<u>*Wetland Conservation in the North Stirling Basin, South Coast region of WA.*</u>

Management Recommendations for the Balicup Group of Wetlands

A report produced by Green Skills for the
WA Department of Environment
& the Australian Government's Natural Heritage Trust

by Wetlands Project Officer, Kevin Hopkinson

January 2005

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This project was supported by the Australian Government's Natural Heritage Trust and the WA Department of Environment

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Field work, photography and report compilation by Kevin Hopkinson.

Do you have any comments or feedback you would like to give?

This report is intended to generate community discussion as to the most practical and effective management practices that can be incorporated into the catchment planning activities of the North Stirling Basin Catchment area.

If you have any comments on the recommendations provided in this report, we would like to hear from you. Comments can be directed to:

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1.0 Summary and Project Background

During 1998, the Water and Rivers Commission (now Dept of Environment-DoE) initiated a regional survey and evaluation of wetlands of the South Coast Region. The survey was conducted by the V & C Semenuik Research Group and a final report was released in March, 1999.

The objectives of the report were to:
- Identify wetland regions
- Classify wetlands into consanguineous suites
  (wetlands related to others by similar natural features)
- Identify wetlands of significance
- Identify significant wetlands which are at risk.

(Semenuik, 1999)

The regional survey and evaluation of wetlands is part of a broader wetland conservation project being undertaken by the DoE and community group Green Skills. This project is a partnership program that has funded 12 wetland management plan projects since 1999. These are detailed below:

Wetland Suite	Location	Year Completed
Manypeaks/Pabelup	Bremer Bay	1999
Corimup	Manypeaks	2000
Mortijinup lakes	Esperance	2000
Mills Lake	Ongerup	2001
Coobidge Creek/Lake gore	Esperance	2001
Coomalbidgup swamp	Esperance	2002
Unicup	Upper Kent River catchment	2002
Moates/Gardner lakes	Two Peoples Bay	2003
Roberts Swamp	Grass Patch, Nth Esperance	2003
Boyatup swamp	Cape Le Grand, Esperance	2004
Balicup	North Stirlings	2005

NHT funding has been secured to provide limited on ground support for wetland fencing, revegetation and strategic earthworks. The project also includes a regional wetland monitoring program and an education component aimed at raising community awareness of the values and threats to South Coast wetlands.

The aim of the project is to focus on catchment areas within suites of significant or outstanding wetlands that have been identified in the survey by Semenuik (1999), and assisting those communities to develop and implement wetland management plans into existing catchment activities.

The North Stirling basin was targeted due to the large number of significant wetlands in the catchment. Many of the wetlands of the area have been identified as being threatened or at risk and are locally, regionally and nationally outstanding.

In addition, the area has been the focus of significant research and on ground works in recent years, including a groundwater study and land reclamation study (Lewis, MF 1992) and a bush corridor plan (Mercer 1995). More recently, part of the area was included in a rapid catchment appraisal to determine risk areas and describe management actions (Dept of Agriculture, 2001).

The local community is therefore already actively involved in catchment planning and management and this presents an excellent opportunity to work with the community to incorporate wetland management into farm and catchment planning activities.

This report documents some of the many significant wetlands of the project area, provides a brief assessment of each site, and includes management recommendations for wetlands considered to be a high priority for management.

2.0 Introduction

The study area for this report is in he North Stirling basin, located to the east of the town of Cranbrook and lies within the Shires of Tambellup, Gnowangerup and Cranbrook. The area surveyed covers the zone classified as the basin floor (Lewis 1992) and contains the large chain of wetlands that lie between the Stirling Range national Park to the south, the Great Southern Highway to the west, and the Camel Lake nature reserve to the east. (Figure 1). The Basin floor area surveyed covers an area of approximately 37,500 ha.

Climate
The area experiences a moderate Mediterranean climate with cool moist winters and hot dry summers. Annual rainfall ranges from 450mm in the lower catchment to 400mm in the north. Annual pan evaporation is 1500mm, which exceeds rainfall from September through to April.

Land Use

Land use ranges from sheep grazing and broadacre cropping to smaller ventures in aquaculture and farm forestry.

The surrounding hills and land adjacent to the railway between Tambellup and Cranbrook has been cleared and farmed since the early 1900's, however most of the study area within the basin floor was not cleared until the 1960's.

Despite this recent clearing, problems from salinity and waterlogging became apparent very quickly, due to the shallow depths to regional groundwater and impermeable sediments of the basin floor.

Report Focus-The Balicup wetlands
The North Stirlings area contains a large group of wetlands that share a range of similar characteristics and attributes. Some of these wetlands are contained within substantial nature reserves and have been recognised as being nationally significant, being listed as the Balicup Lake System in the National Directory of Important Wetlands in Australia (ANCA 1996).

In addition, these wetlands were identified as being regionally significant in the regional evaluation of wetlands of the South Coast region. This evaluation classified the group as the Balicup suite of wetlands, following the listing in the ANCA Directory (Semenuik 1999).

The Balicup suite contains a range of wetlands that occur in both nature reserves and on privately owned property. The nature reserves include the major lakes Balicup, Camel, and Jebarjup.

The wetlands in these reserves have been identified as being important habitat for a large number of waterbirds, particularly those listed on international treaties. This includes the Banded Stilt, and endemic Australian shorebird of international significance (Semenuik 1999).

Management of the wetlands in this area on both privately owned land and in shire reserves will depend upon a number of criteria including:

- Protection of wetlands and waterways on private property through fencing, exclusion of stock and control of feral animals.
- Rehabilitation of degraded sites through revegetation with native species.
- Implementation of catchment activities that will protect the hydrology of the wetlands ie perennial pastures and surface drainage.

3.0 The Wetlands of the Balicup suite

The North Stirling basin is made up of several zones according to landform. These zones, as described by Lewis (1992) are :

Zone 1: The Stirling Range
Zone 2: The Range Foothills
Zone 3: The Northern Slopes
Zone 4: The Basin Floor.

The basin floor extends 45km east-west and 10km north-south, and is made up from a range of sediments resulting from wind, water and gravity forced deposition. The sediments covering the floor appear to have filled a trough in the underlaying bedrock, and it is believed the area may have once drained to the east and west then south around the Stirling Ranges, before the uplifting of the coastal ramp changed the surface gradients (Laws 1986).

The resulting topography is an extremely flat landscape with poorly defined drainage, and little relief, except for dunal highs associated with sand dunes that fringe the many wetlands found across the basin floor. 1:50000 topographical maps show more than 430 lakes in this area (Lewis, 1992).

