swamps Nature Reserve*													
Ellenbrook Nature Reserve*													
<i>Jandakot</i>													
<i>Herdsmen Complex</i>													
JE17C	1	1	5	7	2	4	4	9	11	11	Significant	Moderate	Moderate
Harry Waring Marsupial Reserve*													
<i>Bussendean Central & South Complex</i>													
JE10C	3	2	5	10	3	3	3	13	13	13	Not sig.	Not sig.	Not sig.
JM31	3	2	2	7	3	3	4	10	10	11	Moderate	Moderate	Moderate
JM19	2	3	1	6	4	4	4	10	10	10	Moderate	Moderate	Moderate
JM35	1	2	5	8	2	3	3	10	11	11	Moderate	Moderate	Moderate
JE4C	1	2	3	6	2	3	3	8	9	9	Significant	Significant	Significant
JM7	2	2	3	7	1	3	4	8	10	11	Significant	Moderate	Moderate
JM8	1	2	3	6	1	4	4	7	10	10	Significant	Moderate	Moderate
JM45	1	2	3	6	2	4	4	8	10	10	Significant	Moderate	Moderate
8284	3	2	1	6	2	4	4	8	10	10	Significant	Moderate	Moderate
JM49	3	2	3	8	1	2	3	9	10	11	Significant	Moderate	Moderate
JM39	3	2	3	8	1	3	3	9	11	11	Significant	Moderate	Moderate
North Lake, North Lake*													
Bibra Lake, Bibra Lake*													
South Lake*													
Mandogalup Road Bushland*													

Sub-group / GDE	Conservation value	Current (min 2003) depth to groundwater score	Historic water level change score	Susceptibility (conservation + current depth + historic)	Predicted groundwater level change score			Risk of Impact			Level of possible impact		
					2003-05	2003-08	2003-13	2003-05	2003-08	2003-2013	2003-05	2005-08	2005-13
<i>The Spectacles*</i>													
Sandy Lake*													
Sicklemore Road Bushland*													
Casuarina Prison Bushland*													
Wandi Nature Reserve*													
Banjup Bushland*													
Modong Nature Reserve*													
<i>Cottesloe Central & South Complex</i>													
JM16	1	2	2	5	4	5	5	9	10	10	Significant	Moderate	Moderate
JM14	1	2	3	6	2	4	4	8	10	10	Significant	Moderate	Moderate
<i>Southern River Complex</i>													
Piara Nature Reserve*													
Anstey/Kcane dampland & adjacent Bushland*	2	1	1	4	2	3	3	6	7	7	Severe	Significant	Significant
Balannup & adjacent Bushland*													
<i>Karrakatta Central & South Complex</i>													
Yangebup & Little Rush Lakes, Yangebup*													
Forrestdale Lake & adjacent Bushland*													
BASE-FLOW SYSTEM													
Ellen Brook creek system (on boundary of study area)	1												
Quin Brook Lake 181 (38749652539)*	1	2	3	6	1	1	1	7	7	7	Significant	Significant	Significant

Sub-group / GDE	Conservation value	Current (min 2003) depth to groundwater score	Historic water level change score	Susceptibility (conservation + current depth + historic)	Predicted groundwater level change score			Risk of impact			Level of possible impact		
					2003-05	2003-08	2003-13	2003-05	2003-08	2003-2013	2003-05	2005-08	2005-13
Sumpland 61 (38385652763)*	1	1	2	4	1	1	1	5	5	5	Severe	Severe	Severe
Floodplain 48 (38231652928)*	1	2	2	5	1	1	1	6	6	6	Severe	Severe	Severe
Floodplain 88 (58454652772)*	1	1	3	5	1	1	1	6	6	6	Severe	Severe	Severe
Bennett Brook	1												
Lennards Brook (on boundary of study area)*	1												
CAVE AND AQUIFER ECOSYSTEMS													
Crystal Cave (YN1)	1	1	1	3	1	1	1	4	4	4	Severe	Severe	Severe
Water Cave (YN11)	1	1	1	3	1	1	1	4	4	4	Severe	Severe	Severe
Carpark Cave (YN18)	1	1	1	3	1	1	1	4	4	4	Severe	Severe	Severe
Gilgie Cave (YN27)	1	1	1	3	1	1	1	4	4	4	Severe	Severe	Severe
Cabaret Cave (YN30)	1	1	1	3	1	1	1	4	4	4	Severe	Severe	Severe
Boomerang Cave (YN99)	1	1	1	3	1	1	1	4	4	4	Severe	Severe	Severe
Twilight Cave (YN194)	1	1	1	3	1	1	1	4	4	4	Severe	Severe	Severe
Un-named cave (YN61)	1	1	1	3	1	1	1	4	4	4	Severe	Severe	Severe
Cave on Lot 51 (YN555)	1	1	1	3	1	1	1	4	4	4	Severe	Severe	Severe
Orpheus Cave (YN256) 1	1	1	1	3	1	1	1	4	4	4	Severe	Severe	Severe
Jackhammer Cave (YN458)	1	1	1	3	1	1	1	4	4	4	Severe	Severe	Severe
ESTUARINE AND NEAR-SHORE MARINE ECOSYSTEMS													
Marmion Marine Park													
Limestone reefs													
Seagrass Meadows													
Wrack (Detached Macrophytes)													
Un-vegetated Sand													

Sub-group / GDE	Conservation value	Current (min 2003) depth to groundwater score	Historic water level change score	Susceptibility (conservation + current depth + historic)	Predicted groundwater level change score			Risk of impact			Level of possible impact		
					2003-05	2003-08	2003-13	2003-05	2003-08	2003-2013	2003-05	2005-08	2005-13
Water Column													

Table 10: Possible response to drawdown in the key elements of wetland ecosystems for 4 degrees of risk of impact (adapted from Environmental Protection Authority, 2000, p.20).

Wetlands	Risk of impact and possible response to drawdown			
	Not significant (no detectable change)	Moderate (small change)	Significant (moderate change)	Severe (large change)
<i>Ecosystem processes</i>				
- Primary production	Rates of primary production are maintained within the limits of natural variation.	Some evidence of reduction in rates of primary production in response to drying.	Measurable reductions in rates of primary production in response to drying.	Severe reductions in rates of primary production in response to drying.
- Nutrient recycling	Rates of nutrient recycling are maintained within the limits of natural variation.	Some evidence of reduction in rates of nutrient recycling in response to drying.	Measurable reductions in rates of nutrient recycling in response to drying.	Severe reductions in rates of nutrient recycling in response to drying.
- Foodchains	No detectable change in foodchains.	Some evidence of disruption to foodchains.	Measurable disruptions to foodchains.	Severe disruptions to foodchains.
- Sediment stabilisation	No detectable change in sediment stabilisation.	No detectable change in sediment stabilisation.	Some evidence of sediment destabilisation.	Measurable destabilisation of wetland sediments.
- Pollutant filtration	No detectable change in rates of pollutant filtration	No detectable change in rates of pollutant filtration	Some evidence of change in rates of pollutant filtration.	Measurable reductions in rates of pollutant filtration.
<i>Biodiversity (vegetation)</i>				
- Species composition	No detectable change in species composition.	Some evidence of establishment of exotic species as result of disturbance and/or drying.	Measurable encroachment of xeric species into wetland.	Significant change in dominant populations with terrestrialisation through encroachment of xeric species.
- Species distribution	No detectable change in distribution of species.	Some evidence of changing distribution with disturbance and/or drying allowing establishment of exotic species.	Measurable contraction of wetland through changing demographics of more than one species; with encroachment of xeric species into the wetland.	Greater than 50% reduction in abundance of dominant species and /or significance change in dominant populations, with terrestrialisation through encroachment of xeric species.
- Species mortality	No detectable mortality.	Some mortality of individuals.	Greater than 15% reduction in abundance of dominant species.	Greater than 50% reduction in abundance of dominant species.
- Species richness	No detectable change in species richness.	Some evidence of decline in richness of wetland species.	Measurable decline in richness of wetland species and/or increase xeric species richness.	Significant change in richness of wetland species and replacement by xeric species.
- Community structure	No detectable change in community structure.	Some evidence of change in community structure.	Notable change in community structure.	Significant change in community structure.
<i>Abundances and biomass of biota</i>				
- Vegetation density, cover and frequency	No detectable change in density, cover and abundance.	Some evidence of reduced growth in overstorey and/or understorey species.	Measurable crown dieback in overstorey species and/or reduction in cover of understorey.	Substantial crown dieback in overstorey species and loss of density and cover in understorey.
- Vegetation height and diameter	No detectable change in vegetation height and diameter.	Some evidence of change in height due to loss of vigour and/or thinning of canopy.	Measurable reductions in height due to loss of canopy and/or reduced diameter of adult stems.	Significant reductions in height due to loss of canopy and reduced diameter of adult stems.
- Vertebrate abundance	No detectable change in vertebrate abundance.	Some evidence of reduced vertebrate abundance.	Measurable changes in vertebrate abundance due to reduction in food and/or habitat availability as result of drying.	Greater than 50% reduction in vertebrate abundance due to reduction in food and/or habitat availability as result of drying.
- Macroinvertebrate abundance	No detectable change in macroinvertebrate abundance.	Some evidence of reduced macroinvertebrate abundance.	Measurable changes in vertebrate abundance due to reduction in food and/or habitat availability as result of drying.	Greater than 50% reduction in vertebrate abundance due to reduction in food and/or habitat availability as result of drying.
<i>Quality of water and sediment</i>				
- Physical and biochemical properties of sediments and groundwater	Levels of contaminants & other measures of quality remain within limits of natural variation.	Small detectable changes beyond limits of natural variation but no resultant effect on biota.	Moderate changes beyond limits of natural variation but not to exceed specified criteria.	Substantial changes beyond limits of natural variation.

- Wetlands

- Ecosystem processes

Wetland water levels fluctuate both seasonally and inter-annually in response to rainfall, with groundwater and wetland water levels generally higher in years of high rainfall and lower during poor rainfall years. Prolonged periods of drying induced or exacerbated by drawdown may reduce primary production and nutrient recycling as well as disrupting foodchains. In extreme cases of drying the loss of wetland vegetation may result in sediment destabilization and reduction of pollutant filtration.

- Biodiversity

Progressive drying results in alteration of vegetation habitat type that often leads to colonisation of more xerophytic species (more tolerant of drier conditions). The process of terrestrialisation is the gradual process of dryland plant species colonisation, encroachment and dominance of a site. This is usually a response to a gradual drying of a wetland to the point where water requirements of wetland species can no longer be met. The consequent death of mesophytic wetland species and decline of their populations is followed by gradual colonisation and replacement by xerophytic dryland species with lower water requirements. The process is not irreversible and is commonly interrupted by changes in rainfall patterns and hydrological support mechanisms.

The potential for colonisation by exotic plant species is increased if the impact of drawdown has resulted in canopy decline and suitable habitat for weeds becoming available. The potential for weed invasion depends on the proximity of propagule sources (e.g. from nearby agricultural land uses) and site conditions. Rapid and extensive weed growth has significant ramifications for native species recruitment success, preventing seedling establishment and increasing the risk of disturbance by fire. Invasive species (ruderals) may come to dominate wetland vegetation (e.g. *Typha*) in rare cases.

Reduced or lost structural diversity and populations of aquatic fauna may occur in response to reduced habitat. For example, reduced open water in permanent wetlands during later months of dry season will reduce available habitat for water birds. Lifecycles of invertebrates are often timed to enable completion while seasonal wetlands contain water. Groundwater decline may disrupt these cycles preventing reproduction and/or maturation of aquatic invertebrate species and their ultimate loss from the wetland.

- Abundances and biomass of biota

Alteration of vegetation habitat as a result of groundwater decline will also impact on the abundance of individual plant and fauna species. Vegetation abundance refers to quantity and is measured by number, size or extent. It includes density, cover and frequency as well as measures of size such as biomass, height or diameter. As described in relation to biodiversity, groundwater declines may lead to terrestrialisation of a wetland ecosystem. This will lead to reduction in abundances of wetland vegetation species and an increase in terrestrial species.

Abundances of vertebrate and invertebrate fauna reliant on wetlands and/or wetland vegetation for habitat, breeding grounds, feeding or as a direct source of water, will generally also be negatively impacted by declining water levels.

- Quality of water and sediment

Groundwater declines and the subsequent drying of wetlands will result in changes in physical and biochemical characteristics in wetland sediments and altered physicochemical properties of the water column. Eutrophication may occur due to changes in sediment absorption capacities, internal loading and nutrients derived from the death of aquatic organisms and terrestrial plants growing on the wetland bed (Sommer, 2001). Acidification may also occur in susceptible wetlands along with emissions of CO₂ and CH₄. Shrinking, cracking and compaction of drying sediments may lead to the formation of a hard, impenetrable crust beneath which anoxic condition will prevail (Sommer, 2001).

Table 11: Possible response to drawdown in the key elements of terrestrial ecosystems for 4 degrees of risk of impact (adapted from Environmental Protection Authority, 2000, p. 20).

Terrestrial phreatophytic vegetation		Risk of impact and possible response to drawdown			
Key elements	Not significant (no detectable change)	Moderate (small change)	Significant (moderate change)	Severe (large change)	
<i>Ecosystem processes</i>					
- Primary production	Rates of primary production are maintained within the limits of natural variation.	Some evidence of reduction in rates of primary production in response to drying.	Measurable reductions in rates of primary production in response to drying.	Severe reductions in rates of primary production in response to drying.	
- Nutrient recycling	Rates of nutrient recycling are maintained within the limits of natural variation.	Some evidence of reduction in rates of nutrient recycling in response to drying.	Measurable reductions in rates of nutrient recycling in response to drying.	Severe reductions in rates of nutrient recycling in response to drying.	
- Foodchains	No detectable change in foodchains.	Some evidence of disruption to foodchains.	Measurable disruptions to foodchains.	Severe disruptions to foodchains.	
- Sediment /soil stabilization	No detectable change in soil stabilisation.	No detectable change in soil stabilisation.	Some evidence of soil destabilisation/erosion.	Measurable destabilisation/erosion of soil.	
<i>Biodiversity</i>					
- Species composition	No detectable change in species composition.	Some evidence of encroachment of more drought tolerant species.	Measurable signs of encroachment of more drought tolerant species.	Loss of less drought tolerant species from ecosystem, with establishment of exotic species and gradual dominance by more drought tolerant species.	
- Species distribution	No detectable change in distribution of terrestrial phreatophytic species (not measurable in past 20 years).	Some evidence of changing distribution and encroachment of more drought tolerant species into areas previously dominated by less drought tolerant species.	Measurable change in demographics of some species with encroachment of more drought tolerant species into areas previously dominated by less drought tolerant species.	Overstorey and understorey decline and/or loss of species from ecosystem. > 50% reduction in abundance of dominant populations and/or disturbance allowing establishment of exotic species.	
- Species mortality	No detectable mortality.	Some mortality of individuals.	Greater than 15% reduction in abundance of dominant species.	Greater than 50% reduction in abundance of dominant species.	
- Species richness	No detectable changes in species richness.	Some evidence of decline in richness of less drought tolerant species.	Measurable decline in richness of less drought tolerant species and/or increase xeric species richness.	Significant change in richness of less drought tolerant species and replacement by more xeric species.	
- Community structure	No detectable change in community structure.	Some evidence of change in community structure.	Notable change in community structure.	Significant change in community structure.	
<i>Abundances and biomass of biota</i>					
- Vegetation density, cover and frequency	No detectable change in density, cover and abundance.	Some evidence of reduced growth in overstorey and/or understorey species.	Measurable crown dieback in overstorey species and/or reduction in cover of understorey.	Substantial crown dieback in overstorey species and loss of density and cover in understorey.	
- Vegetation height and diameter	No detectable change in vegetation height and diameter.	Some evidence of change in height due to loss of vigour and/or thinning of canopy.	Measurable reductions in height due to loss of canopy and/or reduced diameter of adult stems.	Significant reductions in height due to loss of canopy and reduced diameter of adult stems.	
- Vertebrate abundance	No detectable change in vertebrate abundance.	Some evidence of reduced vertebrate abundance.	Measurable changes in vertebrate abundance due to reduction in food and/or habitat availability as result of drying.	Greater than 50% reduction in vertebrate abundance due to reduction in food and/or habitat availability as result of drying.	
- Macroinvertebrate abundance	No detectable change in macroinvertebrate abundance.	Some evidence of reduced macroinvertebrate abundance.	Measurable changes in vertebrate abundance due to reduction in food and/or habitat availability as result of drying.	Greater than 50% reduction in vertebrate abundance due to reduction in food and/or habitat availability as result of drying.	
<i>Quality of water and sediment</i>					
- Physicochemical properties of sediment and groundwater	Levels of contaminants & other measures of quality remain within limits of natural variation	Small detectable changes beyond limits of natural variation but no resultant effect on biota	Moderate changes beyond limits of natural variation but not to exceed specified criteria	Substantial changes beyond limits of natural variation	

- Terrestrial phreatophytic vegetation

- Ecosystem processes

Primary production in groundwater dependent terrestrial vegetation is disrupted by groundwater drawdown as individual plants become water stressed leading to reduced vigour and growth rates. Loss of vigour may in turn lead to reduced nutrient uptake from soils and therefore disrupt nutrient cycles. Foodchains may also be disrupted as vegetation structure changes.

- Biodiversity

As species more vulnerable to prolonged dry periods become locally extinct, the diversity and composition of a phreatophytic terrestrial vegetation community changes. In severe cases, diversity may be significantly reduced, and comprise drought tolerant xerophytic species only. Under conditions of moderate drawdown, replacement of mesophytic species with xerophytes (compositional dynamics) will offset any potential reductions in diversity. Upon death of drought intolerant species, spatial niches may become available to weed species colonisation. Such weed species would possess drought tolerance/avoidance mechanisms that facilitate establishment, reproduction and persistence within the community.

- Abundances and biomass of biota

Phreatophytic vegetation may respond to groundwater drawdown at three different levels; individual, population or community. At the population level changes in abundance can be described in terms of reduction in canopy cover, loss of mature plants, increase in mortality rates, reduced seedlings establishment and shift in distribution towards a shallower depth to groundwater (Froend et al., 2002).

- Quality of water and sediment

Although manipulation of the groundwater table during mining operations may lead to re-injection of water of differing qualities into an aquifer, there is little evidence to suggest that groundwater drawdown will lead to changes in the quality of groundwater available to terrestrial vegetation. However, excessive drying of the soil profile may result in changes in organic content and lead to hydrophobic conditions, reducing the water holding capacity of soils.

- Cave and aquifer communities

Subsurface aquifer ecosystems support subterranean fauna and organisms such as invertebrates, crustacea, stygophile and stygobite (PPK Environment & Infrastructure Pty Ltd., 2001). Groundwater dependent cave ecosystems support a variety of flora such as mosses and subterranean fauna including blind fish and crustaceae. These ecosystems are recognized as totally dependent on groundwater and therefore any drawdown will, at best result in reductions in key elements of ecosystem integrity, at worst, in complete collapse of the entire ecosystem. Due to the relictual nature of many of these ecosystems and their subsequent high conservation values, there is no level of change that could be considered acceptable (Table 12).

- Base-flow systems

As riverine and wetland ecosystems support similar processes and biota they can be considered to respond to groundwater drawdown in a similar fashion. However, as it is generally assumed that base-flow systems are only proportionality dependent on groundwater, the level of change in key elements of ecosystem integrity may also be only proportional (Table 13).

Response differences may however occur in relation to water and sediment quality. During dry periods, the baseflow contribution to streamflow is highest. Groundwater drawdown will not only reduce the overall volume of baseflow, but may cause increased concentrations of nutrients, pollutants and salts in both water and sediments.

Table 12: Possible response to drawdown in the key elements of cave and aquifer ecosystems for 4 degrees of risk of impact (adapted from Environmental Protection Authority, 2000, p. 20).

Cave and aquifer ecosystems		Risk of impact and possible response to drawdown		
Key elements	Not significant (no detectable change)	Moderate (small change)	Significant (moderate change)	Severe (large change)
<i>Ecosystem processes</i>				
- Primary production	Rates of primary production are maintained within limits of natural variation.	Severe reductions in rates of primary production in response to drying.	Severe reductions in rates of primary production in response to drying.	Severe reductions in rates of primary production in response to drying.
- Foodchains	No detectable change in foodchains.	Severe disruptions to foodchains.	Severe disruptions to foodchains.	Severe disruptions to foodchains.
<i>Biodiversity</i>				
- Species composition	No detectable change in species composition.	Measurable loss of water dependent cave and aquifer fauna.	Measurable loss of water dependent cave and aquifer fauna.	Measurable loss of water dependent cave and aquifer fauna.
- Species distribution	No detectable change in species distribution.	Measurable contraction of species distribution.	Measurable contraction of species distribution.	Measurable contraction of species distribution.
- Species richness	No detectable change in species richness	Measurable decline in species richness due to drying.	Measurable decline in species richness due to drying.	Measurable decline in species richness due to drying.
- Community structure	No detectable change in community structure.	Measurable change in community structure.	Measurable change in community structure.	Measurable change in community structure.
<i>Abundances and biomass of biota</i>				
- Macroinvertebrate abundance	No detectable change in macroinvertebrate abundance.	Greater than 50% reduction in vertebrate abundance due to reduction in food and/or habitat availability as result of drying.	Greater than 50% reduction in vertebrate abundance due to reduction in food and/or habitat availability as result of drying.	Greater than 50% reduction in vertebrate abundance due to reduction in food and/or habitat availability as result of drying.
<i>Quality of water and sediment</i>				
- Physical and biochemical properties of sediments and water	Levels of contaminants & other measures of quality remain within limits of natural variation	Substantial changes beyond limits of natural variation.	Substantial changes beyond limits of natural variation.	Substantial changes beyond limits of natural variation.

- Estuarine and near-shore marine systems

Some near-shore environments receive freshwater input via aquifers extending off-shore or freshwater seepages above fresh/sea water interface. The occurrence of potentially groundwater dependent seagrass systems and near shore fisheries has become a recent area of focus for marine ecologists (PPK Environment & Infrastructure Pty Ltd., 2001). Studies have suggested that seagrass composition can be altered following groundwater abstraction and the resultant reduction in freshwater input (Hemminga & Duarte, 2000). Groundwater may also provide seagrass in some coastal areas with nutrients (Hatton & Evans, 1998). Fauna, including fish, turtles, crocodiles and macroinvertebrates may feed on other groundwater dependent species or rely on them for habitat.

Although it is likely that these ecosystems are only dependent on groundwater to a limited extent, reductions in groundwater inputs may lead to some small changes in the key elements of ecosystem integrity (Table 14).

- Fauna

Groundwater dependent terrestrial and wetland vegetation provides habitat, breeding sites and food for fauna which by extension must also be groundwater dependent. However, there is another group of fauna that depend on groundwater not only as habitat but as a source of drinking water. This group is dominated by birds and larger mammals, as respiration provides many small mammals with their water requirements. Although described as opportunistically dependent, groundwater drawdown will also impact on the key elements of ecosystem integrity as they relate to this group of organisms (Table 15).

The categorisation of faunal dependence upon groundwater indicates that species most dependent upon groundwater and therefore generally at the lowest point in the landscape are likely to be affected to the greatest extent by falls in groundwater level. This is because the ecosystems on which they depend are likely to disappear or alter drastically; the ecosystems will have no-where to go if groundwater levels fall. Other species are likely to shift down in the landscape in response to catenary changes. They will change in landscape position but probably not in area occupied. It is also possible, however, that there may be large impacts at the top of the landscape. This is because with respect to groundwater, there are very large areas of upland habitats that have low dependence upon groundwater. If such upland habitats are affected, such as through slight changes in soil moisture levels above the groundwater, the effect would occur over large areas. All upland habitats would become slightly more xeric. Therefore, the equivalent upland habitat to what occurs over large areas now would be reduced to a narrow zone on the upper slopes. The significance of this impact cannot be assessed but this sort of effect needs to be recognised.

Table 13: Possible response to drawdown in the key elements of base-flow systems ecosystems for 4 degrees of risk of impact (adapted from Environmental Protection Authority, 2000, p. 20).

Base-flow systems		Risk of impact and possible response to drawdown		
Key elements	Not significant (no detectable change)	Moderate (small change)	Significant (moderate change)	Severe (large change)
<i>Ecosystem processes</i>				
- Primary production	Rates of primary production are maintained within limits of natural variation.	Some evidence of reduction in rates of primary production in response to drying.	Measurable reductions in rates of primary production in response to drying.	Severe reductions in rates of primary production in response to drying.
- Nutrient recycling	Rates of nutrient recycling are maintained within the limits of natural variation.	Some evidence of reduction in rates of nutrient recycling in response to drying.	Measurable reductions in rates of nutrient recycling in response to drying.	Severe reductions in rates of nutrient recycling in response to drying.
- Foodchains	No detectable change in foodchains.	Some evidence of disruption to foodchains.	Measurable disruptions to foodchains.	Severe disruptions to foodchains.
- Sediment stabilisation	No detectable change in sediment stabilisation.	No detectable change in sediment stabilisation.	Some evidence of sediment destabilisation/erosion.	Measurable destabilisation/erosion of sediments.
<i>Biodiversity (vegetation)</i>				
- Species composition	No detectable change in species composition.	Some evidence of establishment of exotic species as result of disturbance and/or drying.	Measurable encroachment of terrestrial species	Significant change in dominant populations with terrestrialisation through encroachment of xeric species.
- Species distribution	No detectable change in distribution of species.	Some evidence of changing distribution with disturbance and/or drying allowing establishment of exotic species.	Measurable contraction of riparian vegetation through changing demographics of more than one species, with encroachment of xeric species.	Greater than 50% reduction in abundance of dominant species and /or significance change in dominant populations, with terrestrialisation through encroachment of xeric species.
- Species mortality	No detectable mortality.	Some mortality of individuals.	Greater than 15% reduction in abundance of dominant species.	Greater than 50% reduction in abundance of dominant species.
- Species richness	No detectable change in species richness.	Some evidence of decline in richness of riparian species.	Measurable decline in richness of riparian species and/or increase xeric species richness.	Significant change in richness of riparian species and replacement by xeric species.
- Community structure	No detectable change in community structure.	Some evidence of change in community structure.	Notable change in community structure.	Significant change in community structure.
<i>Abundances and biomass of biota</i>				
- Vegetation density, cover and frequency	No detectable change in density, cover and abundance.	Some evidence of reduced growth in overstorey and/or understorey species.	Measurable crown dieback in overstorey species and/or reduction in cover of understorey.	Substantial crown dieback in overstorey species and loss of density and cover in understorey.
- Vegetation height and diameter	No detectable change in vegetation height and diameter.	Some evidence of change in height due to loss of vigour and/or thinning of canopy.	Measurable reductions in height due to loss of canopy and/or reduced diameter of adult stems.	Significant reductions in height due to loss of canopy and reduced diameter of adult stems.
- Vertebrate abundance	No detectable change in vertebrate abundance.	Some evidence of reduced vertebrate abundance.	Measurable changes in vertebrate abundance due to reduction in food and/or habitat availability as result of drying.	Greater than 50% reduction in vertebrate abundance due to reduction in food and/or habitat availability as result of drying.
- Macroinvertebrate abundance	No detectable change in macroinvertebrate abundance.	Some evidence of reduced macroinvertebrate abundance.	Measurable changes in vertebrate abundance due to reduction in food and/or habitat availability as result of drying.	Greater than 50% reduction in vertebrate abundance due to reduction in food and/or habitat availability as result of drying.
<i>Quality of water and sediment</i>				
- Physicochemical properties of water column and sediments.	Levels of contaminants & other measures of quality remain within limits of natural variation	Small detectable changes beyond limits of natural variation but no resultant effect on biota	Moderate changes beyond limits of natural variation but not to exceed specified criteria	Substantial changes beyond limits of natural variation

Table 14: Possible response to drawdown in the key elements of estuarine and near-shore marine ecosystems for 4 degrees of risk of impact (adapted from Environmental Protection Authority, 2000, p. 20).

Estuarine and near-shore marine ecosystem		Risk of impact and possible response to drawdown		
Key elements	Not significant (no detectable change)	Moderate (small change)	Significant (moderate change)	Severe (large change)
<i>Ecosystem processes</i>				
- Primary production	Rates of primary production are maintained within limits of natural variation.	Some evidence of reduction in rates of primary production in response to drying.	Measurable reductions in rates of primary production in response to drying.	Severe reductions in rates of primary production in response to drying.
- Nutrient recycling	Rates of nutrient recycling are maintained within the limits of natural variation.	Some evidence of reduction in rates of nutrient recycling in response to drying.	Measurable reductions in rates of nutrient recycling in response to drying.	Severe reductions in rates of nutrient recycling in response to drying.
- Foodchains	No detectable change in foodchains.	Some evidence of disruption to foodchains.	Measurable disruptions to foodchains.	Severe disruptions to foodchains.
- Sediment stabilisation	No detectable change in sediment stabilisation.	No detectable change in sediment stabilisation.	Some evidence of sediment destabilisation/	Measurable destabilisation of sediments.
- Pollutant filtration	No detectable change in rates of pollutant filtration	No detectable change in rates of pollutant filtration	Some evidence of change in rates of pollutant filtration.	Measurable reductions in rates of pollutant filtration.
<i>Biodiversity</i>				
- Species composition	No detectable change in species composition.	No detectable change in species composition.	Some evidence of change in species composition	Measurable signs of change in species composition.
- Species distribution	No detectable change in distribution of species.	No detectable change in distribution of species.	Some evidence of changing distribution	Measurable change in demographics of some species.
- Species richness	No detectable changes in species richness.	No detectable changes in species richness.	Some evidence of decline in richness.	Measurable decline in species richness.
- Community structure	No detectable change in community structure.	No detectable change in community structure.	Some evidence of change in community structure.	Notable change in community structure.
<i>Abundances and biomass of biota</i>				
- Vegetation density, cover and frequency	No detectable change in density, cover and abundance.	Some evidence of reduced growth.	Measurable reduction in density, cover and/or abundance.	Substantial loss of density, cover and abundance.
- Vertebrate abundance	No detectable change in vertebrate abundance.	Some evidence of reduced vertebrate abundance.	Measurable changes in vertebrate abundance due to reduction in food and/or habitat availability.	Measurable changes in vertebrate abundance due to reduction in food and/or habitat availability.
- Macroinvertebrate abundance	No detectable change in macroinvertebrate abundance.	Some evidence of reduced macroinvertebrate abundance.	Measurable changes in vertebrate abundance.	Measurable changes in vertebrate abundance
<i>Quality of water and sediment</i>				
- Physicochemical properties of water column and sediments.	Levels of contaminants & other measures of quality remain within limits of natural variation	Small detectable changes beyond limits of natural variation but no resultant effect on biota	Moderate changes beyond limits of natural variation but not to exceed specified criteria	Substantial changes beyond limits of natural variation

Table 15: Possible response to drawdown in the key elements of groundwater dependent fauna for 4 degrees of risk of impact (adapted from Environmental Protection Authority, 2000, p. 20).

Groundwater dependent fauna		Risk of impact and possible response to drawdown		
Key elements	Not significant (no detectable change)	Moderate (small change)	Significant (moderate change)	Severe (large change)
<i>Ecosystem processes</i>				
- Foodchains	No detectable change in foodchains.	Some evidence of disruption to foodchains.	Measurable disruptions to foodchains.	Severe disruptions to foodchains.
<i>Biodiversity</i>				
- Species composition	No detectable change in species composition.	No detectable change in species composition.	Some evidence of change in species composition	Measurable signs of change in species composition.
- Species distribution	No detectable change in distribution of species.	No detectable change in distribution of species.	Some evidence of changing distribution	Measurable change in demographics of some species.
- Species richness	No detectable changes in species richness.	No detectable changes in species richness.	Some evidence of decline in richness.	Measurable decline in species richness.
- Community structure	No detectable change in community structure.	No detectable change in community structure.	Some evidence of change in community structure.	Notable change in community structure.
<i>Abundances and biomass of biota</i>				
- Vertebrate abundance	No detectable change in vertebrate abundance.	Some evidence of reduced vertebrate abundance.	Measurable changes in vertebrate abundance due to reduction in food and/or habitat availability.	Measurable changes in vertebrate abundance due to reduction in food and/or habitat availability.
- Macroinvertebrate abundance	No detectable change in macroinvertebrate abundance.	Some evidence of reduced macroinvertebrate abundance.	Measurable changes in vertebrate abundance.	Measurable changes in vertebrate abundance
<i>Quality of water and sediment</i>	N/A			

In this section detailed information on the factors considered in the risk of impact matrix are presented for those GDEs for which EWRs have been described in Section 2. Possible responses of vegetation to modelled drawdown are provided at the community and/or species level where appropriate. Comment is also provided on possible response of other ecosystem components where possible.