For the purposes of this study, the basin floor has been separated into a number of wetland areas (Figure 1& Appendix 2) running in a corridor east-west. The largest lakes are found in the central-western group, that begin from Balicup lake in the east and extend north west to Munrillup lake near the Great Southern Highway.

To the west of this group, at the western boundary of the study area, is a chain of smaller wetlands that trend in a more south westerly direction. It is believed these wetlands were once part of an ancient flood plain meander in the nearby Gordon River. Drainage in this area in extremely wet years confirm this as most surface flows trend in a westerly direction toward the river (Miller, pers comm).

To the east of Balicup lake is a small cluster of basins dominated by the Jebarjup lakes to the south. These wetlands are associated with some of the larger blocks of remnant vegetation in the basin floor, and are important areas of intact wetland and fringing vegetation habitat.

West of this group is one of the few east-west trending drainage lines in the basin floor. Arising from the Stirling Range to the south, the waterway flows north then breaks away from the eastern edge of the Jebarjup Nature Reserve, and flows easterly toward the Camel lake nature reserve. To the north of this waterway is a number of smaller wetlands that are part of the catchment for the creek, however these only link up and connect to the waterway in very wet years.

Camel lake Nature reserve is the largest area of remnant vegetation in the basin floor and contains two large wetlands, and several smaller basins. This group marks the eastern most extent of the study area, to the north and east of here the drainage becomes more defined towards the incised valleys of the 6-mile creek and Pallinup river catchment.

The northern corner of the eastern zone contains three main wetland basins, including the highly valued Anderson Lake. These lakes all have better defined surface catchments draining from the west, and together with the wetlands in the north of the western zone, are characteristic of wetlands in the transitional state from well incised waterway to shallow internally drained basin.

3.0 The Wetlands of the Balicup suite (cont')

Most of the wetlands within each wetland group are detailed in table 1. During this survey select wetlands were targeted for more detailed study with brief field assessments completed. Salinity and pH levels of these wetlands have been recorded as part of the field assessment, and the salt concentrations are recorded as electrical conductivity (EC) in ms/m (milli siemens per metre). Refer to Appendix 4 for conversions to actual salt concentrations (part per million, grains per gallon).

Comments regarding wetland and fringing vegetation condition, corridors/connectivity, drainage, and fencing are included which help guide the final assignment of ecological condition and priority for management.

Figure 1 – Wetland Zones of the North Stirling basin

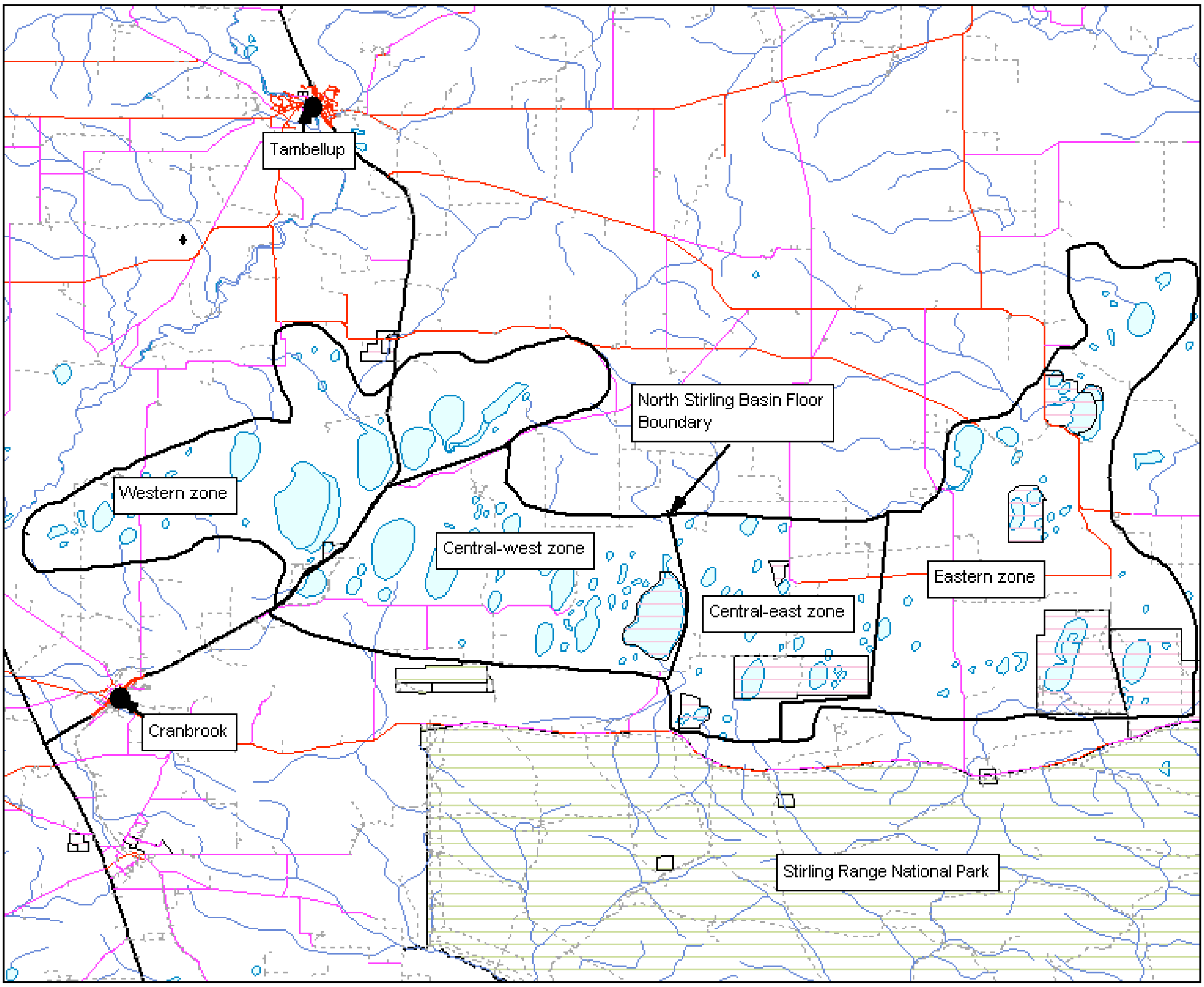

Table 1 – Wetlands of the Balicup suite within the North Stirling Basin Floor								
Region	Loc No.	Wetland Name	Fringing Vegetation	Salinity EC ms/m	pH	Comments	Cons. priority	Man. priorty
Western	3984, 201, 2, 3460,	Boorocup lakes	Poor	-	-	Not visited, aerial photography examined, fringing vegetation appears degraded, with the except for eastern fringe of Boorocup lakes.	L	M
	3005	Wareenip lakes	Excellent	-	-	Saline basins surrounded by large stand of fenced remnant vegetation. Fringes in excellent condition.	H	L
	3005	Wareenip SW	Poor	14600	8.4	Unfenced saline basin, holding water from part of drain network.	L	L
	3005	Wareenip SE	Poor-moderate	3290	10	Unfenced small basin, surface drains feed fresh water into this basin to keep salinity levels lower. Ruppia growth present, many waterbirds (swans etc).	M	M
	3779	Wareenip N	Good	-	-	Not visited, numerous small basins within small block of remnant vegetation, appears to be in good condition.	M	M
	3337	Salt lake	Poor	-	-	Numerous basins, including large salt lake, with little fringing veg intact. Part of extensive drainage network, preventing waterlogging of flats and maintaining water levels in lakes over spring.	L	L
	3337	Milyunup lake	Poor-Moderate	-	-	Large salt lake, much of western fringe narrow, some sedges and veg on eastern dune.	M	M
	1086	Racecourse lake	Moderate	-	-	Medium basin that receives inflow from Tingarup creek catchment to the north, a well vegetated watercourse that forms an important corridor linking with the reasonable but thin band of vegetation surrounding this lake. A priority 2 species of plant, *Melaleuca pritzelii* occurs on this creekline.	M	M
	1253/63 /901	Res 45662	Good	-	-	Not visited, this lake appears to have a broad band of fringing vegetation, particularly the eastern and western sides.	M	M
	1253/63 /901	Res 11778	Moderate	-	-	Not visited, appears to have a less substantial buffer of fringing vegetation than nearby 45662, however this wetland is fed by Yate creek that drains a large area of the Toolbronup catchment to the NW, where extensive drain projects have been undertaken.	L	L
	473	Tom South lake	Poor	-	-	Not visited, site appears degraded with little fringing vegetation.	L	L
	1651	SE Munrillup	Poor-Moderate	_	_	Several small sumplands. Some remnant vegetation protected plus rehabilitation plantings established.	M	L
	1651	Munrillup	Good	-	-	Large salt lake, protected fringes, healthy sedgelands and fringing paperbarks, particularly to the south. Fed by overflow/bypass drain from drainage system from the south.	M	L

Central-western	1013	South Munrillup	Moderate	2630ms/m	9.3	Small basin receiving surface drain flow, salinity moderate, high water levels and good *Ruppia* growth, with many waterbirds. Site has had extensive fringing plantings, good example of protected and part rehabilitated wetland	H	M
	1013	West Munrillup	Good	-	-	Large salt lake, not visited, but part of drained catchment. Protected with reasonable fringing vegetation	M	L
	1/3309	Fares north lakes	Poor	-	-	Cluster of small basins running north-south, little fringing vegetation.	L	L
	1/27810	Fares yate swamp	Poor	Dry	Dry	Rare yate swamp, in poor condition with most trees in decline, has a surface drain linking into this lake with overflow to the salt lake to the south.	L	L
	1/27810	North Horse shoe Lake	Poor	19600ms/m	8.2	Small salt basin, narrow band of fringing vegetation.	L	L
	1/27810	Horse shoe lake	Poor	-	-	Mid sized salt basin, little fringing veg.	L	L
	1/27810	SE Horse shoe lakes	Poor-moderate	-	-	Several small basins with small clumps of remnant vegetation.	L	L
	4353	Fares pink lake	Good-Excellent	24400ms/m	7.4	Mid size salt basin, excellent stand of vegetation, except for small section NW boundary. Fenced and well protected.	H	L
	3449	Res 31518	Poor-Good	-	-	Large salt lake, west boundary narrow but good fringing vegetation buffers the rest of the lake.	M	M
	3449	UCL	Poor	-	-	Mid size salt lake, appears to have little fringing vegetation.	L	L
	5000 5040	SE 31518 lakes	Poor-moderate	-	-	Cluster of small N-S trending salt lakes, only narrow bands of fringing vegetation.	L	L
	4353	Fares yate swamp-2	Moderate	6900ms/m	9.5	Small yate fringed paperbark swamp, degraded basin with dead trees, but some healthy yates in narrow band around fringe, with broader fringe to north of lake.	M	M
Central-western	4353	UCL 4353	Moderate-Good	-	-	mid size salt lake, reasonable fringing veg, particularly on eastern side, linking across to UCL 5040.	M	H
	5050	UCL 5040	Moderate-Good	-	-	Large salt lake, some patchy fringing veg on eastern dune side, however possible link to nearby UCL 4353 to west.	M	H
	5040 4385	Fares eastern swamps	Poor-Moderate	-	-	Series of small basins running alongside eastern boundary of UCL 5040.	M	M
	4523	Fares southern swamps	Moderate	-	-	Group of small basins below SW corner of Balicup Lake, fringing veg narrow but intact.	M	M
	7156	Balicup Lake	Moderate-Excellent	-	-	Large salt lake in nature reserve, poorly vegetated along western boundary, however fringe to north and south in excellent condition, including broad samphire flats and fringing upland buffer.	H	H

Central-Eastern	4386 10657	Balicup north lakes	Excellent	16770 -	8 -	Small salt lakes adjoining nature reserve.	H	L
	4587	North east Balicup lake	Excellent	22600	7.7	Mid size salt lake, adjoining nature reserve, fringing vegetation well intact. End point for local drainage system	H	L
	1/20727 3928	North Balicup	Good	23700	7.5	Mid size basin, receival point for small surface drain, good fringing vegetation.	M	M
	3928	House swamp	Moderate-Good	-	-	Some fringing veg degraded, this wetland receives drainage from broad well vegetated flat to the north.	M	M
	3870 3928	Hams Yate swamp	Excellent-Good	15000	7.5	Large paperbark fringed saline basin contained within protected 260ha remnant block. The basin is the end point of several small drainage lines, including a deep drain from the adjoining property to the north. Appears to be fresh when last full.	H	H
	3928 4587	Hams mid swamps	Good	23500 (eastern lake)	8.1	Two saline basins with well vegetated buffers, linked with a wedge of corridor vegetation.	M	M
	6699 4343	Beejenup Lake	Excellent	-	-	Small basin contained within block of veg adjoining nature reserve, need to check alignment of NR to ensure contains lake. Part of lake extends into privately owned land.	H	M
Central-Eastern	4343	Eastern Balicup group of lakes	Good-excellent	19310-23800	7.2-7.9	Series of small-medium salt lakes, most with good fringing vegetation. Small drains present, potential for further surface drainage. 3 tiny basins degraded, paperbark swamps with little remaining veg intact. Potential to create corridor to connect Hams lakes through Squibb to Jebarjup Lakes.	M	M
	4448	North Jebarjup lakes	Poor-moderate	19300-22800	8-8.3	Numerous small-mid size salt lakes on one location, most have surface drains feeding into the basins. NW corner of location has several small paperbark wetlands, however emergent veg is long in decline from waterlogging/salinity.	L	M
	6570	West Jebarjup lakes	Poor	-	-	Several small wetlands, little intact fringing vegetation. Part of surface drainage project.	L	L
	6697	Salt lakes	Moderate-Excellent	-	-	Salt lake nature reserve. Largest lake shares boundary to east with private farm, little veg on this fringe. Other sections plus 2 smaller wetlands well protected.	H	M