Wetlands

Gngangara Mound

Loch McNess

1. Historic water level change and associated changes in ecological condition.

The hydrograph for the staff gauge at Loch McNess indicates that minimum surface water levels declined 0.1 m from 1995 to 2003. There is no evidence of changes in ecological condition associated with this decline.

2. Current hydrology, ecological condition and conservation values.

Loch McNess is a permanent wetland that exhibits very small seasonal fluctuations in surface water levels. Although the water dependent biota of the Lake appear to be in excellent condition there has been some evidence of declining water quality in the past. Loch McNess maintains very high conservation values.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for Loch McNess indicates the western side of the lake may experience drawdown of 0.75-1.0 m by 2005, increasing to 1.0–2.0 m by 2008 and 2013. On the eastern side drawdown of 1.0-2.0 m is predicted by 2005 and 2008 increasing to 2.0-3.0m by 2013. The magnitude and rate of drawdown far exceed that required to maintain a low risk of impact.

Drawdown predicted on both sides of the lake over each time period combined with historic changes and conservation values represent a severe level of possible impact. Groundwater level decline may impact on surface water levels and result in Loch McNess becoming a seasonally inundated sumpland or at worst, a seasonally waterlogged dampland. This may result in the loss of habitat for aquatic fauna. Groundwater decline of this magnitude is also likely to lead to significant losses of *M. raphiophylla*, *B. littoralis* and *B. articulata*.

Lake Yonderup

1. Historic water level change and associated changes in ecological condition.

The hydrograph for the staff gauge at Lake Yonderup indicates that minimum surface water levels declined 0.06 m from 1995 to 2003. There is no evidence of changes in ecological condition associated with this decline.

2. Current hydrology, ecological condition and conservation values.

Lake Yonderup is a permanent wetland that exhibits very small seasonal fluctuations in surface water levels. The water dependent biota of the Lake appears to be in excellent condition and it maintains very high conservation values.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for Lake Yonderup indicates the lake may experience drawdown of 0.75-1.0 m by 2005, increasing to 1.0–2.0 m by 2008 and 2013. The magnitude and rate of drawdown far exceed that required to maintain a low risk of impact.

Drawdown predicted over each time period combined with historic changes and conservation values represent a severe level of possible impact. Groundwater level decline may impact on surface water levels and result in Lake Yonderup becoming a seasonally inundated sumpland or at worst, a seasonally waterlogged dampland. This may result in the loss of habitat for aquatic fauna. Fringing and emergent vegetation may be lost, in particularly *B. littoralis*, which responds quickly to water level decline and *M. raphiophylla*. *B. articulata* and *T. orientalis* may encroach into the basin, reducing the area of open water and impacted on habitat and feeding grounds of vertebrates and waterbirds.

Lake Wilgarup

1. Historic water level change and associated changes in ecological condition.

The hydrograph for the monitoring bore at Lake Wilgarup indicates that minimum groundwater levels declined 0.55 m from 1995 to 2003. This has coincided with severe declines in the ecological condition of the wetland, including the widespread loss of *M. raphiophylla* saplings and some mature trees, deaths of mature *B. littoralis*, thinning of *B. articulata* and the invasion of exotic species. No surface water has been recorded at Lake Wilgarup since 1998 resulting in the loss of macroinvertebrates and drying of organic rich sediments.

2. Current hydrology, ecological condition and conservation values.

Lake Wilgaup was regarded as a seasonally inundated wetland, but is now dry throughout the year. The ecological condition of the wetland has declines significantly in recent years however, Lake Wilgarup still retains high conservation values.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for Lake Wilgarup indicates the western side of the lake may experience drawdown of 0.5-0.75 m by 2005, increasing to 0.75-1.0 m by 2008 and 1.0-2.0 m by 2013. On the eastern side drawdown of 0.75-1.0 m is predicted by 2005 and 2008 increasing to 1.0-2.0 m by 2013. The magnitude and rate of drawdown far exceed that required to maintain a low risk of impact.

Drawdown predicted over each time period combined with historic changes and conservation values represent a severe level of possible impact. Drawdown will further exacerbate the declining condition of this wetland. Total loss of tree seedlings and emergent macrophytes should be expected along with continued decline in the vigour of mature trees. However, terrestrialisation is unlikely to occur for some time due to the dense nature of litter across the wetland basin. Excessive drying of the peat layer also makes Lake Wilgarup highly susceptible to fire.

Pipidinny Swamp

1. Historic water level change and associated changes in ecological condition.

The hydrograph for the staff gauge at Pipidinny indicates that minimum surface water levels remained relatively constant from 1995 to 2003 however, there has been a decline in peak levels over that time. There has been an increase in the conductivity of the ponds in recent years suggesting the possibility of salt water intrusion associated with surrounding groundwater decline.

2. Current hydrology, ecological condition and conservation values.

Pipidinny Swamp appears to be permanently inundated and continues to support water birds and other groundwater dependent vertebrates and macroinvertebrates. The conservation values of the wetland remain high.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for Pipidinny Swamp indicates wetland may experience drawdown of 0.5-0.75 m by 2005, increasing to 0.75-1.0 m by 2008 and 1.0-2.0 m by 2013 in the east and 0.75-1.0 m in the west. The magnitude and rate of drawdown far exceed that required to maintain a low risk of impact.

Drawdown predicted on both sides of the lake over each time period combined with historic changes and conservation values represent a significant level of possible impact. Groundwater level decline may impact on surface water levels and result in Pipidinny Swamp becoming a seasonally inundated sumpland or at worst, a seasonally waterlogged dampland. This may result in the loss of habitat for aquatic fauna. The sedge species that constitute the TEC at this site may decline in density and condition along with fringing *M. raphiophylla*.

Lake Nowergup

1. Historic water level change and associated changes in ecological condition.

The hydrographs for the staff gauge and monitoring bore at Lake Nowergup indicates that minimum surface water levels declined >0.33 m from 1995 to 2003, drying at the staff gauge since 2000, while peak surface water and minimum and peak groundwater levels have increased. These increases are the

result of artificial maintenance of surface water levels. Despite artificial maintenance the health of *E. rudis* and *M. raphiophylla* has declined significantly in recent years, *B. articulata* has been thinning and *T. orientalis* and other exotics have been encroaching into the basin.

2. Current hydrology, ecological condition and conservation values.

Lake Nowergup is a permanent, deep wetland that has been artificially maintained in recent years. Although there has been decline in the ecological condition of the wetland it retains very high conservation values.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for Lake Nowergup indicates the western side of the lake may experience drawdown of 1.0-2.0 m by 2005, 2008 and 2013. On the eastern side drawdown of 1.0-2.0 m is predicted by 2005 and 2.0-3.0 m by 2008 and 2013. The magnitude and rate of drawdown far exceed that required to maintain a low risk of impact.

Drawdown predicted on both sides of the lake over each time period combined with historic changes and conservation values represent a severe level of possible impact. Unless artificial maintenance is successful in retaining adequate surface water level the predicted declines are likely to result in further encroachment of *T. orientalis* across the basin, loss of *B. articulata* from the wetland fringes and continued decline in the condition of *M. raphiophylla* and *E. rudis*. Recruitment of exotics and tree species across the basin is also possible.

Lake Joondalup

1. Historic water level change and associated changes in ecological condition.

The hydrographs for the staff gauge and monitoring bore at Lake Joondalup indicates that minimum surface water and groundwater levels declined 0.12 and 0.4 m respectively from 1995 to 2003. This has coincided with some decline in the condition of fringing vegetation and encroachment of *T. orientalis* into the southern reaches of the basin. Sediments have dried and contributed to wind-throw of some mature *M. raphiophylla*. Water quality has also been impacted, with high nutrients, high chlorophyll *a* and low DO recorded during summer.

2. Current hydrology, ecological condition and conservation values.

Lake Joondalup retains small pools of surface water throughout most summers. It provides some drought refuge for waterbirds during summer and supports other vertebrate and invertebrate species. Fires and invasion of exotic plant species have impacted on the ecological condition of the wetland along with water level decline however, the wetland it retains very high conservation values.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for Lake Joondalup indicates the western side of the lake may experience drawdown of 0.75-1.0 m by 2005 and 1.0-2.0 m by 2008 and 2013. On the eastern side drawdown of 1.0-2.0 m is predicted by 2005 and 2008, to 2.0-3.0 m by 2013. The magnitude and rate of drawdown far exceed that required to maintain a low risk of impact.

The magnitude and rate of drawdown predicted on both sides of the lake over each time period combined with historic changes and conservation values represent a severe level of possible impact. The surface water component of the wetland is likely to dry completely unless perching occurs resulting in the loss of habitat. There is also likely to be further encroachment of *T. orientalis* and *B. articulata*, increased wind throw of trees, loss of fringing vegetation condition and possible recruitment of exotics and native species across the basin, along with declines in water quality.

Lake Goollelal

1. Historic water level change and associated changes in ecological condition.

The hydrographs for the staff gauge and monitoring bore at Lake Goollelal indicates that minimum surface water level declined 0.06 m from 1995 to 2003 following a long-term trend of increasing water levels. This has led to increased inundation of fringing trees and some decline in the condition of *E. rudis* and contraction of *B. articulata* bands away from the wetland basin.

2. Current hydrology, ecological condition and conservation values.

Lake Goollelal is a permanent wetland that has shown an increasing trend in water levels since the 1970's. The wetland provides habitat and feeding grounds for waterbirds and other vertebrate species. Water quality has, however declined in recent years and exotic vegetation dominates the understorey. Although there has been decline in the ecological condition of the wetland it retains very high conservation values.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for Lake Goollelal indicates the western side of the lake may experience drawdown of 0.5-0.75 m by 2005, to 0.75-1.0 m by 2008 and 2.0-3.0 m by 2013. On the eastern side drawdown of 0.75-1.0 m is predicted by 2005, to 1.0-2.0 m by 2008 and >3.0 m by 2013. The magnitude and rate of drawdown far exceed that required to maintain a low risk of impact.

Although Lake Goollelal has experienced increasing water levels in the past, the magnitude and rate of drawdown predicted on both sides of the lake over each time period in combination with conservation values represent a significant level of possible impact. However, other than increased invasion of exotics, it is likely that the condition of wetland vegetation may improve. In contrast, water quality is likely to decline significantly.

Lake Jandabup

1. Historic water level change and associated changes in ecological condition.

The hydrograph for the staff gauge at Lake Jandabup indicates that minimum surface water levels increased 0.03 m from 1995 to 2003. This rise is due to artificial maintenance implemented to address acidification. The decline in pH had previously led to local extinctions of highly sensitive macroinvertebrate taxa. Prior to augmentation sedge species had encroached into the wetland basin. Despite higher surface water levels the condition of fringing vegetation has continued to decline.

2. Current hydrology, ecological condition and conservation values.

Lake Jandabup is a permanent, shallow wetland that supports macroinvertebrates, waterbirds and other vertebrates. The majority of declines in ecological condition have been arrested through artificial maintenance and the wetland retains very high conservation values however, there remains some concern for fringing vegetation.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for Lake Jandabup indicates the north-eastern corner of the lake may experience drawdown of 2.0-3.0 m by 2005 and to >3.0 m by 2013. The remainder of the lake may experience drawdown of 1.0-2.0 m by 2005 to 2.0-3.0 m by 2008 and >3.0 m by 2013. The magnitude and rate of drawdown far exceed that required to maintain a low risk of impact.

The magnitude and rate of drawdown predicted on both sides of the lake over each time period combined with historic changes and conservation values represent a significant level of possible impact. Unless artificial maintenance is continued and retains adequate surface water level the predicted declines are likely to result in further encroachment of sedges across the basin, and continued decline in the condition of fringing. Recruitment of exotics across the basin is also possible. Water quality issues are also likely to resurface under a drier regime.

Lake Mariginiup

1. Historic water level change and associated changes in ecological condition.

The hydrograph for the monitoring bore at Lake Mariginiup shows that minimum groundwater levels declined 0.38 m from 1995 to 2003. This coincided with declines in the condition of fringing *E. rudis* and encroachment of *T. orientalis* into the basin. Sediments have also dried and water quality impacted through increasing acidification.

2. Current hydrology, ecological condition and conservation values.

Lake Mariginiup has dried completely in most summers since 1997 with maximum depths and periods of inundation generally declining over time. Fires and other disturbances have also resulted in the loss of much of the fringing vegetation and exacerbated sediment drying. Although there has been decline in the ecological condition of the wetland it retains moderate conservation values.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for Lake Mariginiup indicates the north-eastern corner of the lake may experience drawdown of 0.75-1.0 m by 2005, increasing to 2.0-3.0 m by 2008 and >3.0 m by 2013. The rest of the wetland is predicted to experience drawdown of 1.0-2.0 m by 2005 increasing to 2.0-3.0 m by 2008 and >3.0 m by 2013. The magnitude and rate of drawdown far exceed that required to maintain a low risk of impact.

The magnitude and rate of drawdown predicted for the lake over each time period combined with historic changes and conservation values represent a significant level of possible impact. This may lead to the encroachment of *T. orientalis* and *B. articulata* across the entire wetland basin and contraction of *E. rudis* and *M. raphiophylla*. The surface water component of the wetland is likely to dry completely unless perching occurs resulting in the loss of habitat.

Lexia 86

1. Historic water level change and associated changes in ecological condition.

The hydrographs for the monitoring bore at Lexia 86 indicates that groundwater levels declined 0.18 m from 1995 to 2003. This has coincided with decline in health, patch deaths and encroachment of fringing vegetation into the basin and the contraction of *B. articulata*. Sediments have also dried and vertebrate species become less prevalent.

2. Current hydrology, ecological condition and conservation values.

Lexia 86 dries in summer with maximum depths and periods of inundation generally declining over time. Although there has been decline in the ecological condition of the wetland it retains very high conservation values.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for Lexia 86 indicates the wetland may experience an increase in groundwater levels of 0-0.25 m by 2005 and 2008, with levels then decreasing 0.25-0.5 m by 2013. The magnitude and rate of drawdown may exceed that required to maintain a low risk of impact.

The predicted water level increases over the first two time periods, are negated by the decrease predicted by 2013. However, the combination of historic changes and conservation values still represent a significant level of possible impact. *B. articulata* may continue to contract with *A. fascicularis* and other fringing vegetation establishing in the basin.

Lexia 94

1. Historic water level change and associated changes in ecological condition.

The hydrograph for the monitoring bore at Lexia 94 indicates that minimum groundwater levels declined 0.19 m from 1995 to 2003. This has coincided with some decline in the condition of fringing vegetation and the drying and thinning of wetland shrubs and emergent macrophytes across the wetland basin.

2. Current hydrology, ecological condition and conservation values.

Lexia 94 is a seasonally waterlogged wetland and it has been suggested that it is perched. Although there has been decline in the ecological condition of the wetland it retains high conservation values.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for Lexia 94 indicates the wetland may experience an increase in groundwater levels of 0-0.25 m by 2005 and 2008, with levels then decreasing 0.25-0.5 m by 2013. The magnitude and rate of drawdown may exceed that required to maintain a low risk of impact.

The predicted water level increases over the first two time periods, are negated by the decrease predicted by 2013. However, the combination of historic changes and conservation values still represent a significant level of possible impact. Drying and thinning of vegetation may continue across the basin with further decline in fringing tree and shrub species.

Lexia 186

1. Historic water level change and associated changes in ecological condition.

The hydrograph for the monitoring bore at Lexia 186 indicates that minimum groundwater levels declined 0.28 m from 1995 to 2003. This has coincided with some decline in the condition of fringing vegetation and the encroachment of fringing tree species into the basin as *B. articulata* dries and thins.

2. Current hydrology, ecological condition and conservation values.

Lexia 186 is a seasonally waterlogged basin with a small man-made sump that contains water in winter. Although there has been decline in the ecological condition of the wetland it retains very high conservation values.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for Lexia 186 indicates the wetland may experience an increase in groundwater levels of 0-0.25 m by 2005 and 2008, with levels then decreasing 0.25-0.5 m by 2013. The magnitude and rate of drawdown may exceed that required to maintain a low risk of impact.

The predicted water level increases over the first two time periods, are negated by the decrease predicted by 2013. However, the combination of historic changes and conservation values still represent a significant level of possible impact. There may be further decline in vegetation condition.

EPP Wetland 173

1. Historic water level change and associated changes in ecological condition.

The hydrograph for the monitoring bore at EPP 173 indicates that minimum groundwater levels declined 0.06 m from 1995 to 2003. This has coincided with some decline in the condition of fringing vegetation, reduced water quality and drying of organic sediments.

2. Current hydrology, ecological condition and conservation values.

EPP 173 is spring fed yet dries at the staff gauge in most summers. Although there has been decline in the ecological condition of the wetland it retains very high conservation values.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for EPP indicates the wetland may experience drawdown of 0.25-0.5 m by 2005 and 2008 and to 0.5-0.75 m by 2013. The magnitude and rate of drawdown far exceed that required to maintain a low risk of impact.

The magnitude and rate of drawdown predicted at the wetland over each time period combined with historic changes and conservation values represent a significant level of possible impact. Reduction in flows from the springs due to groundwater drawdown will also likely influence the hydrologic regime of EPP173. If the springs stopped flowing, then the depth and duration of inundation in winter and the soil moisture profile in summer all could be affected. It is likely that lower surface water levels will impact on the breeding capabilities of the Black-striped Minnow and other vertebrate species. Emergent vegetation may also contract into the basin with further decline in the condition of fringing species.

Dampland 78

1. Historic water level change and associated changes in ecological condition.

The hydrograph for the monitoring bore at Dampland 78 indicates that minimum groundwater levels declined 0.37 m from 1995 to 2003. This has coincided with drying of the wetland basin and loss of *B. articulata* along with water stress in fringing *M. preissiana* and declines in density of wetland shrubs.

2. Current hydrology, ecological condition and conservation values.

Dampland 78 is a seasonally waterlogged wetland that is becoming drier over time. Although there has been decline in the ecological condition of the wetland it retains high conservation values.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for Dampland 78 indicates the wetland may experience drawdown of >3.0 m by 2005 continuing to 2008 and 2013. The magnitude and rate of drawdown far exceeds that required to maintain a low risk of impact.

Drawdown predicted over each time period combined with historic changes and conservation values represent a significant level of possible impact. However, in light of previous changes in ecological condition, the impact is likely to be more severe, with loss of some mature *M. preissiana* and increased thinning in the understorey.

Lake Gwelup*

1. Historic water level change and associated changes in ecological condition.
Groundwater contours indicate that water levels declined 1.25-1.5 m at Lake Gwelup between 1995 and 2003. This has coincided with encroachment of *T. orientalis* into the wetland basin and a decline in the condition of fringing *E. rudis* and *M. raphiophylla*.
2. Current hydrology, ecological condition and conservation values.
Lake Gwelup is a seasonally inundated wetland that is becoming drier over time. Although it is impacted by fires, weed invasion and other urban disturbance and there has been decline in the ecological condition of the wetland it retains high conservation values.
3. Predicted drawdown and possible GDE/community/species response.
PRAMS 3.0 modelled drawdown for Lake Gwelup indicates the wetland may experience drawdown 1.0-2.0 by 2005 and 2.0-3.0m 2008 and 2013. The magnitude and rate of drawdown far exceed that required to maintain a low risk of impact.

Drawdown predicted over each time period combined with historic changes and conservation values represent a severe level of possible impact. The surface water component of the wetland is likely to dry completely unless perching occurs resulting in the loss of habitat. There is also likely to be further encroachment of vegetation across the basin and declines in the condition of fringing tree species.

Big Carine Swamp*

1. Historic water level change and associated changes in ecological condition.
Groundwater contours indicate that water levels declined 1.0 m at Big Carine Swamp between 1995 and 2003. This has coincided with drying of the wetland basin and encroachment of herbs and grasses. Water stress in fringing *M. raphiophylla* is prevalent with up to 50% of trees dead or very stressed on the western shore and 25% in the south.
2. Current hydrology, ecological condition and conservation values.
Big Carine Swamp is a seasonally waterlogged wetland that is becoming drier over time. Although there has been decline in the ecological condition of the wetland it retains high conservation values.
3. Predicted drawdown and possible GDE/community/species response.
PRAMS 3.0 modelled drawdown for Big Carine Swamp indicates the wetland may experience drawdown of 0.75-1.0 m by 2005 and 2008 to 1.0-2.0 m by 2013. The magnitude and rate of drawdown far exceed that required to maintain a low risk of impact.

Drawdown predicted over each time period combined with historic changes and conservation values represent a severe level of possible impact. As much of the vegetation at Big Carine Swamp is already severely impacted, further declines are likely to result in the loss of many *M. raphiophylla* and domination of the basin by exotics.

Lake Muckenburra*

1. Historic water level change and associated changes in ecological condition.
Groundwater contours indicate that water levels increased 0.75 m at Lake Muckenburra between 1995 and 2003. As the condition of this wetland has not been assessed, it is not possible to comment on changes in ecological condition.
2. Current hydrology, ecological condition and conservation values.

Lake Muckenburra is a seasonally waterlogged wetland that is becoming wetter over time. Although it is not known if there has been a decline in the ecological condition of the wetland it retains very high conservation values as it supports a TEC.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for Lake Muckenburra indicates the wetland may experience drawdown of 0.5-0.75 m by 2005, 0.75-1.0 m by 2008 and 1.0-2.0 m by 2013. The magnitude and rate of drawdown far exceed that required to maintain a low risk of impact.

The magnitude and rate of drawdown predicted over each time period combined with historic changes and conservation values represent a significant to severe level of possible impact. If ponding of surface water is not adequate to meet the requirements of vegetation and fauna, there is likely to be a decline in the condition of fringing vegetation and loss of habitat.

Bambun Lake*

1. Historic water level change and associated changes in ecological condition.

Groundwater contours indicate that water levels increased 0.75 m at Bambun Lake between 1995 and 2003. There appears to have been little change on the condition of the wetland over this time.

2. Current hydrology, ecological condition and conservation values.

Bambun Lake is a permanent wetland. Although much of the surrounding area has been cleared for agriculture and exotics dominant the wetland understorey, intact vegetation appears healthy and the wetland it retains high conservation values.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for Bambun Lake indicates the wetland may experience drawdown of 0.5-0.75 m by 2005, 0.25-0.5 by 2008 and 0.5-0.75 by 2013. The magnitude and rate of drawdown exceed that required to maintain a low risk of impact.

The magnitude and rate of drawdown predicted over each time period combined with historic changes and conservation values represent a moderate to significant level of possible impact. There may be some decline in the condition of fringing *M. rhapsiophylla* and *E. rudis* and contraction of *B. articulata* into the basin.

Yeal Swamp, Lake Bindiar and Wetlands of Yeal Nature Reserve*

1. Historic water level change and associated changes in ecological condition.

Groundwater contours indicate that water levels decreased 1.75-2.0 m between 1995 and 2003 across the Yeal wetlands. Despite this decline, much of the wetland vegetation appears to be in good condition with the exception of *E. rudis*, which is showing signs of water stress and some myrtaceous wetland shrubs which have dried and thinned across the area.

2. Current hydrology, ecological condition and conservation values.

It is probable that Yeal Swamp, Lake Bindiar and some associated wetlands once held surface water for at least some part of the year. These wetlands now appear to be seasonally waterlogged damplands. Although there has been decline in the ecological condition of the Yeal wetland they retain high conservation values as an interconnected suite of relatively undisturbed wetlands.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for the Yeal wetlands indicates the wetlands may experience drawdown of 0.75-1.0 m in the west (including Yeal Swamp and Lake Bindiar) and 1.0-2.0 m in the east by 2005, increasing to 2.0-3.0 across the area by 2008 and >3.0 m by 2013. The magnitude and rate of drawdown exceed that required to maintain a low risk of impact.

The magnitude and rate of drawdown predicted over each time period combined with historic changes and conservation values represent a significant level of possible impact. It is likely that there will be further declines in the condition and spot deaths of *E. rudis* along with encroachment of more xeric species into the wetlands as wetland shrubs continue to thin.

Edgecombe Seepage

1. Historic water level change and associated changes in ecological condition.
The hydrograph for the monitoring bore at Edgecombe Seepage indicates that minimum groundwater levels declined 0.83 m from 1995 to 2003. This has coincided with a decline in faunal diversity.
2. Current hydrology, ecological condition and conservation values.
Edgecombe Seepage is a permanent mound spring. Due to average rainfall in 2003 water levels increased following declines in previous years. The spring was cleared and heavily disturbed however, by 2002 flows were returning and by 2003 the area was recovering. Although there has been decline in the ecological condition of the wetland it retains very high conservation values.
3. Predicted drawdown and possible GDE/community/species response.
PRAMS 3.0 modelled drawdown for Edgecombe Seepage indicates groundwater levels may rise 0.25-0.5 m by 2005, increasing to 0.75-1.0 m by 2008 and 1.0-2.0 m 2013. Although water levels are predicted to rise the wetland remains at significant risk of impact due to historic changes and conservation values. However, it is likely that vegetation will continue to re-establish and increased surface water levels by 2008 and 2013 may restore faunal diversity.

Egerton Spring

1. Historic water level change and associated changes in ecological condition.
The hydrograph for the monitoring bore at Egerton Spring indicates that minimum groundwater levels declined 0.2 m from 1995 to 2003. There has been no recorded change in the ecological condition of the site over this time period.
2. Current hydrology, ecological condition and conservation values.
Edgecombe Seepage is a permanent mound spring. Due to average rainfall in 2003 water levels increased following declines in previous years. The spring discharges good quality fresh water that supports diverse macroinvertebrate fauna and pristine fringing vegetation. The wetland it retains very high conservation values.
3. Predicted drawdown and possible GDE/community/species response.
PRAMS 3.0 modelled drawdown for Egerton Spring indicates groundwater levels may rise 0-0.25 m by 2005, increasing to 0.25-0.5 m by 2008 and to 0.5-0.75 m 2013. Although water levels are predicted to rise the wetland remains at moderate risk of impact due to historic changes and conservation values. However, it is unlikely that there will be a negative impact on the vegetation of the spring.

Kings Spring*

1. Historic water level change and associated changes in ecological condition.
Groundwater contours indicate that water levels decreased 0.5 m between 1995 and 2003 near King Spring. This has coincided with drying and shrinkage of wetlands sediments, declines in condition of *M. raphiophylla* and invasion of the area by exotics.
2. Current hydrology, ecological condition and conservation values.
It is likely that King Spring once held surface water for the majority of the year, if not permanently. However, the system now appears to dry in summer and is unlikely to flood to previous depths in winter. The conservation values of this mound spring may therefore have been largely lost, but further research is required.
3. Predicted drawdown and possible GDE/community/species response.
PRAMS 3.0 modelled drawdown for King Spring indicates the wetland may experience drawdown of 0.25-0.5 m by 2005, increasing to 0.5-0.75 m 2008 and 1.0-2.0 m by 2013. The magnitude and rate of drawdown exceed that required to maintain a low risk of impact.

Drawdown predicted over each time period combined with historic changes and conservation values represent a significant level of possible impact. The surface water component of the wetland is likely to dry completely unless perching occurs resulting in the loss of habitat. Due to the already stressed nature

of the vegetation it is likely that there will be deaths of mature *M. raphiophylla* and further encroachment of exotics.

Jandakot Mound

Thomsons Lake

1. Historic water level change and associated changes in ecological condition.

The hydrographs for the staff gauge and monitoring bore at Thomsons Lake indicates that minimum surface water and groundwater levels declined 0.94 and 1.16 m respectively from 1992 to 2003. This has coincided with some decline in the condition of fringing vegetation and encroachment of *T. orientalis*.

2. Current hydrology, ecological condition and conservation values.

Thomsons Lake is a RAMSAR wetland and supports other vertebrate and invertebrate species. Altered hydrology and invasion of exotic plant species have impacted on the ecological condition of the wetland along with water level decline however, the wetland retains very high conservation values.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for Thomsons Lake indicates the northern side of the lake may experience drawdown of 0.25-0.5 m by 2005, increasing to 0.5-0.75 m by 2008 and to 0.75-1.0 m by 2013. On the southern side drawdown of 0.5-0.75 m is predicted by 2005, increasing to 1.0-2.0 m by 2008 and 2013. The magnitude and rate of drawdown exceed that required to maintain a low risk of impact.

Drawdown predicted on both sides of the lake over each time period combined with historic changes and conservation values represent a severe level of possible impact. The surface water component of the wetland is likely to dry completely unless perching occurs resulting in the loss of habitat. *T. orientalis*, *B. articulata* and exotic species are likely to encroach onto the basin wetland, with further decline in the condition of fringing *M. raphiophylla* and *E. rudis* and recruitment of both species across the basin.

North Lake

1. Historic water level change and associated changes in ecological condition.

The hydrographs for the staff gauge and monitoring bore at North Lake indicates that minimum surface water and groundwater levels declined 1.57 and 0.74 m respectively from 1992 to 2003. This has coincided with some decline in the condition of fringing vegetation and the encroachment of native species into areas that were previously inundated.

2. Current hydrology, ecological condition and conservation values.

North Lake appears to retain small pools of surface water throughout most summers. It provides some drought refuge for waterbirds during summer and supports other vertebrate and invertebrate species. The invasion of exotic plant species have impacted on the ecological condition of the wetland along with water level decline however, the wetland retains very high conservation values.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for North Lake indicates the south-eastern side of the lake may experience drawdown of 0.75-1.0 m by 2005, decreasing to 0.5-0.75 m by 2008 and 2013. The remainder of the wetland may undergo drawdown of 0.75-1.0 m by 2005, 2008 and 2013. The magnitude and rate of drawdown far exceed that required to maintain a low risk of impact.

Drawdown predicted over each time period combined with historic changes and conservation values represent a severe level of possible impact. The surface water component of the wetland is likely to dry completely unless perching occurs resulting in the loss of habitat. There may also be further decline in the condition of fringing vegetation, invasion of exotics and encroachment of vegetation across the basin.

Banganup Swamp

1. Historic water level change and associated changes in ecological condition.

The hydrographs for the monitoring bore at Banganup Swamp indicates that minimum groundwater levels declined 1.234 m from 1997 to 2003 with the wetland drying for longer periods each year over time. This has coincided with encroachment of *T. orientalis* into the basin and decline in water quality

2. Current hydrology, ecological condition and conservation values.

Banganup Swamp is now dry for up to 9 months of the year. Although water level decline has impacted on the ecological condition of the wetland, the wetland retains very high conservation values.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for Banganup Swamp indicates the wetland may experience drawdown of 0.75-1.0 m by 2005, increasing to 1.0-2.0 m by 2008 and 2013, with declines of 2.0-3.0 m possible in the south. The magnitude and rate of drawdown far exceed that required to maintain a low risk of impact.

Drawdown predicted over each time period combined with historic changes and conservation values represent a severe level of possible impact. This may result in the loss of surface water from the system, further contraction of vegetation across the basin and decline in the condition of fringing *M. raphiophylla*.

Bibra Lake

1. Historic water level change and associated changes in ecological condition.

The hydrographs for the staff gauge and monitoring bore at Bibra Lake indicates that minimum surface water levels declined 1.002 m from 1992 to 2003. This has coincided with increase in exotics and contributed to insect attack on *E. rudis*. Previously, prolonged periods of inundation on the west side of the lake caused severe deterioration in tree health.

2. Current hydrology, ecological condition and conservation values.

Bibra Lake retains surface water throughout most summers. It provides some drought refuge for waterbirds during summer and supports other vertebrate and invertebrate species. Insect attack, tree health decline and invasion of exotic plant species have impacted on the ecological condition of the wetland along with water level decline however, the wetland retains very high conservation values.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for Bibra Lake indicates the half of the lake may experience drawdown of 0.75-1.0 m by 2005, decreasing to 0.25-0.5 m by 2008 and back to 0.75-1.0 m by 2013. In other areas drawdown of 0.5-0.75 m is predicted by 2005, 2008 and 2013. The magnitude and rate of drawdown far exceed that required to maintain a low risk of impact.

Drawdown predicted over each time period combined with historic changes and conservation values represent a severe level of possible impact. The surface water component of the wetland is likely to dry completely unless perching occurs resulting in the loss of habitat. There may also be further decline in the condition of fringing vegetation, invasion of exotics and encroachment of vegetation across the basin.

Yangebup Lake

1. Historic water level change and associated changes in ecological condition.

The hydrographs for the staff gauge and monitoring bore at Yangebup Lake indicates that minimum surface water and groundwater levels declined 1.335 and 1.52 m respectively from 1992 to 2003. Vegetation is not monitored at this wetland however, water quality has been impacted, with high nutrients recorded during summer.

2. Current hydrology, ecological condition and conservation values.

Yangebup Lake retains surface water throughout the year. It provides drought refuge for waterbirds during summer and supports other vertebrate and invertebrate species. Despite impacts on the ecological condition of the wetland it retains high conservation values.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for Yangebup Lake indicates the wetland may experience drawdown of 0.75-1.0 m by 2005, 0.25-0.5 m by 2008 and 0.5-0.75 m by 2013. The magnitude and rate of drawdown far exceed that required to maintain a low risk of impact.

Drawdown predicted over each time period combined with historic changes and conservation values represent a severe level of possible impact. This may lead to further decline in water quality and possible drying in summer months.

Lake Kogolup

1. Historic water level change and associated changes in ecological condition.

The hydrographs for the staff gauge at Lake Kogolup South indicates that minimum surface water levels declined 1.35 and 0.4 m from 1992 to 2003. This has coincided with some decline in the condition of fringing vegetation and water quality.

2. Current hydrology, ecological condition and conservation values.

Lake Kogolup South retains some surface water throughout most summers. It provides some drought refuge for waterbirds during summer and supports other vertebrate and invertebrate species. Despite impacts on the ecological condition of the wetland it retains high conservation values.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for Lake Kogolup indicates that North Kogolup may experience drawdown of 0.5-0.75 m by 2005, 0.25-0.5 m by 2008 and 0.5-0.75 m by 2013. At South Kogolup drawdown of 0.5-0.75 m is predicted by 2005, 2008 and 2013. The magnitude and rate of drawdown far exceed that required to maintain a low risk of impact.

Drawdown predicted at Lake Kogolup over each time period combined with historic changes and conservation values represent a severe level of possible impact. This may result in contraction of wetland species and further declines in fringing tree health.

Shirley Balla Swamp

1. Historic water level change and associated changes in ecological condition.

The hydrographs for the staff gauge and monitoring bore at Shirley Balla Swamp indicate that minimum surface water levels have declined since 1993 with groundwater levels declining 0.56 m from 1992 to 2003. This has coincided with some decline in the condition of fringing vegetation along with a reduction in macroinvertebrate species richness and decreasing water quality.

2. Current hydrology, ecological condition and conservation values.

Shirley Balla Swamp has dried for progressively longer periods since 1993 and is now dry for up to 8 months of the year. Fire, physical disturbance and invasion of exotic plant species have impacted on the ecological condition of the wetland along with water level decline however, the wetland retains very high conservation values.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for Shirley Balla Swamp indicates the wetland may experience drawdown of 0.25-0.5 m by 2005 and 0.75-1.0 m by 2008 and 2013. The magnitude and rate of drawdown exceed that required to maintain a low risk of impact.

Drawdown predicted over each time period combined with historic changes and conservation values represent a severe level of possible impact. The surface water component of the wetland is likely to dry completely unless perching occurs resulting in the loss of habitat. There may also be further decline in the condition of fringing vegetation and water quality.

Twin Bartram Swamp

1. Historic water level change and associated changes in ecological condition.

The hydrograph for the monitoring bore at Twin Bartram Swamp indicates that minimum groundwater levels decreased 1996 to 1997, before increasing by 0.22 to 2003. Surface water levels have also increased over that time. There has been little or no change in ecological condition associated with water level change.

2. Current hydrology, ecological condition and conservation values.

Twin Bartram Swamp has retained surface water for progressively longer periods over the past 5 years, possibly due to increased runoff from nearby urban development. Fire and the invasion of exotic plant species have impacted on the ecological condition of the wetland however, the wetland retains high conservation values.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for Twin Bartram Swamp indicates the wetland may experience drawdown of 0.25-0.5 m by 2005 and 0.5-0.75 m by 2008 and 2013. The magnitude and rate of drawdown exceed that required to maintain a low risk of impact.

Drawdown predicted over each time period combined with historic changes and conservation values represent a moderate to significant level of possible impact. This may result in the decline in condition of *M. raphiophylla* across the wetland basin and further invasion by exotics.

Beenyup Rd Swamp

1. Historic water level change and associated changes in ecological condition.

The hydrographs for the staff gauge and monitoring bore at Beenyup Rd Swamp indicates that minimum groundwater levels declined 0.54 from 1992 to 2003, with surface water levels also declining over that time period. This has coincided with some decline in the density of *B. articulata*, increased invasion of exotics across the basin and some decline in the condition of fringing trees.

2. Current hydrology, ecological condition and conservation values.

Beenyup Rd Swamp has dried for progressively longer periods since 1993, with no surface water recorded at the staff gauge at all in 2003. Water level decline has impacted on the ecological condition of the wetland however, it retains high conservation values.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for Beenyup Rd Swamp indicates the wetland may experience drawdown of 0.25-0.5 m by 2005, 0.75-1.0 m by 2008 and 1.0-2.0 m by 2013. The magnitude and rate of drawdown exceed that required to maintain a low risk of impact.

Drawdown predicted over each time period combined with historic changes and conservation values represent a significant to severe level of possible impact. The surface water component of the wetland is likely to remain dry unless perching occurs resulting in the loss of habitat. There is also likely to be total loss of *B. articulata* and further decline in the condition of fringing vegetation.

Forrestdale Lake

1. Historic water level change and associated changes in ecological condition.

The hydrographs for the staff gauge and monitoring bore at Forrestdale Lake indicates that surface water levels have declined since 1992, with groundwater levels falling 0.49 m since 1996. This has coincided with some decline in the condition of fringing vegetation and encroachment of exotics across the wetland basin.

2. Current hydrology, ecological condition and conservation values.

Forrestdale Lake now dries completely in most summers remaining dry for longer periods each year. This has reduced the value of the wetland as an important waterbird and wader habitat. Despite this and the impact of water level decline on vegetation, the wetland retains very high conservation values.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for Forrestdale Lake indicates the western side of the lake may experience drawdown of 0.5-0.75 m by 2005, 0.25-0.5 m by 2008 and 0.5-0.75 by 2013. On the eastern

side drawdown of 0.5-0.75 m is predicted by 2005, levels increase 0-0.25 m by 2008, increasing again by 2013. The magnitude and rate of drawdown exceed that required to maintain a low risk of impact.

Drawdown predicted on both sides of the lake during the first time period combined with historic changes and conservation values represent a severe level of possible impact. The surface water component of the wetland is likely to dry completely unless perching occurs resulting in the loss of habitat. There is also likely to be further encroachment of vegetation across the basin and declines in the condition of fringing *M. raphiophylla* and *E. rudis*.

Mather Reserve Swamp*

1. Historic water level change and associated changes in ecological condition.

The staff gauge at Mather Reserve indicates minimum surface water levels have declined 0.81 m since 1992, while groundwater levels at the bore have decreased 0.39 m since monitoring commenced in 1997. As the condition of this wetland had not been assessed at the time of writing it is not possible to comment on changes in ecological condition.

2. Current hydrology, ecological condition and conservation values.

The Mather Reserve wetland is seasonally inundated however, surface water levels and periods of inundation have declined. Ecological condition is unknown.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for Mather Reserve indicates the wetland may experience drawdown of 0.25-0.5 m by 2005, 0.5-0.75 m by 2008 and 0.75-1.0 m 2013. The magnitude and rate of drawdown far exceed that required to maintain a low risk of impact.

Drawdown predicted over each time period combined with historic changes and conservation values represent a significant to severe level of possible impact. Although the current ecological condition of Mather Reserve Swamp is unknown, it is likely that vegetation condition will decline and the surface water component of the wetland is likely to dry completely.

Spectacles Swamp North *

1. Historic water level change and associated changes in ecological condition.

Groundwater contours indicate water levels at the Spectacles Swamp increased 1.5 m from 1992 to 2003. As the condition of this wetland had not been assessed at the time of writing it is not possible to comment on changes in ecological condition.

2. Current hydrology, ecological condition and conservation values.

Spectacles Swamp North is a seasonally inundated wetland that may support waterbirds. Ecological condition is unknown.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for Spectacles Swamp indicates the western side of the lake may experience drawdown of 0.5-0.75 m by 2005, 0.75-1.0 m by 2008 and 0.5-0.75 by 2013. On the eastern side drawdown of 0.25-0.5 m is predicted by 2005 and 0-0.25 by 2008 and 2013. The magnitude and rate of drawdown far exceed that required to maintain a low risk of impact.

Drawdown predicted on both sides of the lake over each time period combined with historic changes and conservation values represent a severe level of possible impact. Although the current ecological condition of Spectacles Swamp North is unknown, it is likely that vegetation condition will decline and the surface water component of the wetland is likely to dry completely.

Harrisdale Swamp*

1. Historic water level change and associated changes in ecological condition.

Groundwater contours indicate Harrisdale Swamp has experienced an increase in water levels of >3.0 m however, the bore suggests levels have declined 0.37 m since 2000. As the condition of this wetland is unknown it is not possible to comment on changes in ecological condition.

2. Current hydrology, ecological condition and conservation values.

It is likely that Harrisdale Swamp is a seasonally inundated wetland. Ecological condition is unknown.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for Harrisdale Swamp indicates the wetland may experience drawdown of 0.25-0.5 m by 2005, 0-0.25 m by 2008 and 0-0.25 m by 2013. Although the magnitude and rate of drawdown represents a low risk of impact, when considered with historic changes and conservation values the wetland is at significant level of possible impact. Although the current ecological condition of Harrisdale Swamp is unknown, it is likely that vegetation condition will decline.

Terrestrial Vegetation

Gnangara Mound

PM24

1. Historic water level change and associated changes in ecological condition.

Minimum groundwater levels at PM24 declined 0.02 m from 1995-2003. There appears to have been no associated change in ecological condition, with a large number of *E. rudis* and *M. preissiana* saplings currently establishing.

2. Current hydrology, ecological condition and conservation values.

PM24 is located in the basin of Lake Pinjar in an area of 0-3 m depth to groundwater. Despite clearing of much of the wetland basin for agriculture vegetation in the vicinity of PM24 is relatively intact and supports one of the remaining examples of the Pinjar Vegetation Complex in the area. PM24 therefore retains its high conservation values.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for PM24 indicates the wetland may experience an increase in groundwater levels of 0.25-0.5 m by 2005 and 2008, with levels then decreasing 0.25-0.5 m by 2013. The magnitude and rate of drawdown exceed that required to maintain a low risk of impact.

Drawdown predicted at PM24 over each time period combined with historic changes and conservation values represent a significant level of possible impact. This may result in the contraction of sedge species and terrestrialisation of the wetland basin. However, the saplings establishing in the area should persist.

MT3S

1. Historic water level change and associated changes in ecological condition.

Minimum groundwater levels at MT3S declined 0.38 m from 1995-2003. There appears to have been no associated change in ecological condition.

2. Current hydrology, ecological condition and conservation values.

MT3S is located in a small area of remnant *Banksia* woodland at 6-10 m depth to groundwater. The site retains its high conservation value.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for MT3S predicts groundwater drawdown of 0.75-1.0 m by 2005 increasing to 2.0-3.0m by 2008 and >3.0 m by 2013. The magnitude and rate of drawdown exceed that required to maintain a low risk of impact.

Drawdown predicted over each time period combined with historic changes and conservation values represent a moderate level of possible impact. This may result in the loss of some individual *Banksia* and encroachment of more drought tolerant species.

MM18

1. Historic water level change and associated changes in ecological condition.
Minimum groundwater levels at MM18 declined 0.40 m from 1995 to 2003. This coincided with some decline in condition of individual *Banksia*.
2. Current hydrology, ecological condition and conservation values.
MM18 is located in *Banksia* woodland at 3-6 m to groundwater. Although it is adjacent to a major road, the woodland of Whiteman Park is of high conservation value.
3. Predicted drawdown and possible GDE/community/species response.
PRAMS 3.0 modelled drawdown for MM18 indicates groundwater levels may increase 0.5-0.75 m by 2005 and 2008, and 0.25-0.5 m by 2013. Although an increase in groundwater levels should not impact on vegetation the area remains at moderate risk due to historic changes, high conservation values and current depth to groundwater.

MM53

1. Historic water level change and associated changes in ecological condition.
Minimum groundwater levels at MM53 increased 0.08 m from 1995 to 2003. Although this appeared to have little impact there was some decline in vegetation condition during summer 2003/04.
2. Current hydrology, ecological condition and conservation values.
MM53 is located in *Banksia* woodland at 3-6 m depth to groundwater within Whiteman Park. The woodland remains intact and retains its high conservation value.
3. Predicted drawdown and possible GDE/community/species response.
PRAMS 3.0 modelled drawdown for MM53 indicates the wetland may experience an increase in groundwater levels of 0-0.25 m by 2005, to 0.5-0.75 by 2008, and 0.25-0.5 m by 2013. Due to increases in groundwater levels, historic changes, high conservation values and current depth to groundwater the risk of impact to vegetation at MM53 is not significant.

MM59B

1. Historic water level change and associated changes in ecological condition.
Minimum groundwater levels at MM59B decreased 0.2 m from 1995 to 2003. A number of dead and stressed *Banksias* were noted in the area in 2003.
2. Current hydrology, ecological condition and conservation values.
MM59B is located in *Banksia* woodland at 3-6 m depth to groundwater within Whiteman Park. Despite some decline in condition the woodland remains intact and retains its high conservation value.
3. Predicted drawdown and possible GDE/community/species response.
PRAMS 3.0 modelled drawdown for MM59B predicts groundwater level declines of 0.25-0.5 m by 2005, 2008 and 2013. Although the magnitude and rate of drawdown should maintain a low risk of impact, in combination with historic changes, conservation values and current depth to groundwater they represent a moderate to significant level of possible impact. This may result in changes in the distribution of some species and encroachment of more drought tolerant species.

MM55B

1. Historic water level change and associated changes in ecological condition.
Minimum groundwater levels at MM55B increased 0.18 m from 1995-2003. There has been no change in ecological condition at this site.
2. Current hydrology, ecological condition and conservation values.
MM55B is located in *Melaleuca* woodland at 0-3 m depth to groundwater within Whiteman Park. As much of the surrounding area has been cleared for grazing the conservation value of the site is moderate.
3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for MM55B predicts groundwater level declines of 0.5-0.75 m by 2005, decreasing to 0-0.25 m by 2008 and 0.25-0.5 m by 2013. Although there has been a historic groundwater level increase, the combination of conservation values, current depth to groundwater and predicted changes places MM55B at moderate risk of impact. This may result in changing distribution of *M. preissiana* and wetland shrubs in the vicinity.

MM16

1. Historic water level change and associated changes in ecological condition.

Minimum groundwater levels at MM16 increased 0.025 m from 1995 to 2003. There appears to have been no associated change in ecological condition at this site.

2. Current hydrology, ecological condition and conservation values.

MM16 is located in *Banksia* woodland at 3-6 m depth to groundwater within a Bush Forever site that supports a TEC. The woodland remains intact and retains its high conservation value.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for MM16 predicts groundwater level declines of 1.0-2.0 m by 2005, increasing 2.0-3.0 m by 2008 and >3.0 m by 2013. Although there has been a historic groundwater level increase, the combination of conservation values, current depth to groundwater and predicted changes places MM16 at significant risk of impact. This may result in changes in the distribution of some species and encroachment of more drought tolerant species.

PM9

1. Historic water level change and associated changes in ecological condition.

Minimum groundwater levels at PM9 decreased 1.2 m from 1995 to 2003. This coincided with significant declines in understorey density and deaths of individual *Banksias* in the area.

2. Current hydrology, ecological condition and conservation values.

PM9 occurs in a Bush Forever site in *Banksia* woodland at 6-10 m depth to groundwater. Due to the significant decline in vegetation condition, conservation values can only be regarded as moderate.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for PM9 predicts groundwater level declines of 0.75-1.0 m by 2005 and 2008 increasing to 2.0-3.0 m by 2013. Although historic and predicted drawdowns are significant, the greater depth to groundwater and lower conservation value places PM9 at a moderate risk of impact. This could result in further loss of phreatophytic *Banksia* and encroachment of more drought tolerant species in both the overstorey and understorey.

WM1

1. Historic water level change and associated changes in ecological condition.

Minimum groundwater levels at WM1 decreased 0.67 m from 1995 to 2003. This coincided with thinning in the understorey and some *Banksia* deaths.

2. Current hydrology, ecological condition and conservation values.

WM1 is located within a Bush Forever site in *Banksia* woodland at 3-6 m depth to groundwater. Although there has been some decline in vegetation condition the site retains its high conservation value.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for WM1 predicts a groundwater level increase of 0.25-0.5 m by 2005, and 0-0.25 by 2008, before decreasing 0.25-0.5 m by 2013. Although the drawdown predicted to 2013 is negated by the increases to 2005 and 2008, historic changes in combination with current depth to groundwater and conservation values represent a moderate level of possible impact. This may result in further decline in *Banksia* woodland condition.

WM2

1. Historic water level change and associated changes in ecological condition.

Minimum groundwater levels at WM2 decreased 0.38 m from 1995 to 2003. This coincided with decreased vegetation density.

2. Current hydrology, ecological condition and conservation values.

WM2 is located within a Bush Forever site in *Banksia* woodland at 3-6 m depth to groundwater. Although there has been some decline in vegetation density the site retains its high conservation value.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for WM2 predicts a groundwater level decline of 0.25-0.5 m by 2005, increasing to 1.0-2.0 m by 2008, and 2.0-3.0 m by 2013. The magnitude and rate of drawdown over each time period combined with historic changes, current depth to groundwater and conservation values represent a significant level of possible impact. This is likely to result in deaths of mature *Banksia* sp., thinning of the understorey and encroachment of more xeric species.

WM8

1. Historic water level change and associated changes in ecological condition.

Minimum groundwater levels at WM8 decreased 0.25 m from 1995 to 2003. This coincided with decreased vegetation density.

2. Current hydrology, ecological condition and conservation values.

WM8 is located within a Bush Forever site in *Banksia* woodland at 3-6 m depth to groundwater. Although there has been some decline in vegetation density the site retains its high conservation value.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for WM8 predicts a groundwater level decline of >3.0 m by 2005, continuing to 2008 and 2013. The magnitude and rate of drawdown over each time period combined with historic changes, current depth to groundwater and conservation values represent a significant level of possible impact. This is likely to result in deaths of mature *Banksia* sp., thinning of the understorey and encroachment of more xeric species.

NR6C

1. Historic water level change and associated changes in ecological condition.

Minimum groundwater levels at NR6C decreased 0.47 m from 1995 to 2003. This coincided with decreased vegetation density.

2. Current hydrology, ecological condition and conservation values.

NR6C is located within a Bush Forever site in *Banksia* woodland at 3-6 m depth to groundwater. Although there has been some decline in vegetation density and the site is in close proximity to a pine plantation it retains its high conservation value.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for NR6C predicts a groundwater level decline of 2.0-3.0 m by 2005, increasing to >3.0 m by 2008 and 2013. The magnitude and rate of drawdown over each time period combined with historic changes, current depth to groundwater and conservation values represent a significant level of possible impact. This is likely to result in deaths of mature *Banksia* sp., thinning of the understorey and encroachment of more xeric species.

NR11C

1. Historic water level change and associated changes in ecological condition.

Minimum groundwater levels at NR11C decreased 0.26 m from 1995 to 2003. This coincided with decreased vegetation density.

2. Current hydrology, ecological condition and conservation values.

NR11C is located within a Bush Forever site in *Banksia* woodland at 3-6 m depth to groundwater. Although there has been some decline in vegetation density the site retains its high conservation value.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for NR11C predicts a groundwater level decline of 1.0-2.0 m by 2005, increasing to 2.0-3.0 m by 2008 and >3.0 m by 2013. The magnitude and rate of drawdown over each time period combined with historic changes, current depth to groundwater and conservation values represent a significant level of possible impact. This is likely to result in deaths of mature *Banksia* sp., thinning of the understorey and encroachment of more xeric species.

L30C

1. Historic water level change and associated changes in ecological condition.

Minimum groundwater levels at L30C decreased 0.09 m from 1995 to 2003. This coincided with decreased vegetation density.

2. Current hydrology, ecological condition and conservation values.

L30C is located within a Bush Forever site in *Banksia* woodland at 3-6 m depth to groundwater. Although there has been some decline in vegetation density the site retains its very high conservation value.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for L30C predicts a groundwater level decline of 0.75-1.0 m by 2005, 0-0.25 m by 2008 and 0.75-1.0 m by 2013. The magnitude and rate of drawdown over each time period combined with historic changes, current depth to groundwater and conservation values represent a moderate to significant level of possible impact. This is likely to result in further declines in vegetation density due to spot deaths and vegetation condition decline.

L110C

1. Historic water level change and associated changes in ecological condition.

Minimum groundwater levels at L110C decreased 0.25 m from 1995 to 2003. This coincided with decreased vegetation density due to spot deaths in mature *Banksia attenuata*.

2. Current hydrology, ecological condition and conservation values.

L110C is located within a Bush Forever site in *Banksia* woodland at 6-10 m depth to groundwater. Although there has been some decline in vegetation density the site retains its high conservation value.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for L110C predicts a groundwater level increase of 0-0.25 m by 2005, levels will then decline 0-0.25 m by 2008 and 1.0-2.0 m by 2013. The magnitude and rate of drawdown over each time period combined with historic changes, current depth to groundwater and conservation values do not represent a significant level of possible impact. However, there may be some decline in vegetation condition.

L220C

1. Historic water level change and associated changes in ecological condition.

Minimum groundwater levels at L220C decreased 0.08 m from 1995 to 2003. There appears to have been no associated change in ecological condition at this site.

2. Current hydrology, ecological condition and conservation values.

L220C is located within a Bush Forever site in *Banksia* woodland at 6-10 m depth to groundwater. The site retains its very high conservation value.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for L200C predicts a groundwater level decrease of 0-0.25 m by 2005, 0.5-0.75 m by 2008 and 0.75-1.0 m by 2013. The magnitude and rate of drawdown over each time period combined with historic changes, current depth to groundwater and conservation values

represent a moderate to significant level of possible impact. This may result in some decline in vegetation condition.

MM12

1. Historic water level change and associated changes in ecological condition.

Minimum groundwater levels at MM12 decreased 0.90 m from 1995 to 2003. There is some evidence declines in condition and density of *Banksia* woodland at this site.

2. Current hydrology, ecological condition and conservation values.

MM12 is located within a Bush Forever site in *Banksia* woodland at 3-6 m depth to groundwater. The site retains its very high conservation value.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for MM12 predicts a groundwater level decrease of 0.75-1.0 m by 2005 and 1.0-2.0 m by 2008 and 2013. The magnitude and rate of drawdown over each time period combined with historic changes, current depth to groundwater and conservation values represent a significant level of possible impact. This may result in spot deaths of mature *Banksia* and declines in vegetation density.

Ridges*

1. Historic water level change and associated changes in ecological condition.

Minimum groundwater levels at Ridges decreased from 1995 to 2003, with declines ranging from 0.25 m to 2.0 m across the area. This coincided with declines in condition and deaths of *B. ilicifolia* and *E. rudis* at this site.

2. Current hydrology, ecological condition and conservation values.

Ridges is located within a Bush Forever site and supports a Threatened Ecological Community (SCP14). Although there are a number of *E. rudis* in the basin the majority of the site is *Banksia* woodland at 3-6 m depth to groundwater. The site retains its very high conservation value.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for Ridges predicts a groundwater level decrease of 1.0-2.0 m by 2005, 2.0-3.0 m by 2008 and >3.0 m by 2013. The magnitude and rate of drawdown over each time period combined with historic changes, current depth to groundwater and conservation values represent a severe level of possible impact. This is likely to lead to deaths of *B. ilicifolia* and *E. rudis* and phreatophytic *Banksias* and encroachment of more xeric species.

Rosella Rd Bushland (north)*

1. Historic water level change and associated changes in ecological condition.

Minimum groundwater levels in the northern region of Rosella Rd Bushland have declined significantly, with drawdown of >2.0 m in areas of 3-6 m and 6-10 m depth to groundwater. It is not known what impact these declines have had on the vegetation. However, there is likely to have been greater impact in areas of lower depth to groundwater.

2. Current hydrology, ecological condition and conservation values.

Rosella Rd, Bushland is a Bush Forever Site. Although there may have been drawdown impact the site retains its high conservation value.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for Rosella Rd Bushland predicts a groundwater level decrease of 0.5-0.75 m and 0.75-1.0 m by 2005, 1.0-2.0 m by 2008 and >3.0 m by 2013. Vegetation in the 3-6 m depth to groundwater category is at significant risk of impact level with that in the 6-10 m category at moderate risk of impact. This may result in declines in vegetation condition.

Muchea Air Weapons Range*

1. Historic water level change and associated changes in ecological condition.
Minimum groundwater levels in the Muchea Air Weapons Range have declined up to 2.0 m in areas of 6-10 m depth to groundwater. It is not known what impact these declines have had on the vegetation.
2. Current hydrology, ecological condition and conservation values.
Muchea Air Weapons Range is a Bush Forever Site. Although there may have been drawdown impact the site retains its high conservation value.
3. Predicted drawdown and possible GDE/community/species response.
PRAMS 3.0 modelled drawdown for Muchea Air Weapons Range predicts a groundwater level decrease of 0.75-1.0 m by 2005, to 1.0-2.0 m by 2008 and >3.0 m by 2013. The magnitude and rate of drawdown over each time period combined with historic changes, current depth to groundwater and conservation values represent a moderate level of possible impact. This may result in declines in vegetation condition.

Jandakot

JE17C

1. Historic water level change and associated changes in ecological condition.
Minimum groundwater levels at JE17C increased 0.03 m from 1993, when records commenced, to 2003. There is some evidence of declines in condition and density of *E. rudis* at this site.
2. Current hydrology, ecological condition and conservation values.
JE17C is located within a Bush Forever site in *E. rudis*/*M. preissiana* woodland at 0-3 m depth to groundwater. Despite some decline in vegetation condition and invasion of the understorey by exotics, the site retains its very high conservation value.
3. Predicted drawdown and possible GDE/community/species response.
PRAMS 3.0 modelled drawdown for Ridges predicts a groundwater level decrease of 0.5-0.75 m by 2005, to 0.25-0.5 m by 2008 and 0.5-0.75 m by 2013. The magnitude and rate of drawdown over each time period combined with historic changes, current depth to groundwater and conservation values represent a moderate level of possible impact. It is possible that there will be declines in the condition of *M. preissiana* and further declines in *E. rudis*.

JE10C

1. Historic water level change and associated changes in ecological condition.
Minimum groundwater levels at JE10C increased 0.88 m from 1992 to 2003. There has been a recent decline in the condition of *Banksia* woodland at this site.
2. Current hydrology, ecological condition and conservation values.
JE10C is located on a road verge adjacent to private property in *Banksia* woodland at 3-6 m depth to groundwater. Due to near-by clearing and some reduction in the condition of the vegetation this site is of moderate conservation value.
3. Predicted drawdown and possible GDE/community/species response.
PRAMS 3.0 modelled drawdown for JE10C predicts a groundwater level decrease of 0.25-0.5 m by 2005 and 0.75-1.0 m by 2008 and 2013. The magnitude and rate of drawdown over each time period combined with historic changes, current depth to groundwater and conservation values do not represent a significant level of possible impact. There may however, be some further decline in the condition of mature *Banksias*.

JM31

1. Historic water level change and associated changes in ecological condition.
Minimum groundwater levels at JM31 decreased 0.79 m from 1992 to 2003. There has been some decline in the condition of *Banksia* woodland at this site.

2. Current hydrology, ecological condition and conservation values.

JM31 is located on a road verge adjacent to private property in *Banksia* woodland at 3-6 m depth to groundwater. Due to near-by clearing and some reduction in the condition of the vegetation this site is of moderate conservation value.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for JM31 predicts a groundwater level decrease of 0.25-0.5 m by 2005, 0.5-0.75 m by 2008 and 0.75-1.0 m by 2013. The magnitude and rate of drawdown over each time period combined with historic changes, current depth to groundwater and conservation values represent a moderate level of possible impact. It is likely that there will be further decline in the condition of mature *Banksias*.

JM19

1. Historic water level change and associated changes in ecological condition.

Minimum groundwater levels at JM19 decreased 1.26 m from 1992 to 2003. There has been some decline in the condition of *Banksia* woodland at this site.

2. Current hydrology, ecological condition and conservation values.

JE17C is located on the boundary of a Bush Forever site in *Banksia* woodland at 6-10 m depth to groundwater. Groundwater levels are influenced by abstraction from a nearby sand mine and much of the area has been cleared. The site is however, of high conservation value.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for JM19 predicts a groundwater level decrease of 0.25-0.5 m by 2005, 0-0.25 m by 2008 and 0.25-0.5 m by 2013. The magnitude and rate of drawdown over each time period combined with historic changes, current depth to groundwater and conservation values represent a moderate level of possible impact. It is possible that there will be further decline in the condition of mature *Banksias*.

JM35

1. Historic water level change and associated changes in ecological condition.

Minimum groundwater levels at JM35 increased 1.39 m from 1992 to 2003. There has been some recent decline in the condition of *Banksia* woodland at this site.

2. Current hydrology, ecological condition and conservation values.

JM35 is located on the boundary of a Bush Forever site in *Banksia* woodland at 3-6 m depth to groundwater. Despite some decline in vegetation condition and impacts of the adjacent road, the site retains its very high conservation value.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for JM35 predicts a groundwater level decrease of 0.25-0.5 m by 2005, 0-0.25 m by 2008 and 0.25-0.5 m by 2013. The magnitude and rate of drawdown over each time period combined with historic changes, current depth to groundwater and conservation values represent a moderate level of possible impact. It is possible that there will be further decline in the condition of mature *Banksias*.

JE4C

1. Historic water level change and associated changes in ecological condition.

Minimum groundwater levels at JE4C decreased 0.82 m from 1992 to 2003. This coincided with a general decline in the condition of nearby *Banksia* woodland and *M. preissiana*.

2. Current hydrology, ecological condition and conservation values.

JE4C is located in a Bush Forever site in *Melaleuca* woodland at 3-6 m depth to groundwater. Despite some decline in vegetation condition, the site retains its very high conservation value.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for JE4C predicts a groundwater level decrease of 0.5-0.75 m by 2005, to 0.75-1.0 m by 2008 and 1.0-2.0 m by 2013. The magnitude and rate of drawdown over each time period combined with historic changes, current depth to groundwater and conservation values represent a significant level of possible impact. It is likely that there will be further decline in the condition of mature *Banksia* and *M. preissiana* and some encroachment of more xeric species.

JM7

1. Historic water level change and associated changes in ecological condition.

Minimum groundwater levels at JM7 decreased 1.25 m from 1992 to 2003. This coincided with a significant decline in the condition of *M. preissiana* and *E. rudis* and nearby *Banksia* woodland.

2. Current hydrology, ecological condition and conservation values.

JM7 is located in a Bush Forever site in *M. preissiana/ E. rudis* woodland at 3-6 m depth to groundwater. Due to the decline in vegetation condition, the site has dropped from very high to high conservation value.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for JM7 predicts a groundwater level decrease of 0.75-1.0 m by 2005, and 0.5-0.75 m by 2008 and 2013. The magnitude and rate of drawdown over each time period combined with historic changes, current depth to groundwater and conservation values represent a moderate to significant level of possible impact. It is likely that there will be further decline in the condition of *M. preissiana* and *E. rudis* and nearby *Banksia* woodland and some encroachment of more xeric species.

JM8

1. Historic water level change and associated changes in ecological condition.

Minimum groundwater levels at JM8 decreased 1.32 m from 1992 to 2003. Recent signs of water stress have been noted in *Banksia* woodland in the vicinity.

2. Current hydrology, ecological condition and conservation values.

JM8 is located in a Bush Forever site in *Banksia* woodland at 3-6 m depth to groundwater. The site retains its very high conservation value.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for JM8 predicts a groundwater level decrease of 0.75-1.0 m by 2005, 0-0.25 m by 2008 and 0.25-0.5 m by 2013. The magnitude and rate of drawdown over each time period combined with historic changes, current depth to groundwater and conservation values represent a moderate to significant level of possible impact. It is likely that there will be further decline in the condition of mature *Banksias*.

JM45

1. Historic water level change and associated changes in ecological condition.

Minimum groundwater levels at JM45 decreased 1.32 m from 1992 to 2003. Recent signs of water stress have been noted in mature *E. rudis* and *M. preissiana* and *Banksia* woodland in the vicinity.

2. Current hydrology, ecological condition and conservation values.

JM45 is located in a Bush Forever site in mixed *E. rudis/ M. preissiana/ Banksia* woodland at 3-6 m depth to groundwater. The site retains its very high conservation value.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for JM45 predicts a groundwater level decrease of 0.25-0.5 m by 2005, 0.25-0.5 m by 2008 and 0.5-0.75 m by 2013. The magnitude and rate of drawdown over each time period combined with historic changes, current depth to groundwater and conservation values represent a moderate to significant level of possible impact. It is likely that there will be further decline in the condition of *M. preissiana* and *E. rudis* and nearby *Banksia* woodland.

8284

1. Historic water level change and associated changes in ecological condition.

Minimum groundwater levels at 8284 decreased 1.26 m from 1992 to 2003. Recent signs of water stress have been noted in mature *E. rudis* and *M. preissiana* in the vicinity.