Central-Eastern	6698	Jebarjup Nature reserve -Jebarjup swan lake -Jebarjup lake -Eastern fringe lakes.	Excellent	20200 5250 fringe pool - -	8.1 9.7 - -	2 large salt lakes and group of smaller wetlands to within large pristine nature reserve. Sample taken from larger Jebarjup Swan lake in west of reserve. This lake has several shorelines from past high water events, and includes an area of separate wetland pools fringing the northern part of the lake. This pool teeming with macroinvertebrates and healthy *Ruppia*.	H	L
Eastern	4449	East Jebarjup lakes	Moderate-Good	- 22200	- 7	Several mid-small salt lakes, with some good fringing vegetation, mostly fenced and some rehabilitation plantings undertaken on fringes.	M	M
	4/62691	North eastern swamp 1	Moderate-Good	-	-	Not visited, appears to have substantial fringe of veg surrounding mid size saline basin. May be part of catchment feeding the adjoining wetland to the south.	M	M
	3/62691	North eastern swamp 2	Moderate-Good	-	-	As above, waterway flowing in appears to have enhanced drainage in channel.	M	M
	7342	Anderson Lake	Excellent	-	-	Large salt lake and smaller basin contained within large nature reserve, this catchment has been focus catchment and had extensive drainage planned.	H	M
	7485	Cheepanup Lake	Moderate-Good	-	-	Not visited, this named wetland is a large salt lake with reasonable fringing vegetation, except for the western boundary which appears sparse, inflow creek may be major management issue.	M	M
	4657	Three swamps Nature reserve	Good-Excellent	-	-	Group of small to mid size salt lakes, contained within small nature reserve.	H	M
	6083	East Three swamps	Moderate-Good	-	-	Group of small salt lakes, extension of Three swamps group into private property to east.	M	M
	1/24200	West Camel lakes	Moderate-Good	-	-	7 small to mid sized wetlands, 3 are contained within substantial blocks of fringing vegetation. Much of the remaining catchments are planted to perennial pastures with surface drainage aiding seasonal flow into these wetlands.	M	M
	4451	Camel lakes	Excellent	20900	7.8	2 large salt lakes and up to 10 smaller basins contained within large nature reserve. Significant seasonal creek flows into this reserve from the SW and is one of the few defined waterways in this part of the basin floor.	H	H
	4451	Camel yate swamps	Good-Excellent	-	-	2 small yate swamps on southern boundary of nature reserve, near pristine condition with both mature trees and understorey intact. Rare examples of wetlands in good condition outside of Stirling Range National park.	H	H

4.0 Geological history of the Area (adapted from Ferdowsian 2002 and Lewis 1992)

The southern portion of Western Australia is underlain by basement rock from two geological units-the Yilgarn Craton and the Albany Fraser Oregon.

The older Yilgarn Craton underlies most of the wheatbelt and is bound to the west and south by the Darling plateau (Semenuik 1999).

The Albany Fraser Oregon abuts the Yilgarn Craton at a fault line running eastward from Manjimup and is cut cross wise to the south by a number of eastward trending faults (Smith 1997). The Stirling Range appears along this fault at a point known as the Stirling fault (Lisson 1994).

The basin floor has formed over 2 valleys that were oriented east-west and southwest-northeast adjoining the region north of the Stirling fault. It is possible these channels were originally part of the Pallinup River drainage system (Semenuik 1999). About 40million years ago, when Antarctica separated from Australia, the continental region sagged and sea levels began to rise resulting in an inland intrusion of the sea over the North Stirling area. The ancient channels began filling with sediments as the ocean eroded upland materials.

The shallow basins and playas are a result of the sedimentation of these ancient watercourses that has seen a progression from creeks to broad valley flats to basins.

Depressions in this sandplain have been eroded during a period of drying in the last 2 million years, forming the numerous lake beds of the area. The basins have become progressively excavated by the action of prevailing NW wind, to form the larger circular sand ridge fringed wetlands found in the area today (Semenuik 1999).

5.0 Hydrology of the Balicup wetlands

The tertiary sediments that have filled the ancient valleys of the region consist of sands overlying material known as the Plantagenet group. This group consists of material from two origins – the lower laying Werillup formation and the overlying Pallinup siltstone

The Werillup formation consists of lignite, dark clays and coarse sands. The deepest sediments may consist of rounded river pebbles. The material is mainly non marine in nature, being deposited in a swampy environment (Ferdowsian 1997) and originating from the erosive action of ancient watercourses, and has infilled low lying ancient drainage depressions and paleochannels in the underlying bedrock.

The Pallinup siltstone comes from a marine environment and consists of siltstones, sandstones and spongolite. This material sits higher in the landscape and may overly either the Werrilup formation or lay directly over the basement bedrock.

The largely impermeable sediments of the basin floor have a low hydraulic conductivity resulting in little groundwater movement in the area. As a result salts have concentrated and the regional aquifer is extremely saline. Many of the wetlands of the basin are groundwater discharge sites and are therefore naturally saline.

Rising groundwater levels since clearing has increased the rate of discharge to these basins and to others that may have been perched above the regional groundwater, such as the melaleuca and yate covered sumps that occur across the catchment. This has increased salinity levels in both naturally saline and fresh systems.

5.0 Hydrology of the Balicup wetlands (cont')

Most of the wetland basins are shallow with large surface areas, which leads to high evaporation rates over summer and results in the concentration of salts and hypersaline water conditions. In addition, the evaporation of groundwater increases the hydraulic gradient of the sediments around the lakes, maintaining the discharge and groundwater flow towards the lakes (Ferdowsian, 2002).

Surface drainage to these wetlands is limited, with the only major defined watercourses originating in the hills of the Stirling range, and flowing northwards into the major lakes such as Munrillup, Balicup and Jebarjup Swan Lake. There are also waterways originating in the Northern slopes region of the basin, and flowing into the northern most systems such as Racecourse lake in the west and Anderson Lake in the east..

Camel Lake is fed by a system that originates in the Stirling Range, but flows in an easterly direction for much of its length. This may be a relic of the easterly flowing system that used to present in this area, as the waterways to the east of Camel lakes do flow into the six mile creek and then Pallinup River.