2. Current hydrology, ecological condition and conservation values.

8284 is located on a road verge adjacent to private property in mixed *M. preissiana*/*E. rudis*/*Banksia* woodland at 3-6 m depth to groundwater. Due to near-by clearing and some reduction in the condition of the vegetation this site is of moderate conservation value.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for 8284 predicts a groundwater level decrease of 0.5-0.75 m by 2005, 0-0.25 m by 2008 and 0.25-0.5 m by 2013. The magnitude and rate of drawdown over each time period combined with historic changes, current depth to groundwater and conservation values represent a moderate to significant level of possible impact. It is likely that there will be further decline in the condition of *M. preissiana* and *E. rudis* and encroachment of more xeric species.

JM49

1. Historic water level change and associated changes in ecological condition.

Minimum groundwater levels at JM49 decreased 0.39 m from 1992 to 2003. There appears to have been some change in the condition of vegetation in the vicinity.

2. Current hydrology, ecological condition and conservation values.

JM49 is located on a road verge adjacent to private property in mixed *M. preissiana*/*B. littoralis* woodland at 3-6 m depth to groundwater. Due to near-by clearing and some reduction in the condition of the vegetation this site is of moderate conservation value.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for JM49 predicts a groundwater level decrease of 0.75-1.0 m by 2005 and 1.0-2.0 m 2008 and 2013. The magnitude and rate of drawdown over each time period combined with historic changes, current depth to groundwater and conservation values represent a moderate to significant level of possible impact. It is likely that there will be further decline in the condition of *M. preissiana* and possible spot deaths in *B. littoralis* and encroachment of more xeric species.

JM39

1. Historic water level change and associated changes in ecological condition.

Minimum groundwater levels at JM39 decreased 1.32 m from 1992 to 2003. There appears to have been little change in the condition of vegetation in the vicinity.

2. Current hydrology, ecological condition and conservation values.

JM39 is located on a road verge adjacent to private property in *Melaleuca*/*Banksia* woodland at 3-6 m depth to groundwater. Due to near-by clearing this site is of moderate conservation value.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for JM39 predicts a groundwater level decrease of 0.75-1.0 m by 2005, 2008 and 2013. The magnitude and rate of drawdown over each time period combined with historic changes, current depth to groundwater and conservation values represent a moderate to significant level of possible impact. It is likely that there will be declines in condition of mature *Melaleuca* and *Banksias* and encroachment of more xeric species.

JM16

1. Historic water level change and associated changes in ecological condition.

Minimum groundwater levels at JM16 decreased 0.71 m from 1992 to 2003. There appears to have been little change in the condition of vegetation in the vicinity.

2. Current hydrology, ecological condition and conservation values.

JM16 is located in a Bush Forever site in *Banksia* woodland at 3-6 m depth to groundwater. The site retains its very high conservation value.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for JM16 predicts a groundwater level decrease of 0-0.25 m by 2005 before rising 0-0.25 m by 2008 and 2013. The magnitude and rate of drawdown over each time period combined with historic changes, current depth to groundwater and conservation values represent a moderate to significant level of possible impact. It is likely that there will be some decline in the condition of mature *Banksias*.

JM14

1. Historic water level change and associated changes in ecological condition.

Minimum groundwater levels at JM14 decreased 0.73 m from 1992 to 2003. There has been some recent declines and deaths of mature *Banksias* in the vicinity.

2. Current hydrology, ecological condition and conservation values.

JM16 is located in a Bush Forever site in *Banksia* woodland at 3-6 m depth to groundwater. Despite some decline in condition, the site retains its very high conservation value.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for JM14 predicts a groundwater level decrease of 0.5-0.75 m by 2005 and to 0-0.25 m by 2008 and 2013. The magnitude and rate of drawdown over each time period combined with historic changes, current depth to groundwater and conservation values represent a moderate to significant level of possible impact. It is possible that there will be some decline in the condition of mature *Banksias*.

Anstey/Keane Bushland*

1. Historic water level change and associated changes in ecological condition.

Minimum groundwater levels at JM23 decreased 0.73 m from 1992 to 2003. It is not known if there have been associated changes in vegetation condition in the area.

2. Current hydrology, ecological condition and conservation values.

Anstey/Keane Bushland is a Bush Forever Site in *M. preissiana* and *Banksia* sp woodland at 0-3 m depth to groundwater. The site is of high conservation value.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for JM23 predicts a groundwater level decrease of 0.25-0.5 m by 2005 and to 0-0.25 m by 2008 and 2013. The magnitude and rate of drawdown over each time period combined with historic changes, current depth to groundwater and conservation values represent a significant to severe level of possible impact. There is likely to be some decline in the condition of phreatophytic vegetation across the area.

Base Flow Systems

Bennett Brook*

1. Historic water level change and associated changes in ecological condition.

Minimum groundwater levels at MM49B in the vicinity of Bennett Brook increased 0.12 m from 1995 to 2003. It is not known if the surface water levels of the Brook have changed during this time. The current condition of vegetation at Bennett Brook is unknown.

2. Current hydrology, ecological condition and conservation values.

Some areas of Bennett Brook, including Mussel Pool appear to be permanently inundated. Despite clearing of much native vegetation in the area for recreation, the wetland supports fauna and maintains a high conservation value.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for Bennett Brook predicts a groundwater level increase of 0.25-0.5 m by 2005, 0.75-1.0 m by 2008 and 0.5-0.75 m by 2013. The magnitude and rate of drawdown over each time period combined with historic changes, current depth to groundwater and conservation values represent a moderate level of possible impact. However, it is likely that increased water levels will negate any previous impacts on vegetation condition.

Quin Brook*

1. Historic water level change and associated changes in ecological condition.

Minimum groundwater levels at GB22 and GB16 in the vicinity of Quin Brook decreased 0.49 m and 0.73 m respectively from 1995 to 2003. There does not appear to have been associated changes in vegetation condition in the area.

2. Current hydrology, ecological condition and conservation values.

Quin Brook comprises of a series of interconnected wetlands in an area of 0-3 m and 3-6 m depth to groundwater dominated. The wetlands are of high conservation value due to the pristine nature of the vegetation (*M. raphiophylla*, *E. rudis* and *M. preissiana*) despite recent fire and some weed invasion.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for Quin Brook predicts a groundwater level decrease in the south (lake area) of 0.25-0.5 m by 2005, 0.5-0.75 m by 2008 and 1.0-2.0 m by 2013. The remaining three wetlands may experience drawdown of 0.5-0.75 by 2005, 0.75-1.0 m by 2008 and 2.0-3.0 m by 201. The magnitude and rate of drawdown over each time period combined with historic changes, current depth to groundwater and conservation values represent a significant level of possible impact in the south a severe risk in the north. There is likely to be decline in the condition of *M. raphiophylla*, *E. rudis*, *M. preissiana* and other groundwater dependent vegetation.

Cave and Aquifer Ecosystems

Crystal Cave (YN1)

1. Historic water level change and associated changes in ecological condition.
Minimum groundwater levels at YN3 in the vicinity of Crystal Cave decreased 0.64 m from 1995 to 2003.
2. Current hydrology, ecological condition and conservation values.
The permanent stream that once occurred in Crystal Cave is now dry. Cave Fauna now persist only in artificial pools however, the cave maintains a very high conservation value.
3. Predicted drawdown and possible GDE/community/species response.
PRAMS 3.0 modelled drawdown for Crystal Cave predicts a groundwater level decrease of 1.0-2.0 m by 2005 and 2008 and 2.0-3.0 m by 2013. Cave fauna will be unable to survive unaided in Crystal Cave.

Water Cave (YN11)

1. Historic water level change and associated changes in ecological condition.
Minimum groundwater levels at YN7 in the vicinity of Water Cave decreased 0.47 m from 1995 to 2003.
2. Current hydrology, ecological condition and conservation values.
The flow of the permanent stream that occurs in Water Cave has decreased. However, root mat communities persist and the cave maintains a very high conservation value.
3. Predicted drawdown and possible GDE/community/species response.
PRAMS 3.0 modelled drawdown for Water Cave predicts a groundwater level decrease of 0.75-1.0 m by 2005 and 1.0-2.0 m by 2008 and 2013. This is likely to lead to drying of the stream and loss of root mats and associated fauna.

Carpark Cave (YN18)

1. Historic water level change and associated changes in ecological condition.
Minimum groundwater levels at YN7 in the vicinity of Carpark Cave decreased 0.47 m from 1995 to 2003.
2. Current hydrology, ecological condition and conservation values.
The permanent stream that occurs in Carpark Cave now dries for most of the year. However, root mat communities may persist and the cave maintains a very high conservation value.
3. Predicted drawdown and possible GDE/community/species response.
PRAMS 3.0 modelled drawdown for Carpark Cave predicts a groundwater level decrease of 0.75-1.0 m by 2005 and 1.0-2.0 m by 2008 and 2013. This is likely to lead to total drying of the stream and loss of root mats and associated fauna.

Gilgie Cave (YN27)

1. Historic water level change and associated changes in ecological condition.
Minimum groundwater levels at YN8 in the vicinity of Gilgie Cave decreased 1.03 m from 1995 to 2003.
2. Current hydrology, ecological condition and conservation values.
The permanent stream that occurred in Gilgie Cave has dried. Although it is unlikely that root mat communities persist, the cave should be regarded as being of high conservation value.
3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for Gilgje Cave predicts a groundwater level decrease of 0.75-1.0 m by 2005 and 2008 and 1.0-2.0 m by 2013. This is likely to lead to total loss of root mats and associated fauna.

Cabaret Cave (YN30)

1. Historic water level change and associated changes in ecological condition.

Minimum groundwater levels at YN3 and YN4 in the vicinity of Cabaret Cave decreased 0.39 m and 0.64 m respectively from 1995 to 2003.

2. Current hydrology, ecological condition and conservation values.

The permanent stream that occurred in Cabaret Cave has dried. Although it is unlikely that root mat communities persist, the cave should be regarded as being of high conservation value.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for Cabaret Cave predicts a groundwater level decrease of 1.0-2.0 m by 2005 and 2.0-3.0 m by 2008 and 2013. This is likely to lead to total loss of root mats and associated fauna.

Boomerang Cave (YN99)

1. Historic water level change and associated changes in ecological condition.

Minimum groundwater levels at YN3 in the vicinity of Boomerang Cave decreased 0.64 m from 1995 to 2003.

2. Current hydrology, ecological condition and conservation values.

The permanent stream that occurs in Boomerang Cave now dries for most of the year. However, root mat communities may persist and the cave maintains a very high conservation value.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for Boomerang Cave predicts a groundwater level decrease of 1.0-2.0 m by 2005 and 2008 and 2.0-3.0 m by 2013. This is likely to lead to total loss of root mats and associated fauna.

Twilight Cave (194)

1. Historic water level change and associated changes in ecological condition.

Minimum groundwater levels at YN8 in the vicinity of Twilight Cave decreased 1.03 m from 1995 to 2003.

2. Current hydrology, ecological condition and conservation values.

The permanent stream that occurs in Twilight Cave now dries for most of the year. However, root mat communities may persist and the cave maintains a very high conservation value.

3. Predicted drawdown and possible GDE/community/species response.

PRAMS 3.0 modelled drawdown for Twilight Cave predicts a groundwater level decrease of 0.75-1.0 m by 2005 and 2008 and 1.0-2.0 m by 2013. This is likely to lead to total loss of root mats and associated fauna.

YN61*

Location unknown

YN555*

Location unknown

Orpheus Cave (YN256)*

Location unknown

Jackhammer Cave (YN438)*

Location unknown

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APPENDICES

APPENDIX 1: REVIEW OF THE REPRESENTATIVENESS OF JANDAKOT TERRESTRIAL VEGETATION CRITERIA BORES

All terrestrial criteria bores on the Jandakot Mound were visited during April 2004 to assess vegetation condition and the appropriateness of bores as representative of vegetation in the vicinity. Descriptions of sites were supplemented by photographs. Three bores could not be located, JM8, JM15 and JM39.

During the field visits it was noted that land adjacent to many of the bores had been either totally or partially cleared for urban development or other forms of land-use in recent years rendering a number of sites unrepresentative of terrestrial vegetation and reducing the value of others. Of the 25 bores assessed only 8-10 remain truly representative of phreatophytic terrestrial vegetation as shown in the table below. It is the recommendation of the authors that bores 'not representative of terrestrial vegetation' be decommissioned as criteria bores.

Representative of terrestrial vegetation	Representativeness impacted by other factors (land use)	Not representative of terrestrial vegetation
JE17C	JE20C	JM23C
JE4C	JM24	J310
JM7	JE10C	JE18C
JM8	JM31	JM19
JM45	JM35	JM27
JE12C	JM29	JM5
JM16	JM49	JE19C
JM14	JM33	JM18
8284	JE1B	
JM39	JM15	

JE17C

JE17C is located on Branch Cross within the Thomson Lake Nature Reserve. The vegetation surrounding JE17C is *Eucalyptus rudis* and *Melaleuca preissiana* woodland with a fairly dense overstorey with bracken fern and an exotic understorey containing *Pelargonium capitatum* and *Conyza albida* (fleabane). The opposite side of the road is *M. preissiana* and insect impacted *E. rudis*. This area is representative of terrestrial vegetation however, declared rare flora is no longer recorded for this site on the CALM flora base. The condition of the surrounding vegetation is good.



Looking west towards JE17C and *E. rudis* / *M. preissiana* woodland of Thomsons Lake Nature Reserve.



Looking east from JE17C towards *E. rudis* / *M. preissiana* woodland with weed dominated understorey.

JE4C

JE4C is located in the Denis De Young Reserve. The vegetation west of JE4C is *Melaleuca spp.* and dense healthy intact *Casuarina* woodland. Twenty meters east of the bore the vegetation is *M. preissiana* and *B. menziesii* with some *B. ilicifolia* 100m south of the bore. This area is representative of terrestrial vegetation and the condition of the surrounding vegetation is good.



Looking east from JE4C towards dense, intact mixed woodland of Denis de Young Reserve.



Looking west at JE4C.

JM7

JM7 is located on Hope Road leading into Jandakot Airport. The vegetation surrounding JM7 is impacted *E. rudis* and *M. preissiana* woodland above a weedy understorey. Several of the large *M. preissiana* are resprouting and the *E. rudis* have been damaged by insects. This is upslope from *E. rudis* and *Banksia spp.* woodland. On the opposite side of the road the vegetation consists of *Banksia spp.* and *E. totiana* woodland which is in reasonable condition. This area is representative of terrestrial vegetation however, declared rare flora is no longer recorded for this site on the CALM flora base. The condition of the surrounding vegetation is reasonable.



Looking south towards JM7 and severely impacted mature *M. preissiana*.



Looking north from JM7 into *Banksia* woodland.



Impacted *E. rudis* south-east of JM7.

JM8

JM8 is located within the grounds of the Jandakot Airport. This area is representative of terrestrial vegetation and declared rare flora is recorded for this site on the CALM flora base.

JM45

JM45 is located in remnant vegetation southwest of the Jandakot airport. The vegetation close to JM45 is insect impacted *E. rudis* woodland with some *M. preissiana* which are showing signs of tip drying. Surrounding this is *Banksia* woodland showing signs of seasonal drying but generally in good health. This area is representative of terrestrial vegetation however, declared rare flora is no longer recorded for this site on the CALM flora base. The condition of the surrounding vegetation is good.



Looking west from JM45.



Looking north-west from JM45 towards impacted *E. rudis*.

JE12C

JE12C is located on Rowley Road (private property) opposite developed semi-rural land 500m west of intact *Banksia* woodland. The vegetation surrounding JE12C is intact healthy *Banksia* and *Eucalyptus* woodland. This area is representative of terrestrial vegetation. The depth to groundwater in the vicinity of JE12C is greater than 12m and therefore the vegetation is not considered highly groundwater dependant. The condition of the surrounding vegetation is good.



Looking south towards JE12C and healthy *Banksia* woodland.



Looking north from JE12C towards private property.

JM16

JM16 is located at the Harrisdale Swamp Bushland. The vegetation consists of intact *B. attenuata* and *B. menziesii* woodland (1 dead *B. attenuata* noted) with *Banksia* woodland of Canning Vale Prison Bushland on the opposite side of the road. This area is representative of terrestrial vegetation and the condition of the surrounding vegetation is good.



Looking east towards JM16 and intact *Banksia* woodland of Harrisdale Swamp Bushland.



Looking west from JM16 towards *Banksia* woodland of Canningvale Prison Bushland.

JM14

JM14 is located in the Acourt Road Bushland, Jandakot Regional Park. The vegetation consists of *Banksia* woodland with *M. preissiana*. Although an undisturbed area there is evidence of impact with recent deaths of *B. attenuata* and older deaths of *B. ilicifolia*, *B. attenuata* and *B. menziesii* and drying of *B. elegans* in understorey. This area is representative of terrestrial vegetation and the condition of the surrounding vegetation is good.



Looking north from JM14 towards *M. preissiana* and wetland vegetation.



Looking east towards JM14 and dead *Banksia*.



Looking south from JM14 towards healthy *Banksia* overstorey above impacted *Beaufortia elegans*.

8284

8284 is located on private property on Solomon Road. The vegetation on the private property side contains some *E. rudis* and *M. preissiana*. Adjacent to this is the sand mine which has an area of bush near by that contains *M. preissiana*. On the opposite side of the road the vegetation is remnant *Banksia* on cleared semi-rural land. This is approximately 100m north from intact, healthy *Banksia* woodland of Fraser Road Reserve. This area is representative of terrestrial vegetation and the condition of the surrounding vegetation is good.



Looking west towards 8284 and private property.



Looking east from 8284 towards largely cleared private property.

JM39

JM39 is located on Rowley Road. Although we have not yet found the site it appears to be in the vicinity of intact *M. preissiana* and *M. raphiophylla* woodland surrounded by semi-rural lots. This area is representative of terrestrial vegetation and the condition of the surrounding vegetation is good.

JE20C

JE20C is located on Beenyup Road opposite the cut flower farm that leads through to Beenyup Swamp. The vegetation on the side of the road with the bore is *Banksia* woodland with dense *Melaleuca spp.* which look healthy. This is also private property. This areas representiveness has been impacted by land use changes. The vegetation condition is good.



Looking east towards JE20C and *Melaleuca* woodland on private property.



Looking west from JE20C towards cut flower farm on private property.

JM24

JM24 is located off Hammond Road. The vegetation consists of a small area of healthy mixed *Banksia* woodland (1ha) (*B. attenuata*, *B. menziesii* & *B. ilicifolia*). The opposite side of the road has been recently cleared for urban land. There is an area of *E. rudis* approximately 100m to the west. This areas representiveness has been impacted by land use changes. The condition of the remnant vegetation is good.



Looking north from JM24 towards remnant *Banksia* woodland.



Looking south from JM24 towards recently cleared urban land.

JE10C

JE10C is located on Liddelow Road. The land is private property on both sides of the road. The vegetation is impacted *Banksia* (some young *B. ilicifolia* and *B. menziesii* dead) and *Casuarina* woodland with semi-cleared private property opposite. This areas representativeness has been impacted by land use changes. The vegetation condition is reasonable.



Looking east towards JE10C and impacted *Banksia* woodland on private property.



Looking west from JE10C towards disturbed vegetation on private property.

JM31

JM31 is located on Taylor Road (private property). The opposite side has an open area dominated by exotics with some *E. rudis* in the overstorey. An area of *Acacia* shrubs occurs some 100m to the west. This areas representativeness has been impacted by land use changes. The vegetation condition is reasonable.



Looking east from JM31 towards private property.



Looking west from JM31 towards partly cleared *E. rudis* woodland.

JM35

JM35 is located on Taylor Road opposite Denis De Young Reserve (part of Jandakot Regional Park). The vegetation consists of impacted *Banksia* and *Casuarina* woodland opposite cleared land. This areas representativeness has been impacted by land use changes. The vegetation condition is reasonable.



Looking east towards JM35 and impacted *Banksia* /*Casuarina* woodland.



Looking west from JM35 towards Denis de Young Reserve.

JM29

JM29 is located on Beenyup Road (private property). On the opposite side there is an open area and *M. preissiana*/*E. rudis* woodland approximately 50m southwest of the bore. Urban development has begun approximately 200m northwest of the bore. This areas representativeness has been impacted by land use changes. The condition of remnant vegetation is reasonable.



Looking east towards JM29 and cleared private property.



Looking west from JM29 and newly cleared urban land (left side of photo).



Looking south-west from JM29 towards remnant *M. preissiana* / *E. rudis* woodland.

JM49

JM49 is located on Rowley Road on private property. The vegetation consists of *B. littoralis* and *M. preissiana* woodland with dense bracken fern and exotics in the understorey. On the opposite side there is private property which is highly disturbed and 100m west is intact *Banksia* woodland. This areas representiveness has been impacted by land use changes. The vegetation condition is reasonable.



Looking south towards JM49 and *Banksia* / *Melaleuca* woodland on private property.



Looking north from JM49 towards private property,



Looking south-west from JM49 towards intact *Banksia* woodland.

JM33

JM33 is located on Barfield Road. The vegetation consists of a large area of intact *Banksia* / *Casuarina* woodland. On the opposite side there is newly cleared urban land. This areas representativeness has been impacted by land use changes. The vegetation condition is reasonable.



Looking east towards JM33 and healthy, intact *Banksia* woodland.



Looking west from JM33 towards recently cleared urban land.

JE1B

JE1B is located on Solomon Road. The vegetation consists of *B. attenuata* and *B. menziesii* woodland. Approximately 100m west of the sand mine, on the opposite side, the vegetation is intact *Banksia* woodland on private property. This areas representativeness has been impacted by land use changes. The depth to groundwater is greater than 10m and therefore the vegetation is not considered highly groundwater dependant. The vegetation condition is reasonable.



Looking west towards JE1B and *Banksia* woodland on private property.



Looking east from JE1B towards band of *Banksia* woodland adjacent to sand-mine.

JM15

JM15 is located ??? could not find.

JM23C

JM23C is located on private property on Gaebler Road. On the opposite side the land has been recently cleared for urban development. This area is not representative of terrestrial vegetation.



Looking south from JM23C and cleared rural land.



Looking north from JM23C towards recently cleared urban land.

J310

J310 is located on Princep Road in an industrial area. There is no vegetation native directly adjacent to the bore, the closest vegetation consists of healthy, intact *E. rudis* 50m to the west and the condition of the understorey is not known. This area is not representative of terrestrial vegetation. Declared rare flora is no longer recorded for this site on the CALM flora base.



Looking west towards J310 and a timber yard. *E. rudis* can be seen in the background.



Looking east from J310 towards an industrial area.

JE18C

JE18C is located on private property on Tapper Road. The vegetation has been largely cleared, with only a few *E. rudis* left on the road edge. On the opposite side there is a park with a small wetland surrounded by *M. preissiana*, which is approximately 500m from intact vegetation and an area of *Typha*. This area is not representative of terrestrial vegetation.



Looking east towards JE18C and private property.



Looking west from J310 towards reticulated parkland.

JM19

JM19 is located in the Fraser Road Bushland in close proximity to a sand mine. What little vegetation remains in the vicinity is influenced by groundwater abstraction for the mine. This area is not representative of terrestrial vegetation.



Aerial photo showing location of JM19 in area impacted by sand mining.

JM27

JM27 is located on Armadale Road. The vegetation consists of a 20m wide strip of *Banksia / Casuarina* woodland along the roadside. On the opposite side of the road is a cleared rural area. This area is not representative of terrestrial vegetation.



Looking south towards JM27 and cleared rural land.



Looking north from JM27 across Armadale Rd and towards cleared rural land.

JM5

JM5 is located in the grounds of a primary school on Eucalyptus Boulevard in an urban area. This area is not representative of terrestrial vegetation.



Looking north across school ground towards JM5.



Aerial photo showing location of JM5 in the grounds of an urban school.

JE19C

JE19C is located on Beenyp Rd. (private property). On the opposite side of the road the land has been cleared for urban land development (previously *Melaleuca* woodland). The Jandakot Regional Park is located approximately 100m south and the vegetation there is dense wetland vegetation. The area surrounding JE19C is not representative of terrestrial vegetation. Declared rare flora is no longer recorded for this site on the CALM flora base.



Looking east towards JE19C and private property.



Looking west from JE19C towards recently cleared urban land.

JM18

JM 18 is located in a cleared industrial area 400m north of a managed conservation reserve. Wetland vegetation in reserve (*M. preissiana*, *B. articulata*, *A. fascicularis*) intact and healthy and there is evidence of a weed control program. However, the area surrounding JM18 has all been cleared for industrial use.



Looking north towards JM18 and recently cleared industrial land.



Looking south from JM18 and recently cleared industrial land. Wetland reserve can be seen in the background.

APPENDIX 2: ASSESSMENT OF VEGETATION AND WETLAND CONDITION AT 'NEW' STUDY WETLANDS

Map Number	Wetland Type & ID Number / Name	Conservation Category & Overall Condition	Vegetation Type / Community	Vegetation Condition
Out of Map Range	Ridges - Dampflands	Category = none given Some clearing in north section (limestone mining). Track to wetland fringe leading to dumping of car bodies & rubbish.	Terrestrial: Open Woodland of <i>B. menziesii</i> , <i>B. grandis</i> & <i>B. ilicifolia</i> . Understorey dominated by <i>Aidenanthos</i> sp., <i>J. furcellata</i> & <i>Eremicia</i> sp. Wetland: Woodland to open woodland of <i>E. rudis</i> & <i>M. preissiana</i> . Open heath of <i>K. ericifolia</i> around wetland & extending in terrestrial community.	Weeds generally restricted to northern section where pine trees are establishing. Mature <i>E. rudis</i> highly stressed over most of wetland. <i>K. ericifolia</i> heath appears drought stressed.
2034 II SW	Lake Ovalup (18361647226)	Category = 2 Lake surrounded by parkland & urban development with wide buffer of remnant bushland to the north. Main area of lake fed by drains & supports herbage of annual weeds, suggesting surface water is annually jurassic. Lake dry in April 2004.	Terrestrial: Open woodland of <i>E. gonphocephala</i> & <i>C. calophylla</i> with <i>Acacia saligna</i> Wetland: Open forest of <i>E. rudis</i> & <i>M. raphiophylla</i> with annual & perennial grasses dominating understorey. Sedgeland of <i>Typha orientalis</i> in band around lake.	Terrestrial: Recent fire has scorched most of the trees in close proximity to the lake. Wetland: Wetland trees stressed due to recent fire. <i>Typha</i> sp. appears to be encroaching further in wetland suggesting reduced surface water depth & duration.
2034 II NW	Heeryup Swamp (138625648247)	Category = 1 Wetland with one large area of probably permanent open water (may be useful refuge for water birds). Surrounded by cleared parkland on all sides. Connected to Wallabucup Swamp by narrow creek in south-east corner. Creek was flowing slowly in April 2004.	Terrestrial: Scattered <i>Corymbia calophylla</i> with grass understorey on west side Wetland: Low closed forest of <i>M. raphiophylla</i> with understorey of <i>Lepidosperma longistylis</i> & various weedy <i>M. raphiophylla</i> apparent in less dense areas of paperbark forest.	Annual & perennial weeds have invaded the <i>E. rudis</i> & <i>M. raphiophylla</i> around perimeter of swamp, however, a dense canopy over much of the wetland has limited weed invasion into the basin. <i>M. raphiophylla</i> is generally in good condition.
	Wallabucup (13696648190)	Category = 1 Wetland in predominantly cleared catchment of mixed urban & semi-rural development. Agricultural land extend to edge of basin on east side with virtually no remnant vegetation left. To west a narrow & patchy band (0.20m) of littoral vegetation remains surrounded by open parkland.	Terrestrial: None Wetland: Woodland of <i>E. rudis</i> & <i>M. raphiophylla</i> to the margins. Open forest of <i>M. raphiophylla</i> in some central areas with closed to open sedgeland of <i>T. orientalis</i> in wetland. Mixed <i>Typha</i> & <i>Bananea</i> sp. closed sedgeland to the south.	Some die-back of <i>E. rudis</i> is apparent on western side however, probably due to recent fire. Substantial weed invasion is occurring from farmland to the east. <i>Typha</i> showing signs of drought stress.
	Big Carine Swamp (38506647515)	Category = 2 Wetland in large recreation reserve, predominantly turf & a small areas of remnant vegetation in north-east corner. A narrow band of wetland tree species remain around perimeter of lake with more extensive stand towards the centre. Dry in April 2004.	Terrestrial: <i>E. gonphocephala</i> woodland near NE corner. Wetland: Woodland to open forest of <i>E. rudis</i> & <i>M. raphiophylla</i> becoming low open forest of <i>M. raphiophylla</i> towards the centre of the lake. Sedgeland of <i>Typha orientalis</i> & <i>Bananea</i> sp. over much of the lake. Annual & perennial herbs & grasses cover the exposed sediment in the lowest areas.	Scattered <i>Melaleuca</i> seedlings occurring in the lake. Vegetation in lake is in excellent condition. Approximately 50% of the <i>Melaleuca</i> on the west side is dead or very stressed & 25% is stressed at the southern end. Stressed trees are generally restricted to the higher sections of the littoral zone.
	Caremap Swamp (38595647369)	Category = 1 Highly modified from infilling & urban development on all sides. Some deep permanent water occurs at northern end & eastern side. Northern end receives road runoff & is therefore eutrophic.	Terrestrial: None Wetland: Patchy woodland of <i>E. rudis</i> & <i>M. raphiophylla</i> with numerous exotic trees (<i>Salix</i> sp.) Sedgeland of <i>Typha orientalis</i> & <i>Bananea</i> sp.	Vegetation degraded through physical disturbance & presence of invasive weed species. No evidence of drought stress in April 2004.
	Badgerup Lake (39028648551)	Category = 2 Large (>100m) vegetation buffer to north, west & south. Eastern margin predominantly cleared for semi-rural development. Majority of woody littoral species have been cleared from perimeter. Wetland dry in April 2004.	Terrestrial: Low open woodland of <i>B. attenuata</i> , <i>B. menziesii</i> & <i>B. ilicifolia</i> . Understorey includes <i>J. furcellata</i> , <i>Aidenanthos</i> sp., <i>Halenia pinnatifida</i> & <i>Hibbertia</i> sp. Wetland: Open woodland of <i>E. rudis</i> & <i>M. preissiana</i> with an understorey of annual weeds & <i>Carpobrotus</i> sp. Closed sedgeland of <i>T. orientalis</i> on wetland basin. Open woodland of <i>E. rudis</i> , <i>M. preissiana</i> & <i>Viminaria juncea</i> extends through to Little Badgerup Lake at the southern end with <i>B. elegans</i> & <i>Calystro fraxini</i> in the understorey.	Littoral vegetation cleared in a band approx. 20-40m wide around wetland. Annual grasses slashed suggesting zone is intentionally kept clear of vegetation. Recent fire has scorching remaining littoral trees but has not affected the upland vegetation. <i>Typha</i> sedgeland extremely drought stressed.
	Little Badgerup Lake (39037648274)	Category = 2 Wide vegetation buffer surrounds wetland. Semi-rural development encroaching at northern end resulting in the removal of a large area of the wetland tree community that connects this wetland to Badgerup Lake. Some littoral vegetation lost on west side due to clearing. Wetland dry in April 2004.	Terrestrial: Low open woodland of <i>B. attenuata</i> , <i>B. menziesii</i> & <i>B. ilicifolia</i> . Understorey of <i>J. furcellata</i> , <i>Aidenanthos</i> sp. & <i>Macraecania riedelii</i> . Wetland: Open woodland of <i>E. rudis</i> & <i>M. preissiana</i> with understorey of annual weeds & <i>Carpobrotus</i> sp. Closed sedgeland of <i>T. orientalis</i> on basin.	Littoral vegetation has areas of localised clearing on west side. Disturbed areas heavily weed infested. Numerous <i>E. rudis</i> seedlings & saplings around edge of basin. Some mature <i>E. rudis</i> have poor crown condition although some are regenerating vigorously from epicormic growth. Terrestrial vegetation in good condition. <i>Typha</i> community very drought stressed.
2034 II NE	Little Emu Swamp (39360647560)	Category = 2 Swamp in south-east corner of Koondoola Regional Park with buffer of remnant vegetation. Vehicle tracks surround wetland.	Terrestrial: Low open woodland of <i>B. menziesii</i> , <i>B. attenuata</i> & <i>N. floribunda</i> with understorey of <i>X. preissii</i> & <i>J. furcellata</i> . Wetland: Woodland of <i>E. rudis</i> & <i>M. preissiana</i> . Open heath of <i>A. fascicularis</i> & <i>Calystro</i> sp. over open	Vegetation show signs of stress from recent fire, particularly in centre of wetland. No obvious signs of drought stress. Substantial cover of annual weeds & some