In wet years much of the basin floor is waterlogged or flooded, and these areas of flats connect and surface flow occurs between wetland basins. Many surface drainage projects have been undertaken in the area to enhance this natural movement of water, and utilise the wetland basins as evaporation ponds.

Previous studies have shown that whilst most of the salt lakes are discharge points for groundwater, they may also act as recharge points adding water back to the groundwater. There is a possibility therefore that adding water into the lakes may cause rises in groundwater that inundates other areas adjacent to the wetland.

Precise statements about individual wetland hydrology are difficult to make without conducting drilling around each site to determine the geology and groundwater profile. It is clear, however, that most of the Balicup wetlands have been captured by the rising regional watertable.

In general the water balance of the Balicup wetlands is determined by:

- Surface runoff from the catchment via the waterways that feed the wetlands
- Ground water discharging into the wetlands.
- Rainfall percolating through the sands of the dunes that fringe many basins and recharging the watertable within the dune system. This sandy lens of fresh water discharges through the interface with dune and wetland and will seasonally flow into the wetland system.
- Direct rainfall on the wetland,

Water is lost from the wetlands due to:

- Evaporation from summer heat and wind
- Evapotranspiration from fringing wetland vegetation
- Discharge of wetland into ground water.
- Overflow, either along low lying flats or discreet channels linking wetlands.

6.0 Balicup wetlands – Physical Characteristics

Wetlands of the Balicup suite share a number of physical properties that distinguish them from other wetlands in the area. These properties mainly relate to the landform upon which the wetlands have formed.

Semenuik (1999) summarised the Balicup wetlands as being represented by a large range of wetlands that display a history of formation processes evolving from the tertiary period to the present. The suite contains small scale to very large scale lakes, sumplands (seasonally inundated basins), and playas (intermittently inundated basins). Hydrology varies from near permanent to long seasonal inundation to very short periods of intermittent inundation.

The wetlands have formed on sediments of marine and alluvial origins, and may be underlain by mud, muddy sand and coarse quartz sands.

The surface waters are usually more saline than the groundwater, with levels in wetlands ranging from 16000ms/m to 230000ms/m., which is between 3 and 6 times the salt concentration of seawater. The levels at this upper limit classify the water as brine.

Some of the seasonal fresh wetlands that have been captured by saline surface or ground waters display much lower salinity levels, due to the dilation of fresh water input during winter runoff. Levels in some of these lakes range between 2630 to 6900 ms/m, which is between half seawater to being equal to seawater.

The vegetation of the lakes, sumplands and playas varies from having only fringing buffer vegetation on the lakes, to small sumplands and damplands that have vegetation growing across the wetland basin. In most cases these smaller seasonal wetlands are degraded and this emergent vegetation has died, in fact there are only isolated examples of these wetlands with the covering vegetation still intact.

Major species in the wetland vegetation communities range from woodlands and fringing stands of salt paperbark (*Melaleuca cuticularis),* with adjoining flats of samphires growing to high water mark. Almost all the salt lake/sumpland/playas have no vegetation below the high water mark, due to the excessive salinities reached when these lakes hold water.

Other communities include fringing open woodlands of moit (*Eucalyptus decipiens),* moort (*E.platypus)* with understoreys of *Acacia, Hakea* and *Callistemon* species. Fresh sumplands contain open woodlands of yate (*Eucalyptus occidentalis)* and diverse shrublands, heaths, sedgelands and herblands. Dominant sedges and rushes include bare twig rush (*Baumea juncea),* shore rush (*J.kraussi),* club rush (*Isolepis nodosa)* and pale rush (*Juncus pallidus).*

7.0 Significance of the Balicup wetlands

7.1 Regional and National Significance.

The Balicup suite of wetlands have been identified as being both regionally significant and outstanding at a national level due to a number of features. These features include:

- being representative of a diverse range of wetland types,
- processes and vegetation communities;
- the size and type of the wetlands;
- the landscape setting to which they belong;
- the habitat diversity and
- the refuge they provide to waterbirds.

The wetlands are part of an extended linked wetland system that includes a network of floodplains, channels and basins (Semenuik 1999).

These classifications extend to the main lakes within nature reserves, in particular the National listing includes only Balicup, Jebarjup and Camel lakes.

The Regional listing includes the main lakes plus the Boorocup lakes and some unnamed lakes on private property. These include Hams yate swamp and West Camel swamps. Following this study there will be additional sites listed to the regionally significant list including Wareenip lakes, Salt Lake, East Balicup lake and the Three swamps.

The larger lakes of the Balicup suite are considered important because they support large numbers of waterbirds, particularly waterbirds that are part of International Treaties.

Balicup Lake is internationally significant for the Banded Stilt, an endemic Australian shorebird, with greater than 1% of the national population being observed at this lake. This statistic satisfies one of the criteria for listing on the international RAMSAR convention (Jaensch 2000).

Balicup lake is also in the top 10% of sampled wetlands, for numbers of waterbirds listed on both the Japan/Australia and China/Australia migratory bird Agreements and for numbers of waterbirds scheduled under the Wildlife conservation act 1950. This includes the Hooded Plover, which is a nationally rare and vulnerable species that is restricted to the South Coast of Western Australia (Semenuik 1999).

7.2 Local Significance

The wetlands are significant on a local scale for a variety of reasons. Many of the wetlands are within large reserves that provide a valuable area of remnant vegetation, adding significantly to the area's aesthetic qualities. These island remnants are important representatives of vegetation communities that existed in the area before clearing. They are large fauna conservation areas that have the potential to be linked to other remnant areas through vegetated corridors following drainage lines, roads and contours in the catchment.

Many of the wetlands are under surveyed in terms of birds, and fauna such as invertebrates they support. The relationship between vegetation and hydrology and the processes of sedimentation are also unexplored, leaving many unanswered questions relating to understanding the wetland values and processes. These areas provide important foci for future research to enable a better understanding of the significance of the wetland system.

8.0 Threats to the Wetlands of the North Stirling Basin

Wetlands and waterways in southern Western Australia are under threat from changing water quality and degradation of fringing vegetation. Changes to water quality have occurred through increasing salinity, eutrophication and sedimentation. These changes are directly attributable to catchment clearing (Schofield, 1989).

Removal of native vegetation through clearing results in changes to the groundwater regime, with less groundwater being utilised through deep rooted vegetation, and more surface runoff to discharge into waterways. This increase in catchment water has further degraded wetland vegetation through waterlogging and inundation.

Rising groundwater and associated waterlogging and salinisation, combined with grazing by introduced animals, is responsible for much of the decline in vegetation seen in wetlands and waterways across southern Western Australia (Olsen & Skitmore, 1991).