Map Number	Wetland Type & ID Number / Name	Conservation Category & Overall Condition	Vegetation Type / Community	Vegetation Condition
		basin & fire occurs regularly. Wetland dry in April 2004.	sedge/land of <i>B. juncea</i> .	localised areas of physical disturbance (fire & vehicle tracks)
2034 I SE	Spring near the Maze (40077649797)	Category = 1 Spring fed wetland near area of mixed rural land uses & remnant vegetation. Appeared dry in 2004.	Terrestrial: Open woodland of <i>C. calophylla</i> & <i>E. marginata</i> with <i>B. menziesii</i> , <i>B. ilicifolia</i> & <i>A. fraseriana</i> dominating the large gaps. Understorey dominated by <i>Adenanthos</i> sp. & <i>X. preissii</i> . Wetland: Open forest of <i>E. rudis</i> & <i>M. preissiana</i> becoming low closed forest of <i>M. preissiana</i> across seasonally wet area. Understorey of <i>K. ericifolia</i> & <i>Lepidosperma</i> sp. with <i>Leucopogon</i> sp. Some bracken & blackberry near spring. Blackberry extends through most of the wet area to west of spring.	Remnant terrestrial vegetation & wetland vegetation to west of spring in excellent condition. Vegetation to east in good condition however, blackberry rapidly invading understorey.
	Sumpland (39969649158)	Category = 1 Most of wetland overstorey is at edge of basin not across it. <i>B. attenuata</i> seedlings present on basin suggesting drying of wetland.	Terrestrial: Woodland of <i>B. attenuata</i> , <i>B. ilicifolia</i> , <i>B. menziesii</i> & <i>Nyctia floribunda</i> with shrubland of <i>Adenanthos</i> sp., <i>Bassia</i> sp., <i>Erremca</i> sp., <i>Evmenca</i> sp., <i>Grevillea</i> sp., <i>Leucopogon</i> sp., <i>Scholtzia</i> sp. & <i>X. preissii</i> . Wetland: Basin, woodland of <i>B. ilicifolia</i> , <i>M. preissiana</i> & <i>N. floribunda</i> with closed heath of <i>B. elegans</i> & <i>Hypocalymna</i> sp. Perimeter, woodland of <i>B. ilicifolia</i> , <i>C. calophylla</i> , <i>M. preissiana</i> & <i>N. floribunda</i> , with closed heath of <i>B. elegans</i> , <i>Dasygogon</i> sp., <i>Grevillea</i> sp. & <i>Hypocalymna</i> sp.	Vegetation in excellent condition.
	Sumpland (39556649708)	Category = 1 Wetland generally in excellent condition although there has been a fire in the north & evidence of diatomaceous earth mining on the basin. There is some establishment of terrestrial plants on the basin. <i>M. preissiana</i> are regenerating well.	Terrestrial: Woodland to open forest dominated by <i>B. attenuata</i> , <i>B. ilicifolia</i> , <i>B. menziesii</i> , <i>Allocasuarina</i> & <i>E. todiana</i> , with shrubland dominated by <i>Adenanthos</i> sp., <i>Boronia purdicana</i> , <i>E. fimbriata</i> , <i>Hibbertia</i> sp., <i>Leucopogon</i> sp., <i>Macrozamia</i> sp., <i>Melaleuca scabra</i> , <i>Petrophile</i> sp., <i>Scholtzia</i> sp. & <i>Xanthorrhoea</i> sp. Wetland: Basin, low closed forest dominated by <i>M. preissiana</i> , with scattered open shrubland dominated by <i>Astoria</i> sp. & <i>Kunzea</i> sp., with closed sedge/land of <i>B. articulata</i> in the open areas. Perimeter, open heath dominated by <i>Adenanthos</i> sp., <i>Beaufortia</i> sp., <i>Dasygogon</i> sp., <i>Hypocalymna</i> sp., <i>Kunzea</i> sp. & <i>Pericalymna</i> sp.	Most adult and regenerating <i>M. preissiana</i> trees are in excellent condition, however, the mature trees on the northern fringe are generally very stressed or dead. The scrub and shrubland are both generally in excellent condition. The <i>B. articulata</i> population appears to have been very stressed, but currently appears to be regenerating. There are also healthy scattered <i>Kunzea</i> sp. seedlings on the basin.
	Dampland (39556649527)	Category = 2 Dampland with generally intact heath. Overstorey reduced to few resprouting <i>B. ilicifolia</i> . No evidence of <i>M. preissiana</i> .	Terrestrial: Woodland of <i>B. menziesii</i> , <i>B. attenuata</i> & <i>B. ilicifolia</i> over a shrubland to open heath of <i>X. preissii</i> , <i>Adenanthos</i> sp., <i>E. fimbriata</i> , <i>R. ciliata</i> , <i>Boronia erocarpa</i> , <i>Scholtzia</i> sp., <i>M. trichophylla</i> , <i>Leucopogon</i> sp., <i>Hibbertia</i> sp., <i>Stirlingia</i> sp. & <i>Boronia</i> sp. Wetland: Open woodland of <i>B. ilicifolia</i> over a shrubland to open heath of <i>Adenanthos</i> sp., <i>B. elegans</i> , <i>H. angustifolium</i> & <i>D. bromeliifolius</i> .	Numerous dead <i>B. ilicifolia</i> and some dead <i>B. attenuata</i> at the dampland fringe. Fire scars suggest most were killed by a fairly recent, hot fire. Some localised patches of dead scrub, otherwise vegetation is in very good to excellent condition.
	Dampland (39556649556)	Category = 2 Dense areas of annual and perennial weeds along tracks, which pass through the southern end of the wetland.	Terrestrial: Woodland dominated by <i>B. attenuata</i> , <i>B. ilicifolia</i> , <i>B. menziesii</i> and <i>N. floribunda</i> , with shrubland dominated by <i>Adenanthos</i> sp., <i>Allocasuarina humilis</i> , <i>Dasygogon</i> sp., <i>Grevillea ciliata</i> , <i>Hibbertia</i> sp., <i>Leucopogon</i> sp., <i>Macrozamia</i> sp., <i>Melaleuca scabra</i> , <i>Regelia ciliata</i> , <i>R. inops</i> & <i>Xanthorrhoea</i> sp. Wetland: Basin, woodland to closed forest dominated by <i>B. ilicifolia</i> , <i>E. rudis</i> & <i>M. preissiana</i> , with tall open to closed scrub dominated by <i>Adenanthos</i> sp., <i>Beaufortia</i> sp., <i>Hypocalymna</i> sp. & <i>Kunzea</i> sp.	Approximately 50% of the <i>E. rudis</i> & <i>M. preissiana</i> are stressed or very stressed, with some recent death of the <i>E. rudis</i> . There are scattered <i>Banksia</i> sp. stags & patches of dead scrub, which appear drought affected.
	Dampland (39576649679)	Category = 2 No Description given.	Terrestrial: Woodland dominated by <i>B. attenuata</i> , <i>B. ilicifolia</i> , <i>B. menziesii</i> and <i>N. floribunda</i> , with shrubland dominated by <i>Adenanthos</i> sp., <i>Allocasuarina humilis</i> , <i>Dasygogon</i> sp., <i>Grevillea ciliata</i> , <i>Hibbertia</i> sp., <i>Leucopogon</i> sp., <i>Macrozamia</i> sp., <i>M. scabra</i> , <i>Regelia ciliata</i> , <i>R. inops</i> & <i>Xanthorrhoea</i> sp. Wetland: Open woodland dominated by <i>B. ilicifolia</i> & <i>N. floribunda</i> , with tall open to closed scrub dominated by <i>Adenanthos</i> sp., <i>Dasygogon</i> sp. & <i>Kunzea</i> sp.	Numerous <i>M. preissiana</i> stags across the basin, with no visible live specimens; there are areas of dead scrub, possibly due to drought stress, and some dead <i>Banksia</i> sp.
	Sumpland (39610649565)	Category = 1 Terrestrial plant species on the edge of the low open forest, indicate that the wetland is becoming drier, & terrestrial plant species are moving into the wetland.	Terrestrial: Woodland dominated by <i>B. attenuata</i> , <i>B. ilicifolia</i> , <i>B. menziesii</i> & <i>N. floribunda</i> , with shrubland dominated by <i>Adenanthos</i> sp., <i>A. humilis</i> , <i>Dasygogon</i> sp., <i>Grevillea ciliata</i> , <i>Hibbertia</i> sp., <i>Leucopogon</i> sp., <i>Macrozamia</i> sp., <i>M. scabra</i> , <i>Regelia ciliata</i> , <i>R. inops</i> & <i>Xanthorrhoea</i> sp. Wetland: Basin, low open forest dominated by <i>M. preissiana</i> , with tall open scrub dominated by <i>Astoria</i> sp., <i>Adenanthos</i> sp., <i>Kunzea</i> sp. & <i>Pericalymna</i> sp. Perimeter, woodland to open woodland dominated by <i>E. rudis</i> & <i>M. preissiana</i> , with shrubland dominated by <i>Astoria</i> sp., <i>Adenanthos</i> sp., <i>Bassia</i> sp., <i>Dasygogon</i> sp., & <i>Pericalymna</i> sp.	There are large areas of dead scrub & shrubland, also approximately 50% of the <i>M. preissiana</i> are showing signs of chlorosis.
	Dampland (39653649561)	Category = 2 There are two main degrading sources to the wetland, an adjacent road & numerous mounds of litter, such as, general rubbish, used vehicle tyres, asbestos sheets and weeds.	Terrestrial: Woodland dominated by <i>B. attenuata</i> , <i>B. ilicifolia</i> & <i>B. menziesii</i> , with shrubland dominated by <i>Adenanthos</i> sp., <i>Bassia</i> sp., <i>Erremca</i> sp., <i>Hibbertia</i> sp., <i>Paterosmia</i> sp., <i>Regelia</i> sp., <i>Verticordia nitens</i> & <i>Xanthorrhoea</i> sp. Wetland: Woodland dominated by <i>B. ilicifolia</i> , <i>E. marginata</i> , <i>E. rudis</i> & <i>M. preissiana</i> , with tall open scrub dominated by <i>Adenanthos</i> sp., <i>Beaufortia</i> sp., <i>Dasygogon</i> sp. & <i>Kunzea</i> sp.	Numerous <i>M. preissiana</i> stags across the basin; the living <i>M. preissiana</i> are very stressed; the <i>E. rudis</i> is slightly stressed; & the <i>B. ilicifolia</i> & <i>B. attenuata</i> appear to be extending their range into the wetland. However, the scrub is generally in excellent condition.
	Sumpland (39920649456)	Category = 2 Part of the wetland is in private property & consequently little that	Terrestrial: Woodland dominated by <i>B. attenuata</i> , <i>B. ilicifolia</i> & <i>B. menziesii</i> , with shrubland dominated by <i>Hibbertia</i> sp., <i>Leucopogon</i> sp., <i>Paterosmia</i> sp., <i>Macrozamia</i> sp. & <i>Xanthorrhoea</i> sp.	Both the wetland & terrestrial vegetation are generally in excellent condition, with the exception of the vegetation

Map Number	Wetland Type & ID	Conservation Category & Condition	Vegetation Type / Community	Vegetation Condition
(395769500)	Dampland Category = 2	Large dampland with <i>Banksia</i> overstorey and a mixed terrestrial / semi dampland	Open woodland of <i>Banksia</i> overstorey with <i>Acacia</i> spp. and <i>Leucadendron</i> spp. in the understorey.	Approximately 50% of <i>Banksia</i> spp. dead (no evidence of recent fire). Myrtaceous species appear drought stressed in places although a central strip of tall scrub remains healthy. The edges and southern section are dominated by terrestrial species.
(395416917)	Dampland Category = 2	Small dampland close to Myers Rd. A track runs through the east side and has been used for dumping rubbish in and around the wetland. Evidence of frequent fire.	Terrestrial Woodland of <i>Banksia</i> overstorey with <i>Acacia</i> spp. and <i>Leucadendron</i> spp. in the understorey.	Around 50% of <i>Banksia</i> spp. dead or very stressed. Evidence of fire in some areas of the dampland. (Orange saplings of Myrtaceous species are in excellent health). Myrtaceous scrub shows localized signs of stress.
(395654947)	Dampland Category = 2	Large dampland dominated by tall closed scrub of <i>Amorpha</i> with scattered emergent trees. Some vehicle tracks intersect the dampland causing localized disturbance and weed invasion.	Terrestrial Woodland of <i>Banksia</i> overstorey with <i>Acacia</i> spp. and <i>Leucadendron</i> spp. in the understorey.	Around 50-60% of <i>Banksia</i> spp. are dead (some recently) or very stressed. Scattered <i>Acacia</i> spp. saplings can be found in the tall scrub. Majority of <i>Leucadendron</i> spp. are in excellent condition. Tall scrub generally excellent.
(395506919)	Dampland Category = 2	The wetland appears to be in poor condition.	Terrestrial Woodland dominated by <i>Banksia</i> overstorey with <i>Acacia</i> spp. and <i>Leucadendron</i> spp. in the understorey.	There are scattered <i>Acacia</i> spp. saplings across the basin. Some recent <i>Banksia</i> spp. saplings and large areas of drought-stressed scrub.
(3957269792)	Dampland Category = 2	No description given	Terrestrial Woodland dominated by <i>Banksia</i> overstorey with <i>Acacia</i> spp. and <i>Leucadendron</i> spp. in the understorey.	There are dead <i>Banksia</i> spp. on the fringe of the wetland which may be due to fire and drought. The tall scrub appears to be recovering, consequently there is now a wide buffer of mixed wetland and terrestrial vegetation surrounding the basin.
(3961669159)	Dampland Category = 2	Large basin dampland which has lost majority of overstorey & is being colonized by terrestrial species. Some rubbish dumping, mound pruner.	Terrestrial Woodland of <i>Banksia</i> overstorey with <i>Acacia</i> spp. and <i>Leucadendron</i> spp. in the understorey.	Dominant overstorey of <i>Acacia</i> spp. has been lost with only one individual remaining. <i>Leucadendron</i> spp. are south-west corner and very stressed. <i>Banksia</i> spp. are exhibiting on much of the dampland. Heaps in generally very good condition, some stressed and recently dead. <i>Banksia</i> spp. and <i>Acacia</i> spp. occur on the south and west sides.
(3962769484)	Dampland Category = 1	Small dampland with indirect, gradual transition from terrestrial to wetland vegetation type.	Terrestrial Woodland of <i>Banksia</i> overstorey with <i>Acacia</i> spp. and <i>Leucadendron</i> spp. in the understorey.	Occasional stressed <i>Leucadendron</i> spp. occur on the western side. Numerous <i>Acacia</i> spp. saplings within the wetland.
(3964769355)	Dampland Category = 2	Large dampland with virtually all <i>Banksia</i> dead. <i>Banksia</i> colonizing much of the wetland basin.	Terrestrial Woodland of <i>Banksia</i> overstorey with <i>Acacia</i> spp. and <i>Leucadendron</i> spp. in the understorey.	Majority of <i>Banksia</i> spp. dead (most being dead). <i>Banksia</i> spp. are colonizing in areas of dampland. Tall scrub generally excellent with some localized dead patches.
(3971269551)	Dampland Category = 2	No description given	Terrestrial Woodland of <i>Banksia</i> overstorey with <i>Acacia</i> spp. and <i>Leucadendron</i> spp. in the understorey.	Very few live <i>Acacia</i> spp. remain although some regeneration is present on the southern side. Evidence of fire in some areas in generally good condition. Evidence of fire in some areas of the basin although this is regenerating. Terrestrial tree species form the dominant

Map Number	Wetland Type & ID Number / Name	Conservation Category & Overall Condition	Vegetation Type / Community	Vegetation Condition
				overstorey of the dampland
	Dampland (398766-49518)	Category = 2 Dampland located adjacent to private property currently being used for agricultural purposes (market garden). The dampland appears to be becoming dry & drought stressed, with very few live <i>M. pritziana</i> present, & very few <i>M. pritziana</i> stags visible, which possibly indicates that the majority of these trees have been dead for quite some time.	Terrestrial: Woodland dominated by <i>B. attenuata</i> , <i>B. ilicifolia</i> & <i>B. menziesii</i> , with shrubland dominated by <i>Hibbertia</i> sp., <i>Leucopogon</i> sp., <i>Panicum</i> sp., <i>Macrotamia</i> sp. & <i>Xanthorrhoea</i> sp. Wetland: Basin, open woodland dominated by <i>B. attenuata</i> , <i>B. ilicifolia</i> & <i>M. pritziana</i> , with shrubland dominated by <i>B. elegans</i> , <i>Dasyglossum</i> sp. & <i>Hypocalymma</i> sp. Fringe, open forest dominated by <i>C. calophylla</i> , with shrubland dominated by <i>Kunzea</i> sp.	There are almost no live <i>M. pritziana</i> trees, scattered <i>B. ilicifolia</i> stags & patches of dead shrubland with <i>B. attenuata</i> and <i>Dasyglossum</i> sp. seedlings establishing on the basin. The terrestrial vegetation also appears to have <i>Phytolophora cinnamomi</i> .
	Dampland (398066-49362)	Category = 2 The vegetation on the wetland appears to be becoming more terrestrial.	Terrestrial: Woodland to open forest dominated by <i>B. attenuata</i> , <i>B. menziesii</i> & <i>N. floribunda</i> , with shrubland dominated by <i>Albocaulonia humilis</i> , <i>Buxiaea ericarpa</i> , <i>Eremca pumellara</i> , <i>Hibbertia</i> sp., <i>Jackmania</i> sp., <i>Scholtzia</i> sp. & <i>Xanthorrhoea</i> sp. Wetland: Woodland dominated by <i>B. ilicifolia</i> & <i>M. pritziana</i> , with tall open scrub dominated by <i>Kunzea</i> sp.	The terrestrial vegetation is in excellent condition, the <i>Banksia</i> spp. on and around the basin are all in excellent condition, and the scrub is generally excellent with only scattered dead patches. However, the basin appears to be drying, the <i>M. pritziana</i> population is very stressed, with many stags across the basin, and there are <i>Banksia</i> spp. invading the basin.
	Dampland (398926-49232)	Category = 2 No description given.	Terrestrial: Woodland dominated by <i>B. attenuata</i> , <i>B. ilicifolia</i> , <i>B. menziesii</i> & <i>E. nuttiana</i> , with shrubland to open heath dominated by <i>Adenanthos</i> sp., <i>Eremca fimbriata</i> , <i>Leucopogon</i> sp., <i>Petrophile</i> sp., <i>Regelia ciliata</i> , <i>Scholtzia</i> sp. & <i>Xanthorrhoea</i> sp. Wetland: Woodland to low open forest dominated by <i>E. rudis</i> & <i>M. pritziana</i> , with tall open to closed scrub dominated by <i>Kunzea</i> sp.	The terrestrial vegetation is in excellent condition, as is the scrub, and there are large areas of dense <i>E. rudis</i> saplings in the basin. However, the <i>M. pritziana</i> and <i>E. rudis</i> populations are very stressed, with stags across the basin.
	Dampland (396856-49249)	Category = 2 The wetland is generally in poor condition.	Terrestrial: Woodland dominated by <i>B. attenuata</i> , <i>B. ilicifolia</i> , <i>B. menziesii</i> & <i>E. nuttiana</i> , with shrubland to open heath dominated by <i>Adenanthos</i> sp., <i>Eremca fimbriata</i> , <i>Leucopogon</i> sp., <i>Petrophile</i> sp., <i>Regelia ciliata</i> , <i>Scholtzia</i> sp. & <i>Xanthorrhoea</i> sp. Wetland: Basin, woodland to open woodland dominated by <i>B. ilicifolia</i> , with tall open scrub dominated by <i>Choricoma</i> sp., <i>Hypocalymma</i> sp. & <i>Kunzea</i> sp. Perimeter, woodland dominated by <i>B. attenuata</i> , <i>B. ilicifolia</i> & <i>B. menziesii</i> , with open heath dominated by <i>Hypocalymma</i> & <i>Regelia</i> spp.	There are patches of drought stressed scrub in the basin and in the fringing vegetation; scattered dead <i>Banksia</i> spp.; <i>B. attenuata</i> & <i>B. menziesii</i> are moving into the wetland, and <i>M. pritziana</i> stags are present across the wetland, which appear to have previously constituted a <i>M. pritziana</i> woodland, there appears to be no live <i>M. pritziana</i> at present.
	Dampland (396606-49160)	Category = 2 Small dampland dominated by tall Myrtaceae scrub and <i>Banksia</i> species.	Terrestrial: Woodland of <i>B. attenuata</i> , <i>B. ilicifolia</i> & <i>B. menziesii</i> over an open heath of <i>N. pritzii</i> , <i>M. rielleyi</i> , <i>M. scabra</i> , <i>R. ciliata</i> , <i>Adenanthos</i> sp. & <i>Leucopogon</i> spp. Wetland: Woodland of <i>B. ilicifolia</i> & <i>B. attenuata</i> over a closed heath to tall closed scrub of <i>B. elegans</i> , <i>K. ericifolia</i> & <i>H. angustifolium</i> .	Some evidence of <i>M. pritziana</i> stage in the wetland although these are long dead. Overstorey is now dominated by <i>Banksia</i> species. Understorey generally in excellent condition.
	Dampland (398136-49148)	Category = 2 Large areas of terrestrial vegetation appear to have been burnt approximately three to five years ago.	Terrestrial: Woodland to open forest dominated by <i>B. attenuata</i> & <i>B. menziesii</i> , with shrubland dominated by <i>Adenanthos</i> sp., <i>Eremca fimbriata</i> , <i>Leucopogon</i> sp., <i>Panicum</i> sp., <i>Macrotamia</i> sp., <i>Melaleuca scabra</i> , <i>Scholtzia</i> sp., <i>Siringia</i> sp. & <i>Xanthorrhoea</i> sp. Wetland: Woodland dominated by <i>B. attenuata</i> , <i>B. ilicifolia</i> & <i>M. pritziana</i> , with tall open to closed scrub dominated by <i>Araucaria</i> sp., <i>Hypocalymma</i> sp., <i>Kunzea</i> sp. & <i>Xanthorrhoea</i> sp. With fringing vegetation dominated by <i>N. floribunda</i> & <i>Banksia</i> spp.	The scrub is in excellent condition, as are the <i>Banksia</i> spp.; the terrestrial vegetation is fire affected but healthy. However, approximately 50% of the <i>M. pritziana</i> trees in the wetland are stags, and the <i>Banksia</i> spp. appear to be moving into the wetland.
	Dampland (398816-49161)	Category = 1 The wetland is generally in excellent condition. However, there are several disturbances, weeds are present in some areas, such as <i>Pinus</i> sp.; there are several tracks running through the eastern part of the wetland, and much of the terrestrial and a small area of the western part of the wetland are damaged by fire.	Terrestrial: Woodland to open forest dominated by <i>B. attenuata</i> & <i>B. menziesii</i> , with shrubland dominated by <i>Adenanthos</i> sp., <i>Eremca fimbriata</i> , <i>Leucopogon</i> sp., <i>Panicum</i> sp., <i>Macrotamia</i> sp., <i>Melaleuca scabra</i> , <i>Scholtzia</i> sp., <i>Siringia</i> sp. & <i>Xanthorrhoea</i> sp. Wetland: Western area, low open forest dominated by <i>M. pritziana</i> , with closed heath dominated by <i>Choricoma</i> sp., <i>Kunzea</i> sp. & <i>Pteridium esculentum</i> . Eastern area, woodland to low open forest dominated by <i>B. littoralis</i> & <i>M. pritziana</i> , with tall closed to open scrub dominated by <i>Araucaria</i> sp., <i>Choricoma</i> sp., <i>Hypocalymma</i> & <i>Kunzea</i> sp.	The vegetation is generally in excellent condition, with the exception of small areas of the wetland severely affected by fire.
	Dampland (391836-49754)	Category = 2 A large dampland mostly surrounded by cleared pine plantation. The dampland has highly variable vegetation reflecting elevation, which creates a mosaic of vegetation structure. There are numerous tracks surrounding and passing through the dampland, and much of the surrounding vegetation has been cleared. However, the	Terrestrial: Woodland dominated by <i>B. attenuata</i> , <i>B. ilicifolia</i> , <i>B. menziesii</i> , <i>E. nuttiana</i> & <i>N. floribunda</i> , with open heath dominated by <i>Adenanthos</i> sp., <i>Buxiaea ericarpa</i> , <i>Dasyglossum</i> sp., <i>Leucopogon</i> sp., <i>Regelia ciliata</i> , <i>Veronica nitens</i> & <i>Xanthorrhoea</i> sp. Wetland: Lower elevation areas, woodland to low closed forest dominated by <i>B. grandis</i> , <i>B. littoralis</i> , <i>E. marginata</i> , <i>E. rudis</i> , <i>M. pritziana</i> , <i>M. stinnoi</i> , <i>M. tenuifolia</i> & <i>N. floribunda</i> , with closed tall scrub dominated by <i>B. elegans</i> , <i>Kunzea</i> sp. & <i>L. longistylis</i> . Higher elevation areas, woodland to low closed	The vegetation is generally in excellent to pristine condition. There is an occasional <i>M. pritziana</i> stag, otherwise the <i>M. pritziana</i> population are in near-pristine condition. The understorey is in excellent condition, as is the overstorey. There are <i>E. rudis</i> saplings on parts of the basin.

Map Number	Wetland Type & ID	Conversion Category & Number	Vegetation Community	Vegetation Conditions
Dampland	(13921619101)	Category = 2 Large dampland with variable vegetation complexes ranging from wet areas dominated by <i>Adiantum</i> sp. through to terrestrial wet areas dominated by <i>Alnus</i> sp. Half the total area has been cleared for housing and farming and high erosion power faces	Wetland: Woodland of <i>Alnus</i> sp. & <i>Salix</i> sp. with <i>Urtica</i> sp., <i>Lythrum</i> sp. & <i>Thalictrum</i> sp. Wetland: Woodland of <i>Alnus</i> sp. with <i>Urtica</i> sp., <i>Lythrum</i> sp. & <i>Thalictrum</i> sp. Wetland: Woodland of <i>Alnus</i> sp. with <i>Urtica</i> sp., <i>Lythrum</i> sp. & <i>Thalictrum</i> sp. Wetland: Woodland of <i>Alnus</i> sp. with <i>Urtica</i> sp., <i>Lythrum</i> sp. & <i>Thalictrum</i> sp. Wetland: Woodland of <i>Alnus</i> sp. with <i>Urtica</i> sp., <i>Lythrum</i> sp. & <i>Thalictrum</i> sp.	Remaining vegetation is in generally excellent condition. Wetland dominated by <i>Alnus</i> sp., <i>Salix</i> sp., <i>Urtica</i> sp., <i>Lythrum</i> sp., <i>Thalictrum</i> sp., <i>Betula</i> sp., <i>Erigeron</i> sp., <i>Pteridium</i> sp., <i>Asplenium</i> sp. & <i>Marchantia</i> sp.
Dampland	(139412518)	Category = 2 The surrounding vegetation has been cleared to the edge of the wetland on all sides, but the east side. The cleared area appears to have been a grass plantation. There are several other disturbances in the wetland, there is a road cutting the wetland, there appears to have been a grass plantation in the eastern part of the wetland, there are numerous species of weeds in and around the wetland, such as <i>Phragmites</i> sp. and <i>Cyperus</i> sp. The wetland appears to be a mix of wetland types and there are several other disturbances in the wetland.	Wetland: Woodland dominated by <i>Alnus</i> sp., <i>Salix</i> sp., <i>Urtica</i> sp., <i>Lythrum</i> sp. & <i>Thalictrum</i> sp. Wetland: Woodland dominated by <i>Alnus</i> sp., <i>Salix</i> sp., <i>Urtica</i> sp., <i>Lythrum</i> sp. & <i>Thalictrum</i> sp. Wetland: Woodland dominated by <i>Alnus</i> sp., <i>Salix</i> sp., <i>Urtica</i> sp., <i>Lythrum</i> sp. & <i>Thalictrum</i> sp. Wetland: Woodland dominated by <i>Alnus</i> sp., <i>Salix</i> sp., <i>Urtica</i> sp., <i>Lythrum</i> sp. & <i>Thalictrum</i> sp. Wetland: Woodland dominated by <i>Alnus</i> sp., <i>Salix</i> sp., <i>Urtica</i> sp., <i>Lythrum</i> sp. & <i>Thalictrum</i> sp.	Approximately 95% of <i>Alnus</i> is dead, some recently dead. <i>Betula</i> spp. colonizing several sections of dampland. Herb swards in northern section and large patches of <i>Urtica</i> sp. in western section.
Dampland	(139435445)	Category = 2 Large wetland divided by logging road. North-west section lies very close to <i>Alnus</i> plantation.	Wetland: Woodland of <i>Alnus</i> sp., <i>Salix</i> sp., <i>Urtica</i> sp., <i>Lythrum</i> sp. & <i>Thalictrum</i> sp. Wetland: Woodland of <i>Alnus</i> sp., <i>Salix</i> sp., <i>Urtica</i> sp., <i>Lythrum</i> sp. & <i>Thalictrum</i> sp. Wetland: Woodland of <i>Alnus</i> sp., <i>Salix</i> sp., <i>Urtica</i> sp., <i>Lythrum</i> sp. & <i>Thalictrum</i> sp. Wetland: Woodland of <i>Alnus</i> sp., <i>Salix</i> sp., <i>Urtica</i> sp., <i>Lythrum</i> sp. & <i>Thalictrum</i> sp. Wetland: Woodland of <i>Alnus</i> sp., <i>Salix</i> sp., <i>Urtica</i> sp., <i>Lythrum</i> sp. & <i>Thalictrum</i> sp.	All <i>Alnus</i> dead in northern section and large patches of <i>Urtica</i> sp. in western section.
Dampland	(1394354770)	Category = 2 Terrestrial plant species appear to be invading the wetland	Wetland: Woodland dominated by <i>Alnus</i> sp., <i>Salix</i> sp., <i>Urtica</i> sp., <i>Lythrum</i> sp. & <i>Thalictrum</i> sp. Wetland: Woodland dominated by <i>Alnus</i> sp., <i>Salix</i> sp., <i>Urtica</i> sp., <i>Lythrum</i> sp. & <i>Thalictrum</i> sp. Wetland: Woodland dominated by <i>Alnus</i> sp., <i>Salix</i> sp., <i>Urtica</i> sp., <i>Lythrum</i> sp. & <i>Thalictrum</i> sp. Wetland: Woodland dominated by <i>Alnus</i> sp., <i>Salix</i> sp., <i>Urtica</i> sp., <i>Lythrum</i> sp. & <i>Thalictrum</i> sp. Wetland: Woodland dominated by <i>Alnus</i> sp., <i>Salix</i> sp., <i>Urtica</i> sp., <i>Lythrum</i> sp. & <i>Thalictrum</i> sp.	There are very few <i>Alnus</i> sp. in this area, there are only a few <i>Alnus</i> sp. in this area.
Dampland	(13951004779)	Category = 2 The dampland is disturbed by several roads in the northern part, one of which, has been recently widened, claiming a small part of the wetland. There is some evidence of a hot fire occurring approximately five to six years ago.	Wetland: Woodland dominated by <i>Alnus</i> sp., <i>Salix</i> sp., <i>Urtica</i> sp., <i>Lythrum</i> sp. & <i>Thalictrum</i> sp. Wetland: Woodland dominated by <i>Alnus</i> sp., <i>Salix</i> sp., <i>Urtica</i> sp., <i>Lythrum</i> sp. & <i>Thalictrum</i> sp. Wetland: Woodland dominated by <i>Alnus</i> sp., <i>Salix</i> sp., <i>Urtica</i> sp., <i>Lythrum</i> sp. & <i>Thalictrum</i> sp. Wetland: Woodland dominated by <i>Alnus</i> sp., <i>Salix</i> sp., <i>Urtica</i> sp., <i>Lythrum</i> sp. & <i>Thalictrum</i> sp. Wetland: Woodland dominated by <i>Alnus</i> sp., <i>Salix</i> sp., <i>Urtica</i> sp., <i>Lythrum</i> sp. & <i>Thalictrum</i> sp.	The dampland is in excellent condition. There are numerous <i>Alnus</i> sp. in this area.
Dampland	(1395756169)	Category = 3 Small wetland with cleared pine plantation. Wetland was probably cleared initially and has been re-colonised by wetland species.	Wetland: Tall closed scrub of <i>Alnus</i> sp., <i>Salix</i> sp., <i>Urtica</i> sp., <i>Lythrum</i> sp. & <i>Thalictrum</i> sp. Wetland: Tall closed scrub of <i>Alnus</i> sp., <i>Salix</i> sp., <i>Urtica</i> sp., <i>Lythrum</i> sp. & <i>Thalictrum</i> sp. Wetland: Tall closed scrub of <i>Alnus</i> sp., <i>Salix</i> sp., <i>Urtica</i> sp., <i>Lythrum</i> sp. & <i>Thalictrum</i> sp. Wetland: Tall closed scrub of <i>Alnus</i> sp., <i>Salix</i> sp., <i>Urtica</i> sp., <i>Lythrum</i> sp. & <i>Thalictrum</i> sp. Wetland: Tall closed scrub of <i>Alnus</i> sp., <i>Salix</i> sp., <i>Urtica</i> sp., <i>Lythrum</i> sp. & <i>Thalictrum</i> sp.	No wetland trees present. Tall scrub in generally very good condition. Some invasion of annual weeds and pine seedlings is occurring.
Dampland	(1397056482)	Category = 2 Large extensive wetland remnant to the east of cleared garden / central development to the west. The east shows signs of grazing pressure & market gardens are invading into wetland in north-west. A road intersects wetland at northern end. Lake at northern end in April 2004.	Wetland: Tall closed scrub of <i>Alnus</i> sp., <i>Salix</i> sp., <i>Urtica</i> sp., <i>Lythrum</i> sp. & <i>Thalictrum</i> sp. Wetland: Tall closed scrub of <i>Alnus</i> sp., <i>Salix</i> sp., <i>Urtica</i> sp., <i>Lythrum</i> sp. & <i>Thalictrum</i> sp. Wetland: Tall closed scrub of <i>Alnus</i> sp., <i>Salix</i> sp., <i>Urtica</i> sp., <i>Lythrum</i> sp. & <i>Thalictrum</i> sp. Wetland: Tall closed scrub of <i>Alnus</i> sp., <i>Salix</i> sp., <i>Urtica</i> sp., <i>Lythrum</i> sp. & <i>Thalictrum</i> sp. Wetland: Tall closed scrub of <i>Alnus</i> sp., <i>Salix</i> sp., <i>Urtica</i> sp., <i>Lythrum</i> sp. & <i>Thalictrum</i> sp.	Some areas with very poor vegetation by present standards. Wetland is generally in good condition. Some invasion of annual weeds and pine seedlings is occurring.
Dampland	(1397064798)	Category = 2 Majority of lake is cleared or otherwise disturbed by agriculture. No surface water apparent in April 2004.	Wetland: Tall closed scrub of <i>Alnus</i> sp., <i>Salix</i> sp., <i>Urtica</i> sp., <i>Lythrum</i> sp. & <i>Thalictrum</i> sp. Wetland: Tall closed scrub of <i>Alnus</i> sp., <i>Salix</i> sp., <i>Urtica</i> sp., <i>Lythrum</i> sp. & <i>Thalictrum</i> sp. Wetland: Tall closed scrub of <i>Alnus</i> sp., <i>Salix</i> sp., <i>Urtica</i> sp., <i>Lythrum</i> sp. & <i>Thalictrum</i> sp. Wetland: Tall closed scrub of <i>Alnus</i> sp., <i>Salix</i> sp., <i>Urtica</i> sp., <i>Lythrum</i> sp. & <i>Thalictrum</i> sp. Wetland: Tall closed scrub of <i>Alnus</i> sp., <i>Salix</i> sp., <i>Urtica</i> sp., <i>Lythrum</i> sp. & <i>Thalictrum</i> sp.	Majority of lake is cleared or otherwise disturbed by agriculture. No surface water apparent in April 2004.
Dampland	(1397064798)	Category = 2 Majority of lake is cleared or otherwise disturbed by agriculture. No surface water apparent in April 2004.	Wetland: Tall closed scrub of <i>Alnus</i> sp., <i>Salix</i> sp., <i>Urtica</i> sp., <i>Lythrum</i> sp. & <i>Thalictrum</i> sp. Wetland: Tall closed scrub of <i>Alnus</i> sp., <i>Salix</i> sp., <i>Urtica</i> sp., <i>Lythrum</i> sp. & <i>Thalictrum</i> sp. Wetland: Tall closed scrub of <i>Alnus</i> sp., <i>Salix</i> sp., <i>Urtica</i> sp., <i>Lythrum</i> sp. & <i>Thalictrum</i> sp. Wetland: Tall closed scrub of <i>Alnus</i> sp., <i>Salix</i> sp., <i>Urtica</i> sp., <i>Lythrum</i> sp. & <i>Thalictrum</i> sp. Wetland: Tall closed scrub of <i>Alnus</i> sp., <i>Salix</i> sp., <i>Urtica</i> sp., <i>Lythrum</i> sp. & <i>Thalictrum</i> sp.	Majority of lake is cleared or otherwise disturbed by agriculture. No surface water apparent in April 2004.