There are a broad range of processes that threaten the Balicup wetlands. Site specific threats are addressed separately under the individual site assessments and management recommendations.

8.1 Salinity/Inundation/waterlogging

Linked wetland systems such as those found in the basin floor of the north Stirling basin are at specific risk from the rise of saline regional groundwater, because of the existing hydrological link that many of the wetlands have with the regional groundwater. In particular, seasonal fresh wetlands are threatened, and many of this wetland type have already been lost due to changes in hydrology.

Most of the wetlands in the basin floor are naturally saline with no emergent vegetation, and so are able to tolerate increases in salinity and longer periods of inundation. The effects on aquatic invertebrates is not as clear, and is an area that would benefit from further research (Semenuik 1999).

There is an opportunity to utilise excess surface water in the catchment through an integrated surface water management program of shallow surface drains linking with wetland basins. This concept is already being initiated by a number of landholders in the area, to help reduce waterlogging of low lying flats, and enable fresher water to enter the wetland basins. This may benefit wetlands by reducing salinity levels for a period during spring each year, resulting in better environments for aquatic flora and fauna, plus perhaps reducing groundwater discharge through the positive pressure the water in the basin exerts.

The water held in the wetland basins would largely be evaporated off during summer, however overflow drains may need to be put in place to prevent fringing vegetation from being drowned, allowing excess water to escape. Wetlands at the bottom end of these systems therefore need to have a large surface area to accommodate the extra flows resulting from the enhanced run off.

Further investigation into the effects on downstream wetlands is necessary before planning any major integrated drainage works, to ensure no negative impacts arise, and so the project has support from all relevant stakeholders, including downstream landholders/managers.

The issue of surface water management and excess water management is discussed further in management recommendations.

8.2 Eutrophication and sedimentation

Increased surface runoff can resulted in the transport of nutrient rich sediments from the agricultural catchments into wetlands basins. This may have a direct effect on water quality, and also lead to shallowing as transported sediment settles.

Catchment clearing including the fringes of many wetlands has meant the valuable filtering function of the vegetation has been lost. As a result more nutrient rich sediment can enter the wetlands. Inorganic or dissolved phosphorous is adsorbed by soil particles and is readily transported with mobilised sediment (George et al 1996).

Inorganic or dissolved nitrogen occurs as ammonium, nitrate and nitrite. Ammonium adsorbs to soil particles, but is slowly oxidised to nitrite. Both nitrate and nitrite are highly soluble and easily transported by water (George et al 1996).

Fringing sedges and rushes uptake large amounts of nutrients and act as nutrient sinks, storing more nutrients than they use. (Taman, 2001). They also have bio-films of biologically active mucous that surround the plant stems and readily uptakes nutrients from water that comes into contact with the film, so adding to the filtering capacity of the plants.

Despite the elevated nutrient levels in many wetlands, problems with algal blooms have not been recorded. A naturally occurring phenomenon is the appearance of an algae that changes water colour to a vivid pink in many salt lakes as favourable salt concentrations are reached.

Sediment build up in wetlands can also physically threaten wetland function. As wetland basins fill with sediment they become shallower and so flood further and further outwards, effectively drowning fringing vegetation.

Sediment transport in the small catchments of the Balicup wetlands is however relatively minor as the gradients of defined water courses are low, and the material moves in sheet water flow over mainly grassed and pastured paddocks. Protecting and enhancing fringing vegetation that buffers the wetlands can still enhance sediment control and associated nutrient reduction.

Enhanced drainage may increase sediment transport, particularly poorly designed deep drains that collapse and require regular maintenance to keep them operating. Correct drain design and construction is therefore essential to minimise maintenance costs for landholders, and reduce erosion and subsequent sediment transport from drains into wetlands.

8.3 Grazing by livestock

Many of the important wetlands in the study area are fenced to prevent stock access, so grazing by livestock is not a threat to the wetland vegetation. In particular, a number of significant sites have been fenced for many years, and so have buffers of high quality, diverse vegetation within them.

The shire and nature reserves in the catchment also provide valuable protection from the effects of grazing stock. Of importance is the width of the buffering vegetation that has been included within the nature reserves. These sites have hundreds of metres of vegetation that has been included in the surrounding buffer, creating a significant zone of diverse habitat.

In addition, a number of landholders have completed significant fencing projects protecting wetlands and remnant vegetation on their properties, with a number of other projects planned for the near future. Specific fencing requirements are suggested for the individual sites under the management recommendations that follow (See section 9).

8.4 Feral Animals

The isolated nature of the wetlands and surrounding vegetation in an otherwise largely cleared catchment means they are refuge sites for all fauna, including notable fauna such as waterbirds and feral animals such as foxes and rabbits.

Foxes are a concern because they can predate heavily on breeding birds that nest amongst the wetland vegetation. Several of the wetlands support threatened species such as Freckled Duck (Jaensch, 1992). Control of these predators is vital to preserve the conservation value of the wetlands.

Rabbits can cause disturbance through digging warrens and grazing on native vegetation, particularly young seedlings. This can impinge on the ability of vegetation to regenerate after flooding or fire, and places native fauna under stress through added competition for food. The grazing and diggings of rabbits can instigate erosion on fragile sandy areas. Rabbit control is essential in these remnant areas to prevent population explosions that could devastate the area.

Sandy ridges traverse this area and provide excellent areas for rabbits to establish large warren complexes. This is particularly the case in areas that have not been cleared and not disturbed by farming activities. Where warrens are difficult to locate and access to rip and fumigate, individual bait stations may be the most effective method of controlling rabbits to any degree (Parry pers comm).

8.5 Weeds

Weeds can threaten the habitat value of a wetland by out competing native vegetation, affecting nutrient recycling, increasing fire risk, and inhibiting regeneration of natives, particularly after a disturbance such as fire or stock grazing. Fencing to exclude stock is an effective way of reducing weed invasion. Sheep and cattle can transport weed seeds, denude native vegetation, and provide disturbed environments ideal for the establishment of fast growing weeds (Hussey et al, 1997).

Weed management is a common concern to landholders following the fencing of wetlands and waterways, as these colonising plants overrun native plants once they are no longer under pressure from stock. Grass selective sprays can be used in areas of dense infestations, and providing there is sufficient seed source from adjoining native vegetation, understorey seedlings will slowly establish that displaces the weeds. In areas where the remnant vegetation is degraded planting seedlings or direct seeding may be needed to compliment the natural regeneration.

Fire is not an effective management technique for weed control as the burnt ground provides excellent condition for new weeds to establish, often growing more densely than prior to burning. Native seedlings may also be destroyed in a fire, slowing the natural recruitment.

8.6 Other threats

Semenuik (1999) identifies a number of management requirements in response to processes that threaten the Balicup suite wetlands.
They are :

- Buffer zone around system-wetlands on private property and some of the reserves may not have sufficient buffer to protect the wetland processes.
- Recognition of the entire basin floor as a regionally significant feature.
- Protection from nutrient enrichment.
- Recognition and creation of corridors to link wetlands
- Recognition of conservation values-lack of awareness can lead to inappropriate actions taking place ie dumping of rubbish and burning off.
- Inclusion of lunette dunes into conservation reserve

9.0 Management Recommendations

Management recommendations are provided below in Table 2 for those wetlands that have been allocated a High management priority, and select wetlands with a medium management priority in the Balicup wetland table (Table 1).

The medium priority wetlands have been listed due to landholders indicating interest in carrying out fencing/revegetation/surface water management works. This will enable prioritisation of funding opportunities that may become available in the future.

In addition to the site specific recommendations that follow, it is recommended that the priority wetland mapping for this area, as completed by Semenuik (1999) is updated. The list of regionally significant (conservation class management category) wetlands should therefore include the following wetlands:

Balicup Lake
Jebarjup Swan Lake and East Jebarjup Lake
East Balicup (Beejenup) nature reserve
Camel Lakes
Three Swamps
Anderson Lake
Hams Yate Swamp

Plus the following new listings:

Wareenip Lakes
Fares Pink lake
Salt Lakes (listed but not mapped)

The following sites need to be deleted from the current list, as closer examination of these wetlands has shown they may not satisfy necessary criteria for classification as a regionally significant wetland:

UCL 3337-Salt lake (Listed as T13 on the regional database)
SE Munrillup (listed as T11)

In addition, it is recommended that the tiny yate swamps fringing the Camel lake reserve are mapped, and included in the regional list. It is unlikely these wetlands are part of the Balicup suite, rather part of another wetland type that has formed in this landscape. This classification will require further investigation and comparison with existing wetland suites, it is possible these small basins are similar to the Manypeaks group of wetlands found south of the Stirling Ranges.

Restoring the water balance

In waterlogging prone areas like the north Stirling basin, the major cause of land degradation is waterlogging and salinity due to shallow rising water tables and heavy soils that do not transport water readily. Farm productivity, wetlands and native vegetation can all benefit from appropriate water management practices that limits recharge to groundwater.

This can be achieved either through direct uptake of water by plants, or by directing surface water though banks and shallow drains to nearby wetlands, waterways and dams.

Perennials
Using plants that grow all year, or outside of the winter growing period, will enable larger quantities of soil moisture to be utilised, resulting in less recharge to groundwater, and a drier soil profile that will limit waterlogging.

A variety of species are available that will grow in the range of soil types found in the north Stirling basin, from the deep sands to the heavy clays.

In general, all soils can be realistically planted to perennial vegetation, however it is recommended that the lowest lying and waterlogging prone areas, commonly the broad waterways, are revegetated with native plants, and not used as grazing areas. This will allow waterways to remain free from the effects of stock, and become effective corridors for native fauna and flora.

In addition, it is recognised that some species, particularly grasses like veldt and Rhodes grass, have the potential to become weeds and spread rapidly into adjoining areas, so consideration should be given when planting next to sensitive areas such as nature reserves.

Contact the Department of Agriculture or local natural resource management coordinator for more advice on species and assistance available to establish.

Integrated Farm Forestry

There is also a range of options for establishing useful and potentially commercial tree species that can compliment other farm water management practices. Integrating belts or small blocks of trees into the farm can provide important water usage, shelter and erosion control, improve the visual amenity of the farm as well as potential short and long term financial returns. In addition commercial farm forestry can be incorporated with native vegetation and have ecological benefits by increasing the biodiversity value of the planting.

Species such as sandalwood (*Santalum sp.),* associated host species and maritime pines thrive in deep sands that are fragile and have marginal productivity, utilising recharge water and also providing shelter from damaging winds that can denude these fragile areas.

Other options include timber species such as swamp sheoak (*Casuarina obesa)* that will grow on waterlogged and salt affected ground that can compliment other native species and salt tolerant pastures to provide and integrated solution to retaining productivity from salt affected ground.

For advice on the range of programs and the types of assistance that are available to landholders with establishing integrated farm forestry projects, contact

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Surface Drains

Surface drainage is a key component in effectively managing catchment water. A well designed and planned network of shallow surface drains will ensure that ponded rainfall can be collected and moved into nearby wetlands, waterways, (or dams if higher in the landscape). This will reduce waterlogging and periods of inundation and increase the productivity of these areas of land.

As discussed previously, the movement of water into watercourses and wetlands has the potential to cause off site problems through ground water being recharged then discharged in other areas, plus the potential to cause flooding of valuable wetland margins which could threaten fringing vegetation.

Utilising small wetland basins as collection points for surface drainage will enable water to be held until it is evaporated, preventing water and salt accumulation on the low lying areas being drained. In dry to average rainfall years, it is likely there will not be sufficient runoff to cause these chains of wetlands to fill and overflow.

Without using drains and wetlands as storage basins, the low lying flats naturally pond large areas and these ponded areas do not link until sufficient rain has fallen. Utilising wetland basins will have a similar holding effect, until a very wet year, when all basins fill and the system overflows. In this situation, it is likely the pre drainage landscape would too have filled and overflowed, so the water flowing into wetlands and waterways and the bottom of the catchment would have arrived there anyway.

Whilst the end wetlands may then remain quite full, most of these systems have enormous surface areas, that would result in large amounts of the water evaporating in the first summer.

The effects of flooding and discharge to surrounding landscapes may therefore be restricted, however it is recommended that catchment modelling be undertaken to calculate various flow volumes in a range of rainfall situations. This can be completed with the help of staff from the Department of Environment.

Linking surface drains into wetlands will need carefully designed overflow points to allow wetlands to spill over before damaging fringing vegetation (if present), this is an important management issue when designing an integrated drainage project.

Deep Drains

Deep drains have a limited application that is very dependent upon soil type to be successful. In many situations installing and maintaining deep drains costs more than the productivity increases on the land being drained, and are therefore not cost effective.

A study completed on a deep drain network in the North Stirlings area (Ferdowsian et al 1997) concluded that whilst 8ha of land were recovered to productivity after the drains were installed, 32 ha were needed to break even, ie to recover the cost of installing and maintaining the drain.

In addition to being costly, deep drains also cause problems with downstream transport of highly saline water, as well as sediments from erosion of steep banks.

Deep drainage therefore has legal consequences and any planned deep drainage needs formal approval from the Commissioner for Soil and Land conservation, and should be carefully planned with all neighbouring landholders to minimise off site impacts.