Map Number	Wetland Type & ID Number / Name	Conservation Category & Overall Condition	Vegetation Type / Community	Vegetation Condition
	Lake Adams (38844649190)	Category = 3 More than half of wetland is private property & currently used as a paddock. Some scattered wetland trees remain with a weedy understorey. The section under crown reserve has not been cleared but a walkway has been constructed & non local tree species planted.	Terrestrial: Scattered Eucalypts with perennial grass understorey that is regularly mown. Wetland: Woodland of <i>E. rudis</i> & <i>M. precissiana</i> . Open heath of <i>Kunzea</i> & <i>Asterca</i> sp. mixed with sedge/land of <i>B. articulata</i> , <i>B. juncosa</i> & <i>Lepidosperma</i> sp.	In crown reserve around the constructed walkway the planted non-local Eucalypt species & pine trees are rapidly colonising the lake bed & although remnant littoral trees & shrubland show no signs of stress the rapid establishment of non-local trees suggests water levels may be declining.
	Little Marigmap (38830649035)	Category = 4 Wetland lies on private property & is predominantly cleared & grazed. Some scattered Eucalypts remain around the fringe of the seasonally wet area.	Terrestrial: Banksia woodland on surrounding properties to the north & west. Wetland: Open woodland of <i>E. rudis</i> in patches. Understorey & wetland basin contains annual grasses/woods.	Remaining <i>E. rudis</i> trees appear healthy.
	Little Adams Swamp (38955649226)	Category = 3 Wetland on extensively cleared private property with grazing access to the lake bed.	Terrestrial: None Wetland: Patchy distribution of <i>E. rudis</i> & <i>M. precissiana</i> woodland.	No sign of drought stress in remaining trees. Understorey shrubland of <i>Xanthorrhoea preissii</i> with annual grasses.
	Hawkins Road Swamp (39120648926)	Category = 2 Swamp within pine plantation adjacent to cleared land on west side. Tracks intersect swamp, forming a cleared circle near outlet. Some dumping of rubbish & regular fire is apparent.	Terrestrial: Pine plantation Wetland: Open forest of <i>M. precissiana</i> with shrubland of <i>Ilionforia elegans</i> , <i>Kunzea</i> sp. & <i>Asterca fascicularis</i> . <i>Kunzea</i> sp. forms tall closed scrub near wetland centre with <i>B. articulata</i> & <i>Cyperus</i> sp. sedge/land surrounding. Numerous <i>Kunzea</i> sp. seedlings also present here.	Diverse community with some invasion of introduced grasses. Trees scarred from numerous fires. Trees in excellent condition however, some terrestrial species have established within wetland suggesting reduced surface water in recent years.
	Sumpland (38348649057)	Category = 2 Adjoins Neerabup National Park to west, this provides substantial vegetation buffer. Much of east & south-west side private property. Horse have access to much of the perimeter & this zone is highly degraded by grazing. Soil under tree canopy moist suggesting surface water may be present further into wetland.	Terrestrial: Open woodland of <i>E. gomphoccephala</i> & <i>E. tudiana</i> on higher ground grading to <i>B. anemata</i> , <i>B. prionites</i> & <i>B. thicifolia</i> with understorey of annual grasses & weeds. Wetland: Open forest of <i>E. rudis</i> & <i>M. rhaphiophylla</i> on wetland perimeter becoming closed forest of <i>M. rhaphiophylla</i> on basin. Understorey grazed leaving scattered annual weeds.	Clearing under high tension power lines & grazing has led to a highly disturbed area between wetland & National Park, otherwise terrestrial vegetation is in good condition. Wetland vegetation is similarly affected by constant grazing however, vegetation density on the basin prevents stock access so the vegetation appears to be in excellent condition.
	Dampland (39042649008)	Category = 3 Wetland surrounded by cleared farmland with scattered remnant <i>Eucalypts</i> & <i>Ilionforia</i> sp. Remnant littoral trees have understorey of dense annual & perennial grasses.	Terrestrial: Paddock with scattered <i>Eucalypts</i> & <i>Banksia</i> spp. Wetland: Woodland to open forest of <i>E. rudis</i> & <i>M. precissiana</i> .	Some die-back of <i>E. rudis</i> apparent on west side & pines invading from east.
2034 IV NE	Lake Carraboola (37849650146)	Category = 2 Surrounded by Market gardens & pasture. Terrestrial vegetation cleared to edge of lake with some localised infilling at southern end. Areas accessed were dry in April 2004.	Terrestrial: None Wetland: Open forest of <i>E. rudis</i> . Low open forest of <i>M. rhaphiophylla</i> changing to low closed forest further into lake. Sedge/land of <i>Typha</i> with <i>Banania</i> & <i>Juncus</i> sp. in open areas.	Some annual & perennial weeds encroaching margins of the lake.
2035 II SE	Lake Humber (39435652283)	Category = 1 Remnant Wetland. Narrow fringe of littoral vegetation surrounds the lake. Some buffer remains although the majority of the surrounding land is cleared farmland.	Terrestrial: Predominantly cleared. Wetland: Woodland of <i>E. rudis</i> & <i>M. rhaphiophylla</i> with occasional <i>M. viminea</i> . Understorey a sedge/land of <i>B. articulata</i> , <i>Juncus</i> sp. & perennial weeds (Kikuyu). Vegetation in winter wet depression joining lake this lake with Nambing (to south) consists of low closed forest of <i>M. viminea</i> & <i>M. teretifolia</i> with no understorey. Occasional <i>E. rudis</i> occur in northern portion. Bracken forms low closed heath in higher zones of transition area. Transition area is private property.	Understorey in excellent condition. Very weedy understorey around lake. Vegetation of transition zone is generally in very good condition.
	Lake Nambing (39421652168)	Category = 2 Ephemeral lake with narrow strip of littoral vegetation to the south & east separating the wetland from farmland. Some remnant vegetation occurs to the north-west. Dry in April 2004.	Terrestrial: None Wetland: Woodland to open forest of <i>E. rudis</i> , <i>M. rhaphiophylla</i> & <i>C. obesa</i> . Understorey predominantly annual grasses. Some <i>Banania</i> sp. on dry lake bed.	All trees appear in good health. No signs of drought stress.
	Lake Mungala (39402652119)	Category = 2 Wetland completely surrounded by private property. Owners refused access. Following comments are made from distant inspection. Wetland appeared to be dry.	Terrestrial: None Wetland: Woodland to open forest <i>E. rudis</i> , <i>M. rhaphiophylla</i> & <i>C. obesa</i> . Understorey annual grasses.	Trees appeared to be in good health.
2035 II SW	Yea Swamp (38267651751)	Category = 1 Large wetland within nature reserve with vegetation changing from	Terrestrial: Woodland of <i>C. calophylla</i> , <i>B. anemata</i> , <i>B. moresbyi</i> & <i>Allocasuarina fraseriana</i> . Understorey dominated by <i>Xanthorrhoea</i> sp., <i>M. riedlei</i> , <i>Charizoma</i> sp. & <i>Hibbertia</i> sp.	Some localised areas of disturbance from vehicle tracks and invasion of annual weeds. One relatively small area of

Msp Number	Wetland Type & ID Number / Name	Conservation Category & Overall Condition	Vegetation Type / Community	Vegetation Condition
		open woodland to closed heath of tall scrubs with small changes in topography. Dry April 2004.	Wetland: Open woodland of <i>E. rudis</i> & <i>M. preissiana</i> with shrubland of <i>Kunzea</i> sp.	<i>E. rudis</i> death is apparent in the southern section. <i>Kunzea</i> sp. shows signs of drought stress in higher areas in the northern section.
	Dampland (38340651762)	Category = 1 Wetland in excellent condition. Dry April 2004	Terrestrial: Woodland of <i>C. colophylla</i> , <i>B. attenuata</i> , <i>B. menziesii</i> & <i>B. ilicifolia</i> with an understorey dominated by <i>Xanthorrhoea</i> sp. & <i>Kunzea</i> sp. Wetland: Open woodland of <i>E. rudis</i> , <i>M. preissiana</i> & <i>B. littoralis</i> with closed tall scrub of <i>Kunzea</i> sp.	Vegetation in excellent condition. Evidence of fire (>2 yrs) in terrestrial vegetation
	Dampland (38337651800)	Category = 1 Small steep sided dampland in nature reserve. Shows sharp transition from terrestrial to wetland vegetation. Closed low forest of <i>Melaleuca</i> suggests this site is wetter than surrounding damplands. Dry April 2004.	Terrestrial: Woodland of <i>C. colophylla</i> , <i>B. attenuata</i> , <i>B. menziesii</i> & <i>B. ilicifolia</i> with an understorey dominated by <i>Xanthorrhoea</i> sp. & <i>Kunzea</i> sp. Wetland: Low closed forest of <i>M. preissiana</i> , <i>E. rudis</i> & <i>B. littoralis</i> with an open sedge/land of <i>Lepidosperma</i> sp. & occasional <i>Asterica</i> sp.	Vegetation in excellent to pristine condition
	Bindar Lake (38181651941)	Category = 2 Wetland occurs in nature reserve and has excellent vegetation buffer. Pines occur within 100m of western side. Vehicles access the claypan area in the north west leading to some localised areas of damage to the vegetation. Dry in April 2004.	Terrestrial: Woodland of <i>C. colophylla</i> , <i>B. attenuata</i> , <i>B. menziesii</i> & <i>Allocasuarina fraseriana</i> . Understorey dominated by <i>Xanthorrhoea</i> sp., <i>M. riedlei</i> & <i>Hibbertia</i> sp. Wetland: Woodland of <i>E. rudis</i> , <i>M. preissiana</i> & <i>B. littoralis</i> with scattered dense stands of <i>M. preissiana</i> or <i>E. rudis</i> . Tall open scrub to open heath of <i>Kunzea</i> sp. & <i>Beaufortia</i> sp. with <i>Lepidosperma</i> sp. Numerous seedlings of <i>E. rudis</i> & <i>B. littoralis</i> occur around the perimeter of the lowest (open) areas.	Vegetation in very good to excellent condition. Some localised areas of disturbance from vehicle access. Some non-aggressive weeds near tracks and a few pine trees establishing on lake bed. Mature <i>E. rudis</i> showing signs of stress, some very stressed, on the west side and towards the centre of the lake. The majority of the trees to the south are in excellent condition.
	Dampland (38731651919)	Category = 2 A very small dampland with a road running through the middle of it, however, the road does not appear to have serious negative impacts on the condition of the dampland. The dampland and the vegetation are generally in good condition.	Terrestrial: A woodland overstorey of <i>B. menziesii</i> , <i>B. ilicifolia</i> , & <i>B. attenuata</i> . With an open heath understorey of a <i>Myrtaceae</i> shrub, <i>Hibbertia</i> sp., <i>Pteronotus</i> sp. & <i>Kunzea</i> sp. in the western part of the vegetation, & <i>Xanthorrhoea</i> sp., <i>Hibbertia</i> sp., <i>Pteronotus</i> sp. & <i>Kunzea</i> sp. in the eastern part of the vegetation. Wetland: A <i>B. attenuata</i> , <i>B. menziesii</i> & <i>M. preissiana</i> woodland overstorey. With a tall open shrubland understorey of <i>Kunzea</i> sp. & <i>Xanthorrhoea</i> sp. With an open sedge/land of <i>Lepidosperma</i> sp. in openings, & a scattering of <i>Leucopogon</i> sp. & <i>Xanthorrhoea</i> sp.	The vegetation is in very good to excellent condition. Approximately fifty percent of the adult <i>Melaleuca</i> specimens are dead, with some stags. Also patches of the <i>Kunzea</i> sp. are severely drought effected, with several generations dead.
	Dampland (38798652311)	Category = 1 A narrow dampland with a mixed terrestrial understorey. The dampland is located in a large nature reserve, which is essentially undisturbed. However, it should be noted that <i>Phytophthora cinnamomi</i> does occur in adjacent blocks in the nature reserve.	Terrestrial: A woodland overstorey of <i>B. menziesii</i> , <i>B. attenuata</i> & <i>B. ilicifolia</i> . With an understorey dominated by <i>V. nitens</i> & <i>Dasyopogon</i> sp. Wetland: A woodland overstorey of <i>M. preissiana</i> , <i>B. menziesii</i> , <i>B. attenuata</i> & <i>B. ilicifolia</i> . With an open heath understorey of <i>Myrtaceae</i> shrub sp., <i>Bosmina</i> sp., <i>Hibbertia</i> sp., <i>Regelia</i> sp., <i>Xanthorrhoea</i> sp., <i>Ferricardia nitens</i> , <i>Ferrophile</i> sp., <i>Melaleuca trichophylla</i> , <i>Dasyopogon</i> sp., <i>Lepidosperma</i> sp. & <i>Hypolaena</i> sp.	Pristine. No obvious signs of fire, disease, land-use impacts or dieback.
	Dampland (38825652147)	Category = 1 Damplands 120 and 125 are a large pair of damplands that are possibly connected, and are both located in a large undisturbed nature reserve. The dampland is generally in a very good condition.	Terrestrial: An overstorey of <i>E. totiliana</i> , <i>B. menziesii</i> & <i>B. ilicifolia</i> woodland. With an open heath understorey of <i>V. nitens</i> , <i>Myrtaceae</i> shrub sp., <i>Leucopogon</i> sp., <i>Regelia</i> sp., <i>Xanthorrhoea</i> sp., <i>M. trichophylla</i> & <i>M. scabra</i> . Wetland: A woodland overstorey of <i>M. preissiana</i> , <i>B. menziesii</i> , <i>B. attenuata</i> & <i>N. floribunda</i> . With a tall scrubland understorey of <i>Kunzea</i> sp., a shrubland of <i>Beaufortia</i> sp., <i>Xanthorrhoea</i> sp., <i>V. nitens</i> & <i>Adenanthos</i> sp., and a grassland of <i>Dasyopogon</i> sp.	The vegetation is in excellent to pristine condition.
	Dampland (38875652172)	Category = 1 One dampland of a pair that are possibly hydrologically connected. Both are located in a large nature reserve.	Terrestrial: An overstorey of <i>E. totiliana</i> , <i>B. menziesii</i> & <i>B. ilicifolia</i> woodland. With an open heath understorey of <i>V. nitens</i> , <i>Myrtaceae</i> shrub sp., <i>Leucopogon</i> sp., <i>Regelia</i> sp., <i>Xanthorrhoea</i> sp., <i>M. trichophylla</i> & <i>M. scabra</i> . Wetland: The western part of the dampland has an open woodland overstorey of <i>B. ilicifolia</i> , with an open heath understorey of <i>V. nitens</i> , <i>Beaufortia</i> sp., <i>Dasyopogon</i> sp. & <i>Xanthorrhoea</i> sp. The eastern part of the dampland has a woodland overstorey of <i>B. menziesii</i> , with a tall open scrub to tall closed scrub understorey of <i>Kunzea</i> sp., <i>Beaufortia</i> sp. & <i>Adenanthos</i> .	<i>M. preissiana</i> stags are present however, no live specimens are visible. The majority of the <i>B. ilicifolia</i> are re-sprouting (though there are no obvious signs of fire), there are various dead <i>Banksia</i> tree's, and there is some shrub death. However, it should be noted that the condition of the vegetation improves in the eastern part of the dampland, where vegetation condition is excellent.
	Dampland (38861652407)	Category = 1 A small distinct dampland surrounded by larger damplands. There are roads upland of the dampland, however, the roads do not appear to negatively impact the dampland. The wetland is generally in very good condition, with only small patches of dead vegetation.	Terrestrial: The overstorey is a woodland of <i>Banksia attenuata</i> , <i>B. menziesii</i> & <i>B. ilicifolia</i> . With a shrubland understorey of <i>Regelia</i> sp., <i>Beaufortia</i> sp., <i>Macrocrambia</i> sp., <i>Myrtaceae</i> shrub sp. & <i>Dasyopogon</i> sp. Wetland: An overstorey of <i>M. preissiana</i> around the perimeter of the wetland. With a closed tall scrubland of <i>Kunzea</i> sp.	The condition of the terrestrial vegetation is generally in excellent to pristine condition; however, there is some shrub death and some death of <i>B. attenuata</i> . The condition of the wetland vegetation is also in excellent to pristine condition, however, there is some death of mature <i>M.</i>

Map Number	Wetland Type & ID	Conservation Category & Overall Condition	Vegetation Type/Community	Vegetation Condition
1891962725	Dampland	Category = 2 A small dampland in a derrick affected area. There is a road through the middle of wetland, which has had a detrimental impact (the wetland is small and the road has been widened).	Terrestrial Woodland of <i>H. nitida</i> , <i>H. thymifolia</i> & <i>H. thymifolia</i> . With an understorey of <i>Phragmites australis</i> . Terrestrial Woodland of <i>H. nitida</i> , <i>H. thymifolia</i> & <i>H. thymifolia</i> . With an understorey of <i>Phragmites australis</i> . Terrestrial Woodland of <i>H. nitida</i> , <i>H. thymifolia</i> & <i>H. thymifolia</i> . With an understorey of <i>Phragmites australis</i> .	Approximately 60% of the <i>H. nitida</i> is dead or dying. Possible cause is trampling by cattle. However, further investigation is required to determine the cause.
1891962720	Dampland	Category = 2 A medium sized dampland in a line of wetlands, in valley that runs east-west. The land adjacent to the dampland, particularly to the east, appears to be severely derrick affected.	Wetland <i>H. nitida</i> & <i>H. thymifolia</i> woodland with a tall scrubland of <i>Phragmites australis</i> and sedge species. Wetland <i>H. nitida</i> , <i>H. thymifolia</i> , <i>H. thymifolia</i> , <i>H. thymifolia</i> & <i>H. thymifolia</i> . Wetland <i>H. nitida</i> , <i>H. thymifolia</i> , <i>H. thymifolia</i> , <i>H. thymifolia</i> & <i>H. thymifolia</i> .	Approximately 60% of the <i>H. nitida</i> is dead or dying. Possible cause is trampling by cattle. However, further investigation is required to determine the cause.
1891962725	Dampland	Category = 2 A small dampland in a derrick affected area. There is a road through the middle of wetland, which has had a detrimental impact (the wetland is small and the road has been widened).	Terrestrial Woodland of <i>H. nitida</i> , <i>H. thymifolia</i> & <i>H. thymifolia</i> . With an understorey of <i>Phragmites australis</i> . Terrestrial Woodland of <i>H. nitida</i> , <i>H. thymifolia</i> & <i>H. thymifolia</i> . With an understorey of <i>Phragmites australis</i> . Terrestrial Woodland of <i>H. nitida</i> , <i>H. thymifolia</i> & <i>H. thymifolia</i> . With an understorey of <i>Phragmites australis</i> .	Approximately 60% of the <i>H. nitida</i> is dead or dying. Possible cause is trampling by cattle. However, further investigation is required to determine the cause.
1891962725	Dampland	Category = 1 Wetland occurs in large bush block and forms part of a series of damplands with similar vegetation associations. Dampland extends well beyond the boundaries defined in Hill et al. Large block of vegetation separates the damplands from vehicle tracks. Virtually unimpacted western.	Terrestrial Woodland of <i>H. nitida</i> , <i>H. thymifolia</i> & <i>H. thymifolia</i> . With an understorey of <i>Phragmites australis</i> . Terrestrial Woodland of <i>H. nitida</i> , <i>H. thymifolia</i> & <i>H. thymifolia</i> . With an understorey of <i>Phragmites australis</i> . Terrestrial Woodland of <i>H. nitida</i> , <i>H. thymifolia</i> & <i>H. thymifolia</i> . With an understorey of <i>Phragmites australis</i> .	All the <i>H. nitida</i> species are in excellent condition. Some evidence of stress can be seen in the <i>H. nitida</i> . Population although the majority are in good condition. Wetland vegetation in prime condition.
1814462770	Dampland	Category = 1 Flat dampland with mixture of terrestrial and wetland species.	Terrestrial Woodland of <i>H. nitida</i> , <i>H. thymifolia</i> & <i>H. thymifolia</i> . With an understorey of <i>Phragmites australis</i> . Terrestrial Woodland of <i>H. nitida</i> , <i>H. thymifolia</i> & <i>H. thymifolia</i> . With an understorey of <i>Phragmites australis</i> . Terrestrial Woodland of <i>H. nitida</i> , <i>H. thymifolia</i> & <i>H. thymifolia</i> . With an understorey of <i>Phragmites australis</i> .	Vegetation in excellent condition. Some dead <i>H. nitida</i> in the south-east and occasional patches of dead <i>H. nitida</i> in the south-east and occasional patches of dead <i>H. nitida</i> in the south-east.
1882162461	Dampland	Category = 1 The wetland is generally in very good condition, the vegetation is generally in excellent health, and there are no signs of recent fire. The wetland is virtually unimpacted, however, there is an old track through the northern part of the wetland.	Terrestrial Woodland of <i>H. nitida</i> , <i>H. thymifolia</i> & <i>H. thymifolia</i> . With an understorey of <i>Phragmites australis</i> . Terrestrial Woodland of <i>H. nitida</i> , <i>H. thymifolia</i> & <i>H. thymifolia</i> . With an understorey of <i>Phragmites australis</i> . Terrestrial Woodland of <i>H. nitida</i> , <i>H. thymifolia</i> & <i>H. thymifolia</i> . With an understorey of <i>Phragmites australis</i> .	The wetland and terrestrial vegetation are generally in an excellent condition, however, there was some dead <i>H. nitida</i> in the north-east.
1817462105	Dampland	Category = 2 Dampland extends beyond the boundary defined in Hill et al., to an area of wetland crossing the vehicle track to the south-west. The slope into the wetland basin.	Terrestrial Woodland of <i>H. nitida</i> , <i>H. thymifolia</i> & <i>H. thymifolia</i> . With an understorey of <i>Phragmites australis</i> . Terrestrial Woodland of <i>H. nitida</i> , <i>H. thymifolia</i> & <i>H. thymifolia</i> . With an understorey of <i>Phragmites australis</i> . Terrestrial Woodland of <i>H. nitida</i> , <i>H. thymifolia</i> & <i>H. thymifolia</i> . With an understorey of <i>Phragmites australis</i> .	Most of the vegetation on the dampland is in excellent health although the majority of the <i>H. nitida</i> shows signs of stress.
18551625251	Dampland	Category = 1 Very soil is present in the basin of the dampland.	Terrestrial Woodland of <i>H. nitida</i> , <i>H. thymifolia</i> & <i>H. thymifolia</i> . With an understorey of <i>Phragmites australis</i> . Terrestrial Woodland of <i>H. nitida</i> , <i>H. thymifolia</i> & <i>H. thymifolia</i> . With an understorey of <i>Phragmites australis</i> . Terrestrial Woodland of <i>H. nitida</i> , <i>H. thymifolia</i> & <i>H. thymifolia</i> . With an understorey of <i>Phragmites australis</i> .	There are some dead <i>H. nitida</i> in the northern part of the dampland.
1882962108	Dampland	Category = 2 Wetland dominated by an open heath of wetland and terrestrial species with wetland trees generally restricted to the north-west edge.	Terrestrial Woodland of <i>H. nitida</i> , <i>H. thymifolia</i> & <i>H. thymifolia</i> . With an understorey of <i>Phragmites australis</i> . Terrestrial Woodland of <i>H. nitida</i> , <i>H. thymifolia</i> & <i>H. thymifolia</i> . With an understorey of <i>Phragmites australis</i> . Terrestrial Woodland of <i>H. nitida</i> , <i>H. thymifolia</i> & <i>H. thymifolia</i> . With an understorey of <i>Phragmites australis</i> .	Wetland generally restricted to very stressed. Scattered dead <i>H. nitida</i> occur within the open heath, which shows becoming a more terrestrial system.
1883162190	Dampland	Category = 2 Some terrestrial plant species appear to be invading the wetland edge.	Terrestrial Woodland dominated by <i>H. nitida</i> , <i>H. thymifolia</i> & <i>H. thymifolia</i> . With an understorey of <i>Phragmites australis</i> . Terrestrial Woodland dominated by <i>H. nitida</i> , <i>H. thymifolia</i> & <i>H. thymifolia</i> . With an understorey of <i>Phragmites australis</i> . Terrestrial Woodland dominated by <i>H. nitida</i> , <i>H. thymifolia</i> & <i>H. thymifolia</i> . With an understorey of <i>Phragmites australis</i> .	There appears to be almost no <i>H. nitida</i> present on the wetland edge.
1898962168	Dampland	Category = 2 A very large wetland. There are several tracks and a group of beeches in the eastern part of the wetland.	Terrestrial Woodland dominated by <i>H. nitida</i> , <i>H. thymifolia</i> & <i>H. thymifolia</i> . With an understorey of <i>Phragmites australis</i> . Terrestrial Woodland dominated by <i>H. nitida</i> , <i>H. thymifolia</i> & <i>H. thymifolia</i> . With an understorey of <i>Phragmites australis</i> . Terrestrial Woodland dominated by <i>H. nitida</i> , <i>H. thymifolia</i> & <i>H. thymifolia</i> . With an understorey of <i>Phragmites australis</i> .	Wetland dominated by <i>H. nitida</i> , <i>H. thymifolia</i> & <i>H. thymifolia</i> . With an understorey of <i>Phragmites australis</i> . Wetland dominated by <i>H. nitida</i> , <i>H. thymifolia</i> & <i>H. thymifolia</i> . With an understorey of <i>Phragmites australis</i> . Wetland dominated by <i>H. nitida</i> , <i>H. thymifolia</i> & <i>H. thymifolia</i> . With an understorey of <i>Phragmites australis</i> .