Table 2- Site Specific Management Recommendations

Wetland:	**Wareenip SW/SE lakes**
Issues /threats:	These lakes need to be protected from stock to prevent remnant fringing vegetation from being lost. High waterbird use of both these lakes indicates good feeding/refuge sites, fencing and revegetation of the fringe would enhance the habitat values.
Management Recommendations:	• Fence wetland and fringing vegetation • Revegetate fringe with buffering plants, particularly sedges/rushes at drain inflow points to encourage removal of sediment from drain flow.
Wetland:	**Racecourse lake**
Issues /threats:	Sediment from inflow creek
Management Recommendations:	• Creek appears to be mainly fenced, some fringing vegetation may need enhancing, particularly with rushes/sedges. • Fringing vegetation of lake is narrow and could be widened in some parts.
Wetland:	**South Munrillup lake**
Issues /threats:	Sediment from inflow drain. This wetland has had fringing rehabilitation planting's, including some sedges/rushes.
Management Recommendations:	• Continue to revegetate the wetland fringe, recognising water levels may be affected by inflow drain. In particular, focus on the establishment of sedges/rushes at the drain in flow and outflow points.
Wetland:	**Fares yate swamp-2**
Issues /threats:	Stock access and lack of fringing buffer. Basin has lost emergent paperbarks due to salt and inundation. Would benefit from fresh inflow from surface drainage in area if possible, providing a high water outflow was established to prevent drowning of fringing trees.
Management Recommendations:	• Fence fringing yate/moit trees • Establish rows of rushes, understorey bushes and trees • Investigate possibilities of directing surface drains through this wetland.
Wetland:	**UCL 4353-UCL5040 lakes**
Issues /threats:	Band of vegetation connecting these wetlands appears to be patchy. This has potential for an excellent corridor between these 2 large lakes.
Management Recommendations:	• Fence wetlands and this band of vegetation, with a laneway created through the vegetation, utilising existing tracks/firebreaks to enable stock and machinery movement. • Revegetate any areas that appear degraded and unable to regenerate.
Wetland:	**Balicup lake**
Issues /threats:	Lack of fringing buffer on western side
Management Recommendations:	• Establish rows of rushes, understorey bushes and trees along this boundary within existing fencing.
Wetland:	**Hams yate swamp**
Issues /threats:	Sediment from deep drains
Management Recommendations:	• Revegetate disposal point of drains with sedges/rushes. • Fence and plant trees along deep drains to protect from stock trampling and minimise maintenance requirements.

Wetland:	**Hams mid swamps**
Issues /threats:	Stock access and potential for protected vegetated corridor linking fringing wetland remnant vegetation to nearby Balicup nature reserve to the east.
Management Recommendations:	• Fence around fringing vegetation, and include sandy ridge between wetlands that can be planted to native species or agroforestry pine trees.
Wetland:	**Eastern Balicup lakes**
Issues/threats	Potential for linkage to nearby nature reserve.
Management Recommendations	Establish surface drain network between these lakes, and fence and revegetate fringe of surface waterways to create a series of protected corridors across the farm. In particular, focus on major corridor linking main wetlands and vegetation blocks to the Jebarjup nature reserve.
Wetland:	**North Jebarjup lakes**
Issues/threats	Potential for linked drainage project
Management Recommendations	• Survey drainage between wetlands to plan for surface water management project, utilising wetlands as evaporation basins. • Fence and revegetate wetland fringes to increase habitat potential as wetlands basins hold water for longer periods.
Wetland:	**Salt Lake reserve wetlands**
Issues/threats	Drainage issues in adjoining property
Management Recommendations	Ensure drainage to/from these wetlands is planned with any surface water management on adjoining property.
Wetland:	**East Jebarjup lakes**
Issues/threats	All wetland fenced and some areas requiring rehabilitation and infilling from previous plantings.
Management Recommendations	Infill plant where necessary.
Wetland:	**Cheepanup Lake**
Issues/threats	Narrow strip of fringing vegetation on western boundary, plus significant inflow creek may transport sediment.
Management Recommendations	• Enhance western boundary vegetation, if room permits between fenceline and wetland. • Protect and revegetate creek, including establishing sedges/rushes on the creek inflow delta.
Wetland:	**East Three Swamps**
Issues/threats	Stock grazing in areas unfenced-however fencing status unknown
Management Recommendations	Fencing, if required, of the vegetation connected with the nature reserve.
Wetland:	**West Camel lakes**
Issues/threats	Series of 3 wetland basins surrounded by good stands of fringing vegetation, creating a corridor between Camel Lake reserve and the Yentemerrup Rd.
Management Recommendations	• Establish perennial pastures and surface drains in wetland catchments to aid water movement and manage fresh surface water. • Protect and enhance vegetation between eastern and central wetlands.
Wetland:	**Camel Lakes**
Issues/threats	Potential end point of surface drainage in catchment
Management Recommendations	• Investigate possible effects of excess water being diverted to this wetland. • Discuss drainage options with all stakeholders, including CALM and adjoining landholders.

10.0 Conclusion

This report has brought together information about the Balicup group of wetlands that will help to raise local awareness to the value and significance of these unique wetlands and aid in the future management of these sites.

Another aim has been to highlight the important wetlands of the area, and more importantly, identify those that are in need of management.

Significant works have already been undertaken by many landholders in the catchment towards fencing and rehabilitating these valuable wetlands as part of whole farm management project. In particular, the past catchment projects undertaken by Agriculture WA staff and landcare coordinators from the Gillamii Landcare Centre in Cranbrook has helped to drive this activity.

The next important step is to ensure that future property planning decisions are made with regard to possible impacts these actions may have on the wetlands within that property. In most cases, positive benefits will be achieved particularly where water management activities such as establishing perennial plants or surface water drainage are implemented.

The management recommendations in this report should be used as a guide to ensure that some actions can be taken on priority sites to reduce or negate the detrimental processes that threaten these valuable sites.

More detailed investigations are required into site specific hydrology and surface water drainage for the priority sites mentioned, and it is anticipated that funding will be available to assist landholders with this process. Possible sources for 2005 include through the Regional Wetland program and other regional funding such as is offered through Southern Incentives by the South Coast Regional Initiative Planning Team (SCRIPT).

By providing technical expertise and funding assistance to landholders on the ground as they plan the future of their properties, it is hoped some of the valuable and unique Balicup wetlands of the North Stirling basin can be protected and managed long into the future.

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Appendix 1

Location Map of

North Stirling basin

Appendix 2

Maps of wetland zones

Appendix 3

Wetland Aerial and Ground photographs, 2004

Appendix 4

Measurement of

Salinity and conductivity Table