Map Number	Wetland Type & ID Number / Name	Conservation Category & Overall Condition	Vegetation Type / Community	Vegetation Condition
			closed scrub dominated by <i>Adenanthos</i> sp., <i>Beaufortia</i> sp. & <i>Kunzea</i> sp. <i>C. cataphylla</i> dominates the overstorey on the perimeter of the wetland.	<i>Ilicifolia</i> range extending into the wetland. The <i>E. rudis</i> is in notably good condition.
	Dampland (38861652005)	Category = 1 A broad transition zone of mixed terrestrial and wetland vegetation surrounding the dampland.	Terrestrial: Woodland dominated by <i>B. attenuata</i> & <i>B. menziesii</i> , with open heath dominated by <i>E. pauciflora</i> , <i>Hibbertia</i> spp., <i>Leucopogon</i> sp., <i>Lyginia barbata</i> , <i>Regelia ciliata</i> , <i>Scholtzia</i> sp., <i>Stirlingia</i> sp. & <i>V. nitens</i> . Wetland: Basin, woodland dominated by <i>B. ilicifolia</i> & <i>M. preissiana</i> , with shrubland dominated by <i>Beaufortia</i> sp., <i>Hyposcolymus</i> sp., <i>Kunzea</i> sp. & <i>Xanthorrhoea</i> sp. Transition zone, woodland dominated by <i>B. ilicifolia</i> , with shrubland dominated by <i>Kunzea</i> sp., <i>Regelia inops</i> & <i>Xanthorrhoea</i> sp.	The vegetation is generally in very good to excellent condition, however, there is some drought stress in the <i>Kunzea</i> sp. shrubland
	Dampland (38913652246)	Category = 2 Large, linear dampland with wide transition zone of mixed species between terrestrial and wetland vegetation. Evidence of dieback in terrestrial community.	Terrestrial: Woodland of <i>B. menziesii</i> , <i>B. attenuata</i> & <i>B. ilicifolia</i> over a shrubland to open heath of <i>Adenanthos</i> sp., <i>V. nitens</i> , <i>E. pauciflora</i> , <i>Scholtzia</i> sp. & <i>R. ciliata</i> . Wetland: Woodland of <i>M. preissiana</i> , <i>B. littoralis</i> , <i>N. floribunda</i> , <i>B. menziesii</i> , <i>B. attenuata</i> & <i>B. ilicifolia</i> over a tall open to closed scrub of <i>B. elegans</i> , <i>K. ericifolia</i> & <i>Adenanthos</i> sp.	Occasional stressed mature <i>Melaleuca</i> and localised areas of dead scrub, otherwise vegetation in excellent condition. Young <i>Banksia</i> spp. colonising basin of dampland.
	Dampland (38913652012)	Category = 1 No description given	Terrestrial: Woodland of <i>B. menziesii</i> & <i>B. attenuata</i> over an open heath of <i>E. pauciflora</i> , <i>R. ciliata</i> , <i>Scholtzia</i> sp., <i>V. nitens</i> , <i>Lyginia barbata</i> , <i>Stirlingia</i> sp., <i>Leucopogon</i> spp. & <i>Hibbertia</i> sp. Wetland: Upper: Woodland of <i>M. preissiana</i> , <i>B. ilicifolia</i> , <i>B. attenuata</i> & <i>B. menziesii</i> over an open heath of <i>R. inops</i> , <i>K. ericifolia</i> , <i>B. elegans</i> , <i>Leucopogon</i> sp. & <i>Scholtzia</i> sp. Lower: <i>M. preissiana</i> open woodland over a tall open scrub of <i>K. ericifolia</i> & <i>angustifolium</i> .	<i>M. preissiana</i> generally in very good to excellent condition. Occasional dead <i>B. ilicifolia</i> around perimeter. Large areas of dead scrub on the basin with some regeneration of <i>K. ericifolia</i> .
	Dampland (3891652330)	Category = 1 A healthy and intact dampland, with a mixed of wetland and terrestrial vegetation.	Terrestrial: Woodland dominated by <i>B. attenuata</i> , <i>B. ilicifolia</i> , <i>B. menziesii</i> & <i>E. rodiana</i> , with shrubland dominated by <i>Adenanthos</i> sp., <i>Eremaea</i> sp., <i>Dasyopogon</i> sp., <i>Jacksenia</i> sp., <i>Macrozamia</i> sp., <i>Verticordia</i> sp. & <i>Xanthorrhoea</i> sp. Wetland: Woodland dominated by <i>B. attenuata</i> , <i>B. grandis</i> , <i>B. ilicifolia</i> , <i>B. littoralis</i> , <i>B. menziesii</i> , <i>C. cataphylla</i> & <i>M. preissiana</i> , with tall open scrub dominated by <i>Adenanthos</i> sp. and <i>Kunzea</i> sp.; and shrubland dominated by <i>Beaufortia</i> sp., <i>Dasyopogon</i> sp., <i>Leucopogon</i> sp., <i>Jacksenia</i> sp., <i>Regelia inops</i> & <i>Xanthorrhoea</i> sp.	All parts of the vegetation are in excellent condition.
	Dampland (38913652008)	Category = 2 Small dampland dominated by Myrtaceous shrubs. Surrounding vegetation dieback affected.	Terrestrial: Woodland of <i>B. menziesii</i> & <i>B. attenuata</i> over an open heath of <i>E. pauciflora</i> , <i>R. ciliata</i> , <i>Scholtzia</i> sp., <i>V. nitens</i> , <i>Lyginia barbata</i> , <i>Stirlingia</i> sp., <i>Leucopogon</i> spp. & <i>Hibbertia</i> sp. Wetland: Open woodland of <i>M. preissiana</i> & <i>B. ilicifolia</i> . Understorey a tall open scrub of <i>K. ericifolia</i> , <i>R. inops</i> , <i>B. angustifolium</i> with <i>Leucopogon</i> spp. & <i>Adenanthos</i> sp. around the perimeter.	Numerous <i>Melaleuca</i> stags occur on and around the wetland basin with the remaining few live stems showing severe stress. The scrub appears very drought stressed although <i>Kunzea</i> seedlings have germinated amongst the dead plants. <i>B. ilicifolia</i> saplings are establishing in the lower stress of the basin.
	Dampland (39008652386)	Category = 1 A track runs through the wetland. Much of the wetland vegetation is a mix of terrestrial and wetland vegetation, with only small pockets of "true" wetland vegetation.	Terrestrial: Woodland dominated by <i>B. attenuata</i> , <i>B. ilicifolia</i> and <i>B. menziesii</i> , with shrubland dominated by <i>Dasyopogon</i> sp., <i>V. nitens</i> and <i>Xanthorrhoea</i> sp. Wetland: Woodland dominated by <i>B. attenuata</i> , <i>B. ilicifolia</i> , <i>B. menziesii</i> , <i>M. preissiana</i> & <i>N. floribunda</i> , with shrubland dominated by <i>Adenanthos</i> sp., <i>Beaufortia</i> sp., <i>Dasyopogon</i> sp., <i>Kunzea</i> sp. & <i>V. nitens</i> ; and some low areas with an overstorey dominated by <i>M. preissiana</i> , and tall closed scrub dominated by <i>Kunzea</i> sp. and <i>Dasyopogon</i> sp.	There are some senescent <i>M. preissiana</i> on the wetland; and some <i>Banksia</i> sp. seedlings on the wetland, indicating an invasion of terrestrial species, and some <i>Banksia</i> sp. stags in the terrestrial vegetation.
	Dampland (39008652298)	Category = 1 A distinct and sharp transition between terrestrial and wetland vegetation is observed at this site.	Terrestrial: Woodland dominated by <i>B. attenuata</i> , <i>B. ilicifolia</i> , <i>B. menziesii</i> & <i>E. rodiana</i> , with shrubland dominated by <i>Adenanthos</i> sp., <i>Acaia</i> sp., <i>Eremaea</i> sp., <i>Macrozamia</i> sp., <i>Regelia</i> sp., <i>Verticordia</i> sp. & <i>Xanthorrhoea</i> sp. Wetland: Low open forest dominated by <i>B. littoralis</i> , <i>M. preissiana</i> & <i>N. floribunda</i> ; with tall open forest of <i>C. cataphylla</i> on the western fringe; and low open heath to tall open scrub dominated by <i>Beaufortia</i> sp., <i>Kunzea</i> sp., <i>Pericalymma</i> sp. & <i>Xanthorrhoea</i> sp.	The vegetation is generally excellent to pristine.
	Dampland (39026652224)	Category = 1 No description given.	Wetland: Woodland dominated by <i>B. attenuata</i> , <i>B. ilicifolia</i> & <i>N. floribunda</i> , with tall closed scrub dominated by <i>Beaufortia</i> sp., <i>Dasyopogon</i> & <i>Kunzea</i> sp.	There are numerous <i>M. preissiana</i> stags on the basin, with very few live individuals observed. <i>Banksia</i> species appear to be replacing the <i>M. preissiana</i> as the dominant overstorey species. The scrub is in excellent condition.
	Dampland (39045652254)	Category = 2 No description given	Terrestrial: Woodland dominated by <i>B. attenuata</i> , <i>B. ilicifolia</i> , <i>B. menziesii</i> & <i>E. rodiana</i> , with shrubland dominated by <i>Adenanthos</i> sp., <i>Eremaea</i> sp., <i>Dasyopogon</i> sp., <i>Jacksenia</i> sp., <i>Macrozamia</i> sp., <i>Verticordia</i> sp. & <i>Xanthorrhoea</i> sp. Wetland: Woodland to low open forest dominated by <i>B. ilicifolia</i> , <i>M. preissiana</i> & <i>N. floribunda</i> , with tall	The vegetation is generally in excellent condition. There is some <i>M. preissiana</i> stags and stressed individuals.

Map Number	Wetland Type & ID Number / Name	Conservation Category & Overall Condition	Vegetation Type / Community	Vegetation Condition
	(38669651758)	Dampland occurs in a swale between two low dunes running north-south. Possibly connected to the other damplands in this area at the southern end.	<i>sanguinea</i> , <i>Myrtaceae</i> sp., <i>Regelia</i> sp., <i>Hibbertia</i> sp., <i>M. trichophylla</i> , <i>Xanthorrhoea</i> sp. & <i>Pterocarya</i> sp. Wetland: Open woodland of <i>M. preissiana</i> , <i>E. rudis</i> , <i>B. ilicifolia</i> & <i>B. attenuata</i> . Tall shrubland (closed in places) of <i>Kunzea</i> sp. & <i>Adeonanthus</i> sp.	occasional dead <i>B. ilicifolia</i> , <i>E. rudis</i> appear healthy
	Lake (Gimgin Brook Lake) (38749652539)	Category = 1 Large semi-permanent lake. Intact vegetation buffer although heavy weed infestation in inflow. Some surface water still present in May 2004.	Terrestrial: Woodland of <i>B. attenuata</i> , <i>B. menziesii</i> & <i>B. ilicifolia</i> with a shrubland dominated by <i>Xanthorrhoea</i> sp., <i>Melaleuca</i> sp., <i>Petrophile</i> sp. & <i>V. nitens</i> . Wetland: Open forest of <i>M. preissiana</i> , <i>M. rhaphiophylla</i> & <i>E. rudis</i> with an open shrubland of <i>M. ericifolia</i> and sedge/land of <i>Lepidosperma</i> sp. Around the wetland basin, vegetation becomes a low closed forest of <i>M. rhaphiophylla</i> with <i>M. teretifolia</i> dominating the understorey.	Weed invasion predominantly annual grasses in inflow. Vegetation excellent to pristine.
	Scrubland (38385632763)	Category = 1 Large scrubland joined to, and forming part of the floodplains 88 and 48. Surface water present in June 2004.	Terrestrial: Woodland of <i>B. attenuata</i> , <i>B. menziesii</i> & <i>B. ilicifolia</i> with a shrubland dominated by <i>Xanthorrhoea</i> sp., <i>M. scabra</i> , <i>Petrophile</i> sp. & <i>V. nitens</i> . Wetland: Upper floodplain: Woodland of <i>M. preissiana</i> , <i>B. littoralis</i> with a closed heath of <i>B. elegans</i> , <i>Calyx</i> sp., <i>Eremaea</i> sp. & <i>K. ericifolia</i> . Vegetation becomes closed forest of <i>E. rudis</i> , <i>M. preissiana</i> & <i>M. rhaphiophylla</i> in the southern (lower) section. Lower floodplain: Woodland of <i>M. preissiana</i> & <i>M. rhaphiophylla</i> with an open heath by tall open scrub of <i>Asterca</i> sp. & <i>Kunzea ericifolia</i> . Lower areas adjacent to open water contain <i>M. lateralis</i> closed tall shrub with admixtures of <i>K. ericifolia</i> , <i>Asterca</i> sp. & <i>B. elegans</i> .	<i>E. rudis</i> in the north-west section show signs of stress. Some die-back apparent in the terrestrial vegetation.
	Floodplain 88 (38454652772)	Category = 1 Numerous tracks cross the floodplain leading to weed invasion in localised areas. Recent fire is apparent in central region.	Terrestrial: Woodland of <i>B. attenuata</i> , <i>B. menziesii</i> & <i>B. ilicifolia</i> with a shrubland dominated by <i>Xanthorrhoea</i> sp., <i>Melaleuca</i> sp., <i>Petrophile</i> sp. & <i>V. nitens</i> . Wetland: Upper floodplain: Woodland of <i>M. preissiana</i> & <i>B. littoralis</i> with a closed heath of <i>B. elegans</i> , <i>Calyx</i> sp., <i>Eremaea</i> sp. & <i>K. ericifolia</i> . Vegetation becomes closed forest of <i>E. rudis</i> , <i>M. preissiana</i> & <i>M. rhaphiophylla</i> in the southern (lower) section. Lower floodplain: woodland of <i>M. preissiana</i> & <i>M. rhaphiophylla</i> with an open heath of <i>Asterca</i> sp. & <i>Kunzea ericifolia</i> . Channel: Tall closed shrub of <i>M. lateralis</i> with admixtures of <i>K. ericifolia</i> , <i>Asterca</i> sp. & <i>B. elegans</i> .	Recent fire (< 2yrs) in central section has caused some death of Myrtaceus shrublands. Paperbarks appear to be regenerating well. Some aggressive weeds around vehicle tracks (eg. <i>Mentha</i> sp.). Die-back apparent in some sections of terrestrial vegetation.
	Floodplain 48 (3821652928)	Category = 1 Large floodplain with localised areas of disturbance in the privately owned northern section (roughly half the floodplain). The following description applies predominantly to the southern section within the Yeal Reserve.	Terrestrial: Woodland of <i>B. attenuata</i> , <i>B. menziesii</i> & <i>B. ilicifolia</i> with a shrubland dominated by <i>Xanthorrhoea</i> sp., <i>Melaleuca</i> sp., <i>Petrophile</i> sp. & <i>V. nitens</i> . Wetland: The upper floodplain consists of a low open to closed forest of <i>M. preissiana</i> with <i>Beaufortia</i> sp., <i>Eremaea</i> sp. & <i>Xanthorrhoea</i> sp. In the channel, <i>M. preissiana</i> & <i>M. rhaphiophylla</i> form a low open to closed forest with a tall open scrub of <i>M. teretifolia</i> , <i>M. lateralis</i> & <i>K. ericifolia</i> , <i>Asterca</i> sp. & <i>Lepidosperma</i> sp. occur in the gaps.	Weed invasion and die-back is apparent around the vehicle tracks. Some patches of terrestrial vegetation contain numerous dead <i>Banksia</i> spp.
	Dampland (38039652524)	Category = 1 The dampland is generally in excellent condition, it is located in a large nature reserve. The dampland is close to a track, however, it seems to be no longer in use and is quite overgrown.	Terrestrial: A woodland of <i>B. attenuata</i> , <i>B. menziesii</i> & <i>B. ilicifolia</i> . The understorey is dominated by <i>Xanthorrhoea</i> sp. and <i>Eremaea</i> sp., with some <i>V. nitens</i> , <i>M. trichophylla</i> and <i>Hibbertia</i> sp. Wetland: A woodland overstorey of <i>B. attenuata</i> , <i>B. ilicifolia</i> , <i>N. floribunda</i> and <i>M. preissiana</i> . With a tall open scrub of <i>Kunzea</i> sp.; and up from the centre a shrubland of <i>Xanthorrhoea</i> sp., <i>Asterca</i> sp. and <i>Dasygogon</i> sp.	The condition of the vegetation is in excellent, with occasional <i>Banksia</i> sp. and <i>M. preissiana</i> signs and stressed individuals.
	Dampland (38139652681)	Category = 2 Large variable dampland with a wide transition zone of mixed terrestrial / wetland vegetation. Large areas of dead <i>M. preissiana</i> and <i>B. littoralis</i> .	Terrestrial: Woodland of <i>E. marginata</i> , <i>B. menziesii</i> , <i>B. attenuata</i> & <i>B. ilicifolia</i> over a shrubland of <i>Adeonanthus</i> sp., <i>E. paniculata</i> , <i>R. ciliosa</i> , <i>Leucopogon</i> spp., <i>V. nitens</i> & <i>Xanthorrhoea</i> sp. Wetland: Woodland of <i>M. preissiana</i> , <i>N. floribunda</i> , <i>B. littoralis</i> , <i>R. ilicifolia</i> , <i>B. attenuata</i> & <i>B. menziesii</i> over an open to closed scrub of <i>K. ericifolia</i> , <i>Xanthorrhoea</i> sp. & <i>Dasygogon bruniellifolius</i> . <i>Asterca</i> sp. & <i>Pterocarya</i> sp. shrubland dominates the lower areas.	Patches of dead and stressed overstorey species although most trees in good health. Understorey in excellent condition. Evidence of recent fire.
	Dampland (38122652574)	Category = 2 Large wetland with indistinct boundary. Overstorey of <i>Melaleuca</i> is all but gone although a tall scrub of Myrtaceus species still dominates much of the wetland.	Terrestrial: Woodland of <i>B. menziesii</i> , <i>B. attenuata</i> , <i>B. ilicifolia</i> with a shrubland of <i>Xanthorrhoea</i> sp., <i>Regelia</i> sp., <i>Eremaea</i> sp., <i>Leucopogon</i> sp., <i>Hibbertia</i> spp., <i>M. scabra</i> , <i>Banksia</i> sp. and <i>M. trichophylla</i> . Wetland: Woodland of <i>M. preissiana</i> , <i>Banksia menziesii</i> , <i>B. attenuata</i> and <i>B. ilicifolia</i> generally restricted to the perimeter. Understorey a tall open scrub of <i>Beaufortia</i> sp., <i>Kunzea</i> sp. with <i>Dasygogon</i> sp. in gaps.	Only a few <i>M. preissiana</i> remain around the perimeter with numerous signs present on the wetland basin. Large patches of Myrtaceus tall scrub are dead or very stressed. Some dead <i>Banksia</i> spp. are present in and around the wetland. Vegetation appears to be changing to a more terrestrial community structure.
	Dampland (38147652733)	Category = 2 Large variable dampland with obvious decline in overstorey health. Open scrub of Myrtaceus species dominates the lower areas on peat soils.	Terrestrial: Woodland of <i>Banksia menziesii</i> , <i>B. attenuata</i> & <i>B. ilicifolia</i> over a shrubland of <i>Adeonanthus</i> sp., <i>Eremaea paniculata</i> , <i>Regelia ciliosa</i> , <i>Leucopogon</i> spp., <i>Vericordia nitens</i> & <i>Xanthorrhoea</i> sp. Wetland: Woodland of <i>M. preissiana</i> , <i>B. littoralis</i> , <i>B. ilicifolia</i> , <i>B. attenuata</i> & <i>B. menziesii</i> over an open heath to tall open scrub of <i>Beaufortia elegans</i> , <i>Kunzea ericifolia</i> , <i>Adeonanthus</i> sp., <i>Xanthorrhoea preissii</i> & <i>Dasygogon bruniellifolius</i> .	Approximately 30% of the <i>M. preissiana</i> are dead or stressed. Some recently dead <i>B. attenuata</i> and <i>B. ilicifolia</i> occur along with dead patches of Myrtaceus scrub.

Map Number	Wetland Type & (B)	Conservation Category & (C)	Vegetation Type / Community	Vegetation Condition
(131516527087)	Dampland	Category = 2	Terrestrial Woodland of <i>E. marginata</i> , <i>H. monticola</i> , <i>H. artemisia</i> , <i>H. hirsuta</i> over a swardland of <i>E. pascuorum</i> , <i>H. hirsuta</i> , <i>H. artemisia</i> & <i>H. monticola</i> over an open sward of <i>H. hirsuta</i> , <i>H. artemisia</i> & <i>H. monticola</i>	90% of <i>M. pratensis</i> dead or very success. Occasional dead or success <i>H. hirsuta</i> sp. Most of the swardland is dead or showing signs of drought stress. <i>H. hirsuta</i> spp. seedlings at low levels.
(1316252373)	Dampland	Category = 2	Terrestrial Woodland of <i>E. marginata</i> , <i>H. monticola</i> , <i>H. artemisia</i> & <i>H. hirsuta</i> over a swardland of <i>E. pascuorum</i> , <i>H. hirsuta</i> , <i>H. artemisia</i> & <i>H. monticola</i> over an open sward of <i>H. hirsuta</i> , <i>H. artemisia</i> & <i>H. monticola</i>	Approximately 70% of <i>M. pratensis</i> is success to very success. Some dead <i>H. hirsuta</i> occurs around the wetland perimeter. Fall sown in excellent condition.
(1316252373)	Dampland	Category = 2	Terrestrial Woodland of <i>E. marginata</i> , <i>H. monticola</i> , <i>H. artemisia</i> & <i>H. hirsuta</i> over a swardland of <i>E. pascuorum</i> , <i>H. hirsuta</i> , <i>H. artemisia</i> & <i>H. monticola</i> over an open sward of <i>H. hirsuta</i> , <i>H. artemisia</i> & <i>H. monticola</i>	Some success <i>M. pratensis</i> and scattered dead <i>H. hirsuta</i> spp. species is present.
(1316252373)	Dampland	Category = 2	Terrestrial Woodland of <i>E. marginata</i> , <i>H. monticola</i> , <i>H. artemisia</i> & <i>H. hirsuta</i> over a swardland of <i>E. pascuorum</i> , <i>H. hirsuta</i> , <i>H. artemisia</i> & <i>H. monticola</i> over an open sward of <i>H. hirsuta</i> , <i>H. artemisia</i> & <i>H. monticola</i>	Large variable dampland with a wide transition zone of mixed terrestrial / wetland vegetation.
(1316252373)	Dampland	Category = 1	Terrestrial Woodland of <i>E. marginata</i> , <i>H. monticola</i> , <i>H. artemisia</i> & <i>H. hirsuta</i> over a swardland of <i>E. pascuorum</i> , <i>H. hirsuta</i> , <i>H. artemisia</i> & <i>H. monticola</i> over an open sward of <i>H. hirsuta</i> , <i>H. artemisia</i> & <i>H. monticola</i>	Terrestrial Woodland of <i>E. marginata</i> , <i>H. monticola</i> , <i>H. artemisia</i> & <i>H. hirsuta</i> over a swardland of <i>E. pascuorum</i> , <i>H. hirsuta</i> , <i>H. artemisia</i> & <i>H. monticola</i> over an open sward of <i>H. hirsuta</i> , <i>H. artemisia</i> & <i>H. monticola</i>
(1316252373)	Dampland	Category = 1	Terrestrial Woodland of <i>E. marginata</i> , <i>H. monticola</i> , <i>H. artemisia</i> & <i>H. hirsuta</i> over a swardland of <i>E. pascuorum</i> , <i>H. hirsuta</i> , <i>H. artemisia</i> & <i>H. monticola</i> over an open sward of <i>H. hirsuta</i> , <i>H. artemisia</i> & <i>H. monticola</i>	Small dampland with swards success vegetation. Most species showing signs of drought stress. Terrestrial
(1316252373)	Dampland	Category = 2	Terrestrial Woodland of <i>E. marginata</i> , <i>H. monticola</i> , <i>H. artemisia</i> & <i>H. hirsuta</i> over a swardland of <i>E. pascuorum</i> , <i>H. hirsuta</i> , <i>H. artemisia</i> & <i>H. monticola</i> over an open sward of <i>H. hirsuta</i> , <i>H. artemisia</i> & <i>H. monticola</i>	Small dampland with gradual slope towards a central forest dominated by <i>Betula</i> spp.
(1316252373)	Dampland	Category = 2	Terrestrial Woodland of <i>E. marginata</i> , <i>H. monticola</i> , <i>H. artemisia</i> & <i>H. hirsuta</i> over a swardland of <i>E. pascuorum</i> , <i>H. hirsuta</i> , <i>H. artemisia</i> & <i>H. monticola</i> over an open sward of <i>H. hirsuta</i> , <i>H. artemisia</i> & <i>H. monticola</i>	Small dampland showing signs of drought stress. Most <i>M. pratensis</i> are dead and are being replaced by <i>H. hirsuta</i> spp.
(1316252373)	Dampland	Category = 2	Terrestrial Woodland of <i>E. marginata</i> , <i>H. monticola</i> , <i>H. artemisia</i> & <i>H. hirsuta</i> over a swardland of <i>E. pascuorum</i> , <i>H. hirsuta</i> , <i>H. artemisia</i> & <i>H. monticola</i> over an open sward of <i>H. hirsuta</i> , <i>H. artemisia</i> & <i>H. monticola</i>	Small dampland showing signs of drought stress. Most <i>M. pratensis</i> are dead and are being replaced by <i>H. hirsuta</i> spp.
(1316252373)	Dampland	Category = 2	Terrestrial Woodland of <i>E. marginata</i> , <i>H. monticola</i> , <i>H. artemisia</i> & <i>H. hirsuta</i> over a swardland of <i>E. pascuorum</i> , <i>H. hirsuta</i> , <i>H. artemisia</i> & <i>H. monticola</i> over an open sward of <i>H. hirsuta</i> , <i>H. artemisia</i> & <i>H. monticola</i>	Large dampland supporting <i>Salix</i> trees across much of the wetland basin. Dense <i>Myrica</i> swards throughout.
(1316252373)	Dampland	Category = 1	Terrestrial Woodland of <i>E. marginata</i> , <i>H. monticola</i> , <i>H. artemisia</i> & <i>H. hirsuta</i> over a swardland of <i>E. pascuorum</i> , <i>H. hirsuta</i> , <i>H. artemisia</i> & <i>H. monticola</i> over an open sward of <i>H. hirsuta</i> , <i>H. artemisia</i> & <i>H. monticola</i>	Small dampland dominated by <i>Betula</i> spp. with a <i>Myrica</i> sward.
(1316252373)	Dampland	Category = 1	Terrestrial Woodland of <i>E. marginata</i> , <i>H. monticola</i> , <i>H. artemisia</i> & <i>H. hirsuta</i> over a swardland of <i>E. pascuorum</i> , <i>H. hirsuta</i> , <i>H. artemisia</i> & <i>H. monticola</i> over an open sward of <i>H. hirsuta</i> , <i>H. artemisia</i> & <i>H. monticola</i>	Large dampland supporting <i>Salix</i> trees across much of the wetland basin. Dense <i>Myrica</i> swards throughout.
(1316252373)	Dampland	Category = 2	Terrestrial Woodland of <i>E. marginata</i> , <i>H. monticola</i> , <i>H. artemisia</i> & <i>H. hirsuta</i> over a swardland of <i>E. pascuorum</i> , <i>H. hirsuta</i> , <i>H. artemisia</i> & <i>H. monticola</i> over an open sward of <i>H. hirsuta</i> , <i>H. artemisia</i> & <i>H. monticola</i>	Dampland has lost the majority of its wetland and is essentially an open heath to tall open scrub of mixed wetland and terrestrial species.
(1316252373)	Dampland	Category = 1	Terrestrial Woodland of <i>E. marginata</i> , <i>H. monticola</i> , <i>H. artemisia</i> & <i>H. hirsuta</i> over a swardland of <i>E. pascuorum</i> , <i>H. hirsuta</i> , <i>H. artemisia</i> & <i>H. monticola</i> over an open sward of <i>H. hirsuta</i> , <i>H. artemisia</i> & <i>H. monticola</i>	The dampland is steep-sided, with a rapid and distinct transition between terrestrial and wetland vegetation, with some very large <i>M. pratensis</i> present.
(1316252373)	Dampland	Category = 2	Terrestrial Woodland of <i>E. marginata</i> , <i>H. monticola</i> , <i>H. artemisia</i> & <i>H. hirsuta</i> over a swardland of <i>E. pascuorum</i> , <i>H. hirsuta</i> , <i>H. artemisia</i> & <i>H. monticola</i> over an open sward of <i>H. hirsuta</i> , <i>H. artemisia</i> & <i>H. monticola</i>	Small dampland in a shallow stable pool west of the large Dampland. The wetland slopes down to a heath area of wetland vegetation on a hard soil with healthy mature trees and saplings / seedlings.
(1316252373)	Dampland	Category = 2	Terrestrial Woodland of <i>E. marginata</i> , <i>H. monticola</i> , <i>H. artemisia</i> & <i>H. hirsuta</i> over a swardland of <i>E. pascuorum</i> , <i>H. hirsuta</i> , <i>H. artemisia</i> & <i>H. monticola</i> over an open sward of <i>H. hirsuta</i> , <i>H. artemisia</i> & <i>H. monticola</i>	Large dampland found in northern end of dampland 20. Large <i>M. pratensis</i> and <i>H. hirsuta</i> spp. A few <i>E. pascuorum</i> and <i>M. pratensis</i> seedlings can be found in the central area.
(1316252373)	Dampland	Category = 2	Terrestrial Woodland of <i>E. marginata</i> , <i>H. monticola</i> , <i>H. artemisia</i> & <i>H. hirsuta</i> over a swardland of <i>E. pascuorum</i> , <i>H. hirsuta</i> , <i>H. artemisia</i> & <i>H. monticola</i> over an open sward of <i>H. hirsuta</i> , <i>H. artemisia</i> & <i>H. monticola</i>	No description given.

Map Number	Wetland Type & ID	Conversion Category & Elevation	Vegetation Type (Community)	Vegetation Condition
	Dampland (3560052287)	Category = 2 Dampland in two distinct zones based on elevation gradient. Higher zone supports mixed terrestrial / wetland communities and the northern part of the dampland.	Terrestrial: Woodland of <i>H. americana</i> & <i>H. nigricans</i> with a shrubland dominated by <i>Xanthorrhoea</i> sp. Fescue sp., <i>L. nitens</i> & <i>L. purpurea</i> Wetland: Upper zone supports a woodland in open woodland of <i>M. pruriens</i> , <i>H. americana</i> , <i>H. nigricans</i> , <i>H. lucida</i> , <i>H. elliptica</i> , <i>H. nitens</i> & <i>L. nitens</i> . Lower zone consists of a tall open to closed scrub of <i>C. cretata</i> and <i>Boerhaavia</i> sp.	The condition of the vegetation is in excellent to pristine condition. With a few sage and stressed individuals are apparent on the edge of the wetland. Tall scrub in excellent condition with heathland dead patches.
	Dampland (3560052113)	Category = 1 A large flat basin covered with a tall open scrub and a closed woodland in which it is located. The dampland is generally from vehicle on the eastern side.	Terrestrial: Woodland of <i>H. americana</i> & <i>H. nigricans</i> with a shrubland dominated by <i>Xanthorrhoea</i> sp. Fescue sp., <i>L. nitens</i> & <i>L. purpurea</i> Wetland: Woodland of <i>H. americana</i> & <i>H. nigricans</i> with a shrubland dominated by <i>Xanthorrhoea</i> sp.	The condition of the vegetation is in excellent to pristine condition.
	Dampland (3560052060)	Category = 2 In description given	Terrestrial: Woodland of <i>H. americana</i> & <i>H. nigricans</i> with a shrubland dominated by <i>Xanthorrhoea</i> sp. Fescue sp., <i>L. nitens</i> & <i>L. purpurea</i> Wetland: Woodland of <i>H. americana</i> & <i>H. nigricans</i> with a shrubland dominated by <i>Xanthorrhoea</i> sp.	<i>M. pruriens</i> in generally excellent condition. A few sages and stressed individuals are apparent on the edge of the wetland. Tall scrub in excellent condition with heathland dead patches.
	Dampland (3560052194)	Category = 1 The dampland is generally in excellent condition. The dampland is located in a large nature reserve, however, a track passes through the northern part of the dampland.	Terrestrial: Woodland of <i>H. americana</i> & <i>H. nigricans</i> with a shrubland dominated by <i>Xanthorrhoea</i> sp. Fescue sp., <i>L. nitens</i> & <i>L. purpurea</i> Wetland: Woodland of <i>H. americana</i> & <i>H. nigricans</i> with a shrubland dominated by <i>Xanthorrhoea</i> sp.	The condition of the vegetation is generally excellent, with some stressed <i>M. pruriens</i> trees.
	Dampland (3560052182)	Category = 1 Isolated dampland with terrestrial species throughout. Wetland.	Terrestrial: Woodland of <i>H. americana</i> & <i>H. nigricans</i> with a shrubland dominated by <i>Xanthorrhoea</i> sp. Fescue sp., <i>L. nitens</i> & <i>L. purpurea</i> Wetland: Woodland of <i>H. americana</i> & <i>H. nigricans</i> with a shrubland dominated by <i>Xanthorrhoea</i> sp.	Wetland in good condition. Terrestrial species appear to be containing across the dampland.
	Dampland (3560052041)	Category = 1 The dampland is generally in excellent condition, and is located in a large nature reserve.	Terrestrial: Woodland of <i>H. americana</i> & <i>H. nigricans</i> with a shrubland dominated by <i>Xanthorrhoea</i> sp. Fescue sp., <i>L. nitens</i> & <i>L. purpurea</i> Wetland: Transition vegetation consisting of a woodland overstorey of <i>H. americana</i> , <i>H. nigricans</i> , <i>H. lucida</i> , <i>H. elliptica</i> , <i>H. nitens</i> and <i>L. nitens</i> . Understorey consists of a woodland overstorey of <i>L. purpurea</i> , <i>Asterina</i> sp., <i>H. nitens</i> , <i>Xanthorrhoea</i> sp. and <i>Lamium</i> sp. The tree dampland vegetation consists of a woodland overstorey of <i>H. americana</i> and <i>M. pruriens</i> . With a tall closed scrub of <i>A. nitens</i> sp.	The vegetation is in excellent condition, with only a few stressed <i>M. pruriens</i> trees.
	Dampland (3560052093)	Category = 1 The dampland is in excellent condition, one of the best in the area.	Terrestrial: Woodland of <i>H. americana</i> & <i>H. nigricans</i> with a shrubland dominated by <i>Xanthorrhoea</i> sp. Fescue sp., <i>L. nitens</i> & <i>L. purpurea</i> Wetland: A basin overstorey of <i>M. pruriens</i> woodland to low open forest, with a closed tall scrub of <i>Xanthorrhoea</i> sp. Understorey of <i>Erigeron</i> sp., <i>Leucopogon</i> sp., <i>Scutaria</i> sp., <i>Schizanthus</i> sp., <i>L. nitens</i> , and <i>Xanthorrhoea</i> sp.	Wide range of size classes in the <i>M. pruriens</i> , and healthy <i>Kentia</i> sp. seedlings.
	Dampland (3560052377)	Category = 2 There is a road through the middle of the dampland, and some areas in reserve, however the wetland is generally in excellent condition. The dampland is located in a nature reserve.	Terrestrial: A woodland overstorey of <i>H. americana</i> , <i>H. lucida</i> and <i>H. nigricans</i> with a shrubland dominated by <i>Xanthorrhoea</i> sp. Fescue sp., <i>L. nitens</i> & <i>L. purpurea</i> Wetland: The overstorey is a <i>L. nitens</i> , <i>M. pruriens</i> , <i>H. americana</i> , <i>H. lucida</i> , <i>H. elliptica</i> , <i>H. nitens</i> and <i>M. pruriens</i> . With a closed tall scrub of <i>Xanthorrhoea</i> sp.	There is some dying off in numerous <i>L. nitens</i> and some <i>M. pruriens</i> trees, recently dead <i>M. pruriens</i> and dead or stressed <i>H. elliptica</i> in the western part of the dampland.
	Dampland (3560052687)	Category = 2 There are signs of a previous fire. <i>Asterina</i> sp. and <i>H. lucida</i> plants appear to be beginning to colonise the wetland.	Terrestrial: A woodland overstorey of <i>H. americana</i> , <i>H. lucida</i> and <i>H. nigricans</i> with a shrubland dominated by <i>Xanthorrhoea</i> sp. Fescue sp., <i>L. nitens</i> & <i>L. purpurea</i> Wetland: A woodland dominated by <i>H. lucida</i> , <i>H. americana</i> and <i>M. pruriens</i> with a closed tall scrub of <i>Xanthorrhoea</i> sp. Understorey dominated by <i>Asterina</i> sp., <i>H. americana</i> sp., <i>H. nitens</i> and <i>Xanthorrhoea</i> sp.	The vegetation is generally in excellent condition. The area of occasional death of <i>Banksia</i> sp. and <i>M. pruriens</i> trees, and scattered dead <i>M. pruriens</i> , <i>Asterina</i> sp. and <i>H. lucida</i> plants appear to be beginning to colonise the wetland.
	Dampland	Category = 1 Open forest of <i>H. americana</i> with occasional <i>H. nigricans</i> , <i>H. lucida</i> and <i>H. elliptica</i> with a diverse shrubland overstorey.	Terrestrial: Open forest of <i>H. americana</i> with occasional <i>H. nigricans</i> , <i>H. lucida</i> and <i>H. elliptica</i> with a diverse shrubland overstorey.	Vegetation within the area defined as the dampland is in excellent condition.

Map Number	Wetland Type & ID	Conversion Category & Overall Condition	Vegetation Type / Community	Vegetation Condition
Dampland 1876-1632-163	No description given.	Category = 1 Former pasture of dense terrestrial vegetation slightly eroded by large dampland / floodplain	Terrestrial: A woodland wetland dominated by <i>H. aurantia</i> , <i>H. montana</i> , <i>E. ustralis</i> , with a silted channel of <i>Urtica</i> spp. and <i>Lythrum</i> spp. Wetland: <i>Urtica</i> spp. and <i>Lythrum</i> spp. with a tall closed scrub understorey dominated by <i>Amorpha</i> spp.	Majority have been dead for some time, some terrestrial plant species are recolonizing, and the shrubland <i>Urtica</i> spp. is dominated by <i>Lythrum</i> spp. in several conditions.
Dampland 1876-1632-163	Large dampland / floodplain	Category = 1 Former pasture of dense terrestrial vegetation slightly eroded by large dampland / floodplain	Terrestrial: A woodland wetland dominated by <i>H. aurantia</i> , <i>H. montana</i> , <i>E. ustralis</i> , with a silted channel of <i>Urtica</i> spp. and <i>Lythrum</i> spp. Wetland: <i>Urtica</i> spp. and <i>Lythrum</i> spp. with a tall closed scrub understorey dominated by <i>Amorpha</i> spp.	Majority have been dead for some time, some terrestrial plant species are recolonizing, and the shrubland <i>Urtica</i> spp. is dominated by <i>Lythrum</i> spp. in several conditions.
Dampland (3797762088)	There is a track through the middle of the dampland	Category = 1 Small field dominated by <i>Alysicarpus</i> shrubs within the Qum Brook floodplain	Terrestrial: Woodland of <i>E. montana</i> , <i>H. montana</i> , <i>H. ustralis</i> , with a silted channel of <i>Urtica</i> spp. and <i>Lythrum</i> spp. Wetland: <i>Urtica</i> spp. and <i>Lythrum</i> spp. with a tall closed scrub understorey dominated by <i>Amorpha</i> spp.	The majority of the <i>A. pruriens</i> are dead or very stressed. Some healthy individuals remain at the western side. Understorey vegetation is variable with scattered dead shrubs where the majority is in very poor condition. The majority of the <i>Urtica</i> spp. are dead or very stressed. The majority of the <i>Lythrum</i> spp. are dead or very stressed. The majority of the <i>Amorpha</i> spp. are dead or very stressed.
20X5 III SE 1876-1632-20	Large dampland existing across eastern boundary through cleared pasture. Recent fires have affected much of the wetland although large unburnt patches remain, particularly in the northern section. DRY in May 2004	Category = 2 Wetland Open woodland of <i>E. ustralis</i> , <i>H. aurantia</i> & <i>H. montana</i> with a silted channel of <i>Urtica</i> spp. and <i>Lythrum</i> spp.	Terrestrial: Woodland of <i>E. ustralis</i> , <i>H. aurantia</i> & <i>H. montana</i> with a silted channel of <i>Urtica</i> spp. and <i>Lythrum</i> spp. Wetland: Open woodland of <i>E. ustralis</i> , <i>H. aurantia</i> & <i>H. montana</i> with a silted channel of <i>Urtica</i> spp. and <i>Lythrum</i> spp.	Fires have caused significant depletion of the understorey in heather areas. Some weevil weevil is present around the vehicle tracks that cross the wetland. Some pine trees can be found in clusters near the wetland.
Dampland (3796862593)	Large dampland approximately 100m east of the main Tick Flat wetland. Separated from the Tick Flat group by a low dam. Recent fires is evident in the southern half of the wetland. DRY in May 2004	Category = 2 Wetland Open woodland of <i>E. ustralis</i> , <i>H. aurantia</i> & <i>H. montana</i> with a silted channel of <i>Urtica</i> spp. and <i>Lythrum</i> spp.	Terrestrial: Woodland of <i>E. ustralis</i> , <i>H. aurantia</i> & <i>H. montana</i> with a silted channel of <i>Urtica</i> spp. and <i>Lythrum</i> spp. Wetland: Open woodland of <i>E. ustralis</i> , <i>H. aurantia</i> & <i>H. montana</i> with a silted channel of <i>Urtica</i> spp. and <i>Lythrum</i> spp.	The majority of the <i>A. pruriens</i> are dead or very stressed. Some healthy individuals remain at the western side. Understorey vegetation is variable with scattered dead shrubs where the majority is in very poor condition. The majority of the <i>Urtica</i> spp. are dead or very stressed. The majority of the <i>Lythrum</i> spp. are dead or very stressed. The majority of the <i>Amorpha</i> spp. are dead or very stressed.
Dampland (3757762591)	Small wetland in the central section of the Tick Flat complex. Unburnt in the recent fires. DRY in May 2004	Category = 1 Wetland Open woodland of <i>E. ustralis</i> , <i>H. aurantia</i> & <i>H. montana</i> with a silted channel of <i>Urtica</i> spp. and <i>Lythrum</i> spp.	Terrestrial: Woodland of <i>E. ustralis</i> , <i>H. aurantia</i> & <i>H. montana</i> with a silted channel of <i>Urtica</i> spp. and <i>Lythrum</i> spp. Wetland: Open woodland of <i>E. ustralis</i> , <i>H. aurantia</i> & <i>H. montana</i> with a silted channel of <i>Urtica</i> spp. and <i>Lythrum</i> spp.	Terrestrial: Woodland of <i>E. ustralis</i> , <i>H. aurantia</i> & <i>H. montana</i> with a silted channel of <i>Urtica</i> spp. and <i>Lythrum</i> spp. Wetland: Open woodland of <i>E. ustralis</i> , <i>H. aurantia</i> & <i>H. montana</i> with a silted channel of <i>Urtica</i> spp. and <i>Lythrum</i> spp.
2 Damplands (379162246)	Wetlands lie to the west of the main Tick Flat wetland in a <i>H. aurantia</i> & <i>H. montana</i> woodland with a variable understorey consisting of <i>A. pruriens</i> and dampland species. Understorey defined in Hill <i>et al.</i>	Category = 2 Wetland Woodland of <i>E. ustralis</i> , <i>H. aurantia</i> & <i>H. montana</i> with a silted channel of <i>Urtica</i> spp. and <i>Lythrum</i> spp.	Terrestrial: Woodland of <i>E. ustralis</i> , <i>H. aurantia</i> & <i>H. montana</i> with a silted channel of <i>Urtica</i> spp. and <i>Lythrum</i> spp. Wetland: Woodland of <i>E. ustralis</i> , <i>H. aurantia</i> & <i>H. montana</i> with a silted channel of <i>Urtica</i> spp. and <i>Lythrum</i> spp.	Terrestrial: Woodland of <i>E. ustralis</i> , <i>H. aurantia</i> & <i>H. montana</i> with a silted channel of <i>Urtica</i> spp. and <i>Lythrum</i> spp. Wetland: Woodland of <i>E. ustralis</i> , <i>H. aurantia</i> & <i>H. montana</i> with a silted channel of <i>Urtica</i> spp. and <i>Lythrum</i> spp.
3 Damplands (379162246)	Wetlands are defined by Hill <i>et al.</i> (1996) in this section as wet areas in Tick West. No distinct boundaries exist between the dampland which essentially forms one long dampland ranging in an east-west direction. Elevations suggest the dampland drains from west to east	Category = 2 Wetland Woodland of <i>E. ustralis</i> , <i>H. aurantia</i> , <i>H. montana</i> , <i>H. ustralis</i> , with an open heath dominated by <i>Mitella</i> spp. and <i>Lythrum</i> spp.	Terrestrial: Woodland of <i>E. ustralis</i> , <i>H. aurantia</i> , <i>H. montana</i> , <i>H. ustralis</i> , with an open heath dominated by <i>Mitella</i> spp. and <i>Lythrum</i> spp. Wetland: Woodland of <i>E. ustralis</i> , <i>H. aurantia</i> , <i>H. montana</i> , <i>H. ustralis</i> , with an open heath dominated by <i>Mitella</i> spp. and <i>Lythrum</i> spp.	Terrestrial: Woodland of <i>E. ustralis</i> , <i>H. aurantia</i> , <i>H. montana</i> , <i>H. ustralis</i> , with an open heath dominated by <i>Mitella</i> spp. and <i>Lythrum</i> spp. Wetland: Woodland of <i>E. ustralis</i> , <i>H. aurantia</i> , <i>H. montana</i> , <i>H. ustralis</i> , with an open heath dominated by <i>Mitella</i> spp. and <i>Lythrum</i> spp.

Map Number	Wetland Type & ID Number / Name	Conservation Category & Overall Condition	Vegetation Type / Community	Vegetation Condition
	Dampland (37984652796)	Category = 1 Small, steep sided wetland supporting very dense stands of wetland trees with a closed tall scrub of myrtaceous species. Locally unique vegetation complex suggests this site is wetter than surrounding damplands. Moist, organic sediment.	Terrestrial: Woodland of <i>E. toffiana</i> , <i>B. menziesii</i> & <i>B. attenuata</i> over a shrubland of <i>Xanthorrhoea</i> sp., <i>Regelia ciliata</i> , <i>M. scabra</i> , <i>Bostiana</i> sp., <i>E. paniculata</i> & <i>Hibbertia</i> sp. Wetland: Open to closed forest of <i>M. preissiana</i> & <i>B. littoralis</i> . Understorey a closed tall scrub of <i>K. ericifolia</i> , <i>Asteria</i> sp. & <i>M. ericifolia</i> . Upper littoral zone a sedge/land of <i>Lepidosperma</i> sp.	Pristine wetland. Density of trees and shrubs and presence of <i>M. ericifolia</i> make this a locally unique wetland in an unusually "wet" site.
	Dampland (37984652582)	Category = 1 The dampland is located in a large nature reserve. The dampland has a distinct basin with steep sides, and is in excellent to pristine condition. There are some very large <i>M. preissiana</i> trees that are in excellent condition and some <i>M. preissiana</i> saplings in the basin. The basin is quite damp. There is also some <i>Peridium esculentum</i> individuals in the basin.	Terrestrial: A woodland of <i>B. attenuata</i> , <i>B. ilicifolia</i> & <i>B. menziesii</i> , with a shrubland understorey of <i>Adenanthos</i> sp., <i>Asteria</i> sp., <i>Eremaea</i> sp., <i>Hibbertia</i> sp. & <i>Xanthorrhoea</i> sp. Wetland: The perimeter of the dampland is woodland of <i>M. preissiana</i> , <i>B. attenuata</i> , <i>B. ilicifolia</i> , <i>B. menziesii</i> & <i>Nyssia</i> sp. With a closed tall scrub in the basin, consisting primarily of <i>Kunzea</i> sp., with occasional <i>Acacia</i> sp. and sedge species.	Some of the up-slope <i>M. preissiana</i> are in poor condition, however, others are in excellent condition, as is the shrubland and the terrestrial vegetation.
	Dampland (38030652677)	Category = 2 Large dampland dominated by terrestrial vegetation over much of its area. Wetland species dominate in the lowest area in the north-east.	Terrestrial: Woodland of <i>E. toffiana</i> , <i>B. menziesii</i> & <i>B. attenuata</i> . Understorey a shrubland of <i>E. paniculata</i> , <i>Adenanthos</i> sp., <i>R. ciliata</i> & <i>Xanthorrhoea</i> sp. Wetland: woodland of <i>M. preissiana</i> , <i>B. ilicifolia</i> & <i>B. attenuata</i> with a <i>Beaufortia</i> sp., <i>Adenanthos</i> sp. & <i>Lomandra</i> sp. shrubland. Lower areas are dominated by a <i>E. rudis</i> , <i>M. preissiana</i> & <i>B. ilicifolia</i> woodland with a tall open scrub of <i>Beaufortia</i> sp. & <i>Kunzea ericifolia</i> .	South: Some dead and stressed <i>B. ilicifolia</i> , otherwise vegetation in excellent condition. West: Roughly 50% of <i>E. rudis</i> very stressed. Some recently dead. Myrtaceous scrub shows signs of drought stress. North West: Melaleuca stags amongst healthy individuals. Some stressed <i>E. rudis</i> . Some recently dead <i>Banksia</i> spp. and large patches of dead Myrtaceous scrub. Obvious signs of drought stress in overstorey and understorey along west side.
	Dampland (38090652550)	Category = 1 The dampland is in excellent condition, it is large/medium sized and is in a large nature reserve. The dampland has a road through the southern tip, however, the road appears to pose no direct significant threat.	Terrestrial: A woodland of <i>B. attenuata</i> , <i>B. ilicifolia</i> & <i>B. menziesii</i> , with a shrubland understorey of <i>Adenanthos</i> sp., <i>Asteria</i> sp., <i>Eremaea</i> sp., <i>Hibbertia</i> sp. & <i>Xanthorrhoea</i> sp. Wetland: A woodland to open forest overstorey of <i>E. rudis</i> , <i>M. preissiana</i> , <i>B. littoralis</i> & <i>Nyssia</i> sp. With a tall open scrub of <i>Adenanthos</i> sp., <i>Beaufortia</i> sp., <i>Thysoctymma</i> sp., <i>Kunzea</i> sp. & <i>Xanthorrhoea</i> sp.	The <i>B. littoralis</i> , <i>M. preissiana</i> & <i>E. rudis</i> on the higher ground, are all in excellent to pristine condition. However, the <i>E. rudis</i> and <i>M. preissiana</i> on the lower ground are very stressed, with the occasional <i>M. preissiana</i> stag.
	Dampland (38024652205)	Category = 2 The dampland is steep-sided, with a rapid and distinct transition between terrestrial and wetland vegetation, with some very large <i>M. preissiana</i> present.	Terrestrial: Woodland dominated by <i>B. attenuata</i> , <i>B. menziesii</i> & <i>E. toffiana</i> , with a shrubland dominated by <i>Acacia</i> sp., <i>Beaufortia</i> sp., <i>E. paniculata</i> , <i>K. ericifolia</i> , <i>Scholtzia</i> sp. & <i>Xanthorrhoea</i> sp. Wetland: Basin, woodland dominated by <i>E. rudis</i> & <i>M. preissiana</i> , with a tall open scrub dominated by <i>Asteria</i> sp. and <i>Kunzea</i> sp. Transition vegetation, a woodland dominated by <i>B. attenuata</i> , <i>B. menziesii</i> , <i>E. rudis</i> & <i>M. preissiana</i> . With an open heath dominated by <i>Asteria</i> sp., <i>Kunzea</i> sp., <i>Macrocramia</i> sp. & <i>Xanthorrhoea</i> sp.	The majority of the <i>E. rudis</i> appear stressed, with numerous dead <i>E. rudis</i> stems on the basin, however some <i>E. rudis</i> plants are in excellent condition, in particular the more mature individuals. The <i>M. preissiana</i> trees are in excellent condition. There is some <i>E. rudis</i> and <i>M. preissiana</i> saplings around the edge of the basin.
	Dampland (38026652641)	Category = 1 No description given.	Terrestrial: A woodland of <i>B. attenuata</i> , <i>B. ilicifolia</i> & <i>B. menziesii</i> , with a shrubland of <i>Adenanthos</i> sp., <i>Eremaea</i> sp., <i>Leucopogon</i> sp., <i>Scholtzia</i> sp., <i>Verticordia</i> sp. & <i>Xanthorrhoea</i> sp. Wetland: A woodland of <i>B. littoralis</i> , <i>M. preissiana</i> & <i>N. floribunda</i> , with a shrubland of <i>Beaufortia</i> sp., <i>Asteria</i> sp. & <i>Pericalymma</i> sp., with a closed tall scrub of <i>Kunzea</i> sp. and a sedge species in the centre of the dampland.	The vegetation is in excellent condition, with <i>M. preissiana</i> saplings.
	Dampland (38033652611)	Category = 2 Some terrestrial plant species appear to be invading the dampland.	Terrestrial: A woodland of <i>B. attenuata</i> , <i>B. ilicifolia</i> & <i>B. menziesii</i> , with a shrubland understorey of <i>Adenanthos</i> sp., <i>Eremaea</i> sp., <i>Leucopogon</i> sp., <i>Scholtzia</i> sp., <i>Verticordia</i> sp. & <i>Xanthorrhoea</i> sp. Wetland: A woodland of <i>B. ilicifolia</i> & <i>M. preissiana</i> , with a shrubland to tall open scrub of <i>Adenanthos</i> sp., <i>Beaufortia</i> sp., <i>Thysoctymma</i> sp. & <i>Pericalymma</i> sp.	The condition of the terrestrial vegetation is excellent. The <i>M. preissiana</i> population is senescent but living.
	Dampland (38056652738)	Category = 1 Small dampland in a shallow swale just west of the large Dampland 20. The wetland slopes down to a linear area of wetland vegetation on a loam soil with healthy mature trees and saplings / seedlings.	Terrestrial: Woodland of <i>E. toffiana</i> , <i>B. menziesii</i> & <i>B. attenuata</i> . Understorey a shrubland of <i>E. paniculata</i> , <i>Adenanthos</i> sp., <i>R. ciliata</i> & <i>Xanthorrhoea</i> sp. Wetland: Woodland of <i>E. rudis</i> , <i>M. preissiana</i> , <i>B. ilicifolia</i> & <i>B. attenuata</i> over an open scrub of <i>Beaufortia</i> sp. & <i>Adenanthos</i> sp. Lower zone supports a low open forest of <i>E. rudis</i> & <i>M. preissiana</i> with a shrubland of <i>Asteria</i> sp. & <i>P. ellipticum</i> .	<i>E. rudis</i> in excellent condition with numerous saplings in the lowest areas. <i>M. preissiana</i> generally good with some scattered stags in the upper perimeter and occasional dead <i>Banksia</i> spp. Understorey excellent.
	Dampland (38046652635)	Category = 1 No description given.	Terrestrial: A woodland of <i>B. attenuata</i> , <i>B. ilicifolia</i> & <i>B. menziesii</i> , with a shrubland of <i>Adenanthos</i> sp., <i>Eremaea</i> sp., <i>Leucopogon</i> sp., <i>Scholtzia</i> sp., <i>Verticordia</i> sp. & <i>Xanthorrhoea</i> sp. Wetland: An open forest of <i>M. preissiana</i> , with a tall closed scrub of only <i>Kunzea</i> sp., surrounded by a	The vegetation is in an excellent condition.

Map Number	Wetland Type & ID Number / Name	Conservation Category & Overall Condition	Vegetation Type / Community	Vegetation Condition
			Woodland of <i>B. attenuata</i> and <i>B. ilicifolia</i> , with a shrubland of <i>Adenanthos</i> sp., <i>Kunzea</i> sp. and <i>Pericalymna</i> sp.	
	Dampland (38058652554)	Category = 1 The dampland is generally in excellent condition. The dampland is located in a nature reserve close to other damplands. There is a road through part of the dampland.	Wetland: An open woodland overstorey of <i>N. floribunda</i> , <i>B. ilicifolia</i> , <i>B. littoralis</i> , <i>B. menziesii</i> , and <i>E. indiana</i> . With a closed tall scrub understorey of <i>Adenanthos</i> sp., <i>Kunzea</i> sp., <i>Beaufortia</i> sp. and <i>Scholtzia</i> sp.	The condition of the vegetation is generally excellent to pristine, there is scattered dead <i>B. attenuata</i> and some <i>M. preissiana</i> are senescent but otherwise appear healthy.
	Dampland (38083652724)	Category = 2 Large dampland joined to northern end of dampland 20. Large flat basin with mixed terrestrial / wetland species.	Terrestrial: Woodland of <i>E. indiana</i> , <i>B. menziesii</i> & <i>B. attenuata</i> . Understorey is shrubland of <i>E. pauciflora</i> , <i>Adenanthos</i> sp., <i>R. ciliata</i> & <i>Xanthorrhoea</i> sp. Wetland: Woodland of <i>E. rudis</i> , <i>M. preissiana</i> , <i>N. floribunda</i> , <i>B. ilicifolia</i> , <i>B. attenuata</i> & <i>B. menziesii</i> over a shrubland to tall open scrub of <i>Xanthorrhoea</i> sp., <i>Kunzea cristifolia</i> , <i>Beaufortia</i> sp. & <i>Adenanthos</i> sp.	Some localised patches of dead scrub with occasional dead and stressed <i>M. preissiana</i> and <i>Banksia</i> spp. A few <i>E. rudis</i> and <i>M. preissiana</i> seedlings can be found in the central area.
	Dampland (38078652433)	Large areas of transition vegetation, which consists of the terrestrial vegetation plus stands of <i>Melaleuca preissiana</i> and shrublands of <i>Kunzea</i> sp. Areas of peaty soil in basin, with <i>Melaleuca preissiana</i> seedlings and saplings.	Terrestrial: A woodland of <i>B. attenuata</i> and <i>B. menziesii</i> , with an open heath of <i>Adenanthos</i> sp., <i>M. trichophylla</i> , <i>Pteropyle</i> sp., <i>R. ciliata</i> sp., <i>Verticordia</i> sp. and <i>Xanthorrhoea</i> sp. Wetland: Basin, closed forest of <i>M. preissiana</i> , with a tall open scrub of <i>Kunzea</i> sp., and a very open sclerophyll. An open forest of <i>E. rudis</i> and <i>M. preissiana</i> , with a open heath of <i>Kunzea</i> sp. Shrubland of <i>Beaufortia</i> sp. & <i>Pericalymna</i> sp., with <i>Lepidosperma</i> sp.	The condition of the vegetation is excellent, with some <i>Banksia</i> and <i>M. preissiana</i> deaths, and localised areas of dead <i>Myrtaceae</i> scrub.
	Dampland (38090652633)	Category = 2 The dampland appears to be becoming invaded with terrestrial plant species.	Terrestrial: Woodland dominated by <i>B. attenuata</i> , <i>B. ilicifolia</i> & <i>B. menziesii</i> , with a shrubland understorey dominated by <i>Adenanthos</i> sp., <i>Eremica</i> sp., <i>Lycopogon</i> sp., <i>Verticordia</i> sp. & <i>Xanthorrhoea</i> sp. Wetland: Woodland to open woodland dominated by <i>B. ilicifolia</i> , <i>M. preissiana</i> & <i>N. floribunda</i> , with a tall open scrub dominated by <i>Adenanthos</i> sp., <i>Beaufortia</i> sp., <i>Asterica</i> sp. & <i>Pericalymna</i> sp., with occasional <i>Dasyopogon</i> sp. & <i>Hypolaena</i> sp.	Significant death of the <i>Myrtaceae</i> shrubs, some tree stags, decreased density in both the overstorey and the understorey, with a general terrestrial trend in area, and a variety of size classes in the <i>M. preissiana</i> .
	Dampland (38082652192)	Category = 1 A peaty soil found in the basin of the dampland supports an open forest of <i>B. littoralis</i> and <i>M. preissiana</i> . There has previously been a fire, which has had a large impact on the vegetation of the dampland, however the vegetation, particularly the <i>M. preissiana</i> are regenerating.	Terrestrial: A woodland of <i>B. attenuata</i> , <i>B. menziesii</i> , <i>E. rudis</i> & <i>E. indiana</i> , with an open heath of <i>Eremica</i> sp., <i>Regelia</i> sp., <i>Scholtzia</i> sp., <i>Verticordia</i> sp. and <i>Xanthorrhoea</i> sp. Wetland: Basin, an open forest of <i>M. preissiana</i> and <i>B. littoralis</i> , with a shrubland of <i>Beaufortia</i> sp., <i>Kunzea</i> sp. and <i>Pericalymna</i> sp. with <i>Lepidosperma</i> sp. Transition vegetation, a woodland overstorey of <i>B. attenuata</i> , <i>B. ilicifolia</i> , <i>B. menziesii</i> , <i>E. rudis</i> , <i>M. preissiana</i> , and <i>N. floribunda</i> , with a shrubland of <i>Adenanthos</i> sp., <i>Asterica</i> sp., <i>Beaufortia</i> sp., <i>Kunzea</i> sp. and <i>Pericalymna</i> sp. with <i>Lepidosperma</i> sp.	The <i>M. preissiana</i> open forest is regenerating from a previous fire, but are otherwise in excellent condition. The <i>E. rudis</i> is notably in excellent condition, and there are scattered dead <i>Banksia</i> spp. up-slope.
	Dampland (38088652250)	Category = 1 The dampland is located in a large nature reserve close to a road. It shows virtually no signs of disturbance from surrounding land uses and is in an excellent condition.	Wetland: A low open forest of <i>M. preissiana</i> & <i>B. attenuata</i> , with shrubland understorey of <i>Regelia</i> sp., <i>Beaufortia</i> sp., <i>Xanthorrhoea</i> sp., <i>V. nitens</i> , <i>Calyx</i> sp., <i>Asterica</i> sp. & a diversity of <i>Myrtaceae</i> shrubs with clumps of <i>Dasyopogon</i> .	The condition of the vegetation is excellent to pristine.
	Dampland (38097652471)	Category = 2 The dampland is generally in excellent condition, however there is a road through the middle of it. The dampland is located in a large area of reserve and so has a considerable buffer from most land-uses, except for the road through it and the small pine plantation near by.	Terrestrial: A woodland of <i>B. attenuata</i> and <i>B. menziesii</i> , with occasional <i>M. preissiana</i> . With a shrubland understorey of <i>Xanthorrhoea</i> sp., <i>Myrtaceae</i> shrub sp., <i>Kunzea</i> sp., <i>M. trichophylla</i> & <i>Adenanthos</i> sp. Wetland: A woodland of <i>M. preissiana</i> , with closed tall scrub of <i>Kunzea</i> sp. & <i>Beaufortia</i> sp.	The vegetation is generally in excellent condition, with minor localised drought stress in the <i>Kunzea</i> and <i>M. preissiana</i> .
2035 III NF	Tanglefoot Swamp (37607652972)	Category = 1 Pristine wetland in extensive reserve of undisturbed vegetation.	Terrestrial: Woodland to open woodland of <i>E. indiana</i> , <i>B. attenuata</i> , <i>B. ilicifolia</i> & <i>B. menziesii</i> . Understorey is dominated by <i>Hibbertia</i> sp., <i>Xanthorrhoea</i> sp., <i>Calothamum</i> sp., <i>Stylidium latifolia</i> , <i>Asterina</i> sp. & <i>Cyperaceae</i> spp. Wetland: Species rich community with a mixture of terrestrial and wetland plants. Overstorey consists of a woodland of <i>M. preissiana</i> & <i>E. rudis</i> with <i>B. attenuata</i> , <i>B. menziesii</i> & <i>B. ilicifolia</i> . Diverse understorey is a tall shrubland of <i>Kunzea</i> sp. & <i>Adenanthos</i> sp. to an open heath of <i>M. trichophylla</i> , <i>Beaufortia</i> sp., <i>Lycopogon</i> sp., <i>Lepidosperma</i> sp., <i>Asterica</i> sp., with <i>Conostylis</i> sp., <i>Xanthorrhoea</i> sp., <i>Pteropyle</i> sp. & <i>Hibbertia</i> spp. on the fringe.	Some isolated dead <i>Banksia</i> occurs on the fringe of the wetland. Otherwise, vegetation is in pristine condition.
	Dampland (37797652988)	Category = 2 No description given.	Terrestrial: Woodland dominated by <i>B. attenuata</i> , <i>B. menziesii</i> , <i>E. indiana</i> & <i>N. floribunda</i> . With a shrubland understorey dominated by <i>Adenanthos</i> sp., <i>Eremica</i> sp., <i>Lycopogon</i> sp., <i>Macrorhynchus</i> sp., <i>C. sanguinea</i> , <i>Regelia</i> sp., <i>V. nitens</i> , & <i>Xanthorrhoea</i> sp. Wetland: A <i>M. preissiana</i> woodland, with a closed heath dominated by <i>B. elegans</i> , <i>Asterica</i> sp. & <i>Hypocalymna</i> sp.	There is evidence of a previous fire; some <i>M. preissiana</i> trees are stressed, but otherwise the vegetation is in excellent condition.
	Dampland	Category = 2	Terrestrial: Woodland dominated by <i>B. attenuata</i> , <i>B. menziesii</i> , <i>E. indiana</i> & <i>N. floribunda</i> . With a	The vegetation is generally in excellent condition; the

Map Number	Wetland Type & ID Number / Name	Conservation Category & Overall Condition	Vegetation Type / Community	Vegetation Condition
	(37852653007)	<i>E. rudis</i> & <i>M. raphiophylla</i> seedlings and saplings are present on the edge of the basin.	Shrubland understorey dominated by <i>Adiantum</i> sp., <i>Eremaea</i> sp., <i>Leucopogon</i> sp., <i>Macrocramia</i> sp., <i>C. sanguineus</i> , <i>Regelia</i> sp., <i>V. nitens</i> , & <i>Xanthorrhoea</i> sp. Wetland: On the upper slope of the wetland, there is a perimeter woodland of <i>B. ilicifolia</i> , <i>B. menziesii</i> , <i>E. rudis</i> & <i>M. preissiana</i> . With an understorey that is essentially completely cleared, with the exception of some <i>Asterca</i> sp. and <i>Hypocalymma</i> sp. Between the basin and the upper slope of the wetland, perimeter woodland of <i>B. littoralis</i> , <i>M. raphiophylla</i> & <i>M. viminea</i> ; in the eastern part is a low open forest of <i>M. verticillata</i> . The basin is largely bare due to the seasonal water that is held, with the exception of clusters of <i>Baumea articulata</i> .	overstorey is in excellent condition; however, the <i>Baumea articulata</i> has recently died.
	Dampland (37879652973)	Category = 2 The wetland is in excellent condition.	Terrestrial Woodland dominated by <i>B. attenuata</i> , <i>B. menziesii</i> , <i>E. nodiflora</i> & <i>N. floribunda</i> . With a shrubland understorey dominated by <i>Adiantum</i> sp., <i>Eremaea</i> sp., <i>Leucopogon</i> sp., <i>Macrocramia</i> sp., <i>C. sanguineus</i> , <i>Regelia</i> sp., <i>V. nitens</i> , & <i>Xanthorrhoea</i> sp. Wetland: Up-slope: a low open forest of <i>Alphacarrina</i> sp., <i>B. littoralis</i> , <i>D. menziesii</i> & <i>M. preissiana</i> , with a shrubland understorey dominated by <i>Asterca</i> sp., <i>Adiantum</i> sp., <i>Beaufortia</i> sp. & <i>Hypocalymma</i> sp. Basin: a low closed forest of <i>M. viminea</i> , with an open shrubland dominated by <i>Asterca</i> sp., <i>M. verticillata</i> & <i>Baumea</i> sp.	The condition of the vegetation is excellent; the trees are in pristine condition; however, the <i>Baumea</i> sp. appears to be very drought stressed.
2035 II NW	Deepwater Lagoon (38881652828)	Category = 3 This site is extremely degraded, being paddock with some remnant stands of <i>Melaleuca</i> sp. on the perimeter of the lake, however surface water is present.	Not applicable as the area is a pastoral paddock.	Not applicable as the area is a pastoral paddock.