Department of Water
Government of Western Australia

Upper Avon River Recovery Plan
Section 20 – Yealering Lakes

River Recovery Plan Series

REPORT NO. RRP 12
SEPTEMBER 2006

Department of **Water**
Government of **Western Australia**

Upper Avon River Recovery Plan

Section 20 – Yealering Lakes

Prepared by
Viv Read & Associates
for Department of Water and
the Avon Waterways Committee

Jointly funded by
Department of Water,
Avon Catchment Council,
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Department of Water

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Bernard Kelly (Department of Water, Northam Office) provided direction and management for the project. Kate Gole, Rachael Major (Department of Water, Northam Office) and Hamish West (Department of Water, Regional Support) prepared map information.

Viv Read (Viv Read & Associates) undertook the planning processes and prepared the draft Recovery Plan.

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Cover photograph: Lake Yealering from the air
Associate Professor Jenny Davis, Murdoch University

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Abbreviations

ACC	Avon Catchment Council
AWC	Avon Waterways Committee
CALM	Department of Conservation and Land Management
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DAWA	Department of Agriculture WA
DoE	Department of Environment
DoW	Department of Water
WRC	Water and Rivers Commission

Preface

This Recovery Plan is for the Yealering Lakes section of the Avon River, extending from the Squires Rd Crossing to the lake itself.

The purpose of this River Recovery Plan is to provide management guidelines and a set of proposed actions for the river. Management is required in response to many processes that currently threaten the health of the river system. Salinity and increased stream flow causing erosion and sedimentation are two of the key threats to the river.

The Recovery Plan has been initiated by the Department of Water (formerly Department of Environment) but is intended for adoption by those who live and work by the river and many others with an interest in river management. The Department of Water, in partnership with the Avon Catchment Council (ACC), will provide opportunities for partnership arrangements for implementing the actions. Funding for the survey and planning processes has been provided under the Commonwealth and State Government investment initiatives for natural resource management directed through the ACC.

The planning for the Yealering Lakes section of the Avon River was undertaken during 2005. The actions of the plan are intended for implementation over the coming 3-5 year period with an expectation that they will achieve change in the river environment as perceived within the local Vision for the river in about 20 years from now.

Bernard Kelly

Department of Water
Senior Natural Resource Management Officer
Swan-Avon Region
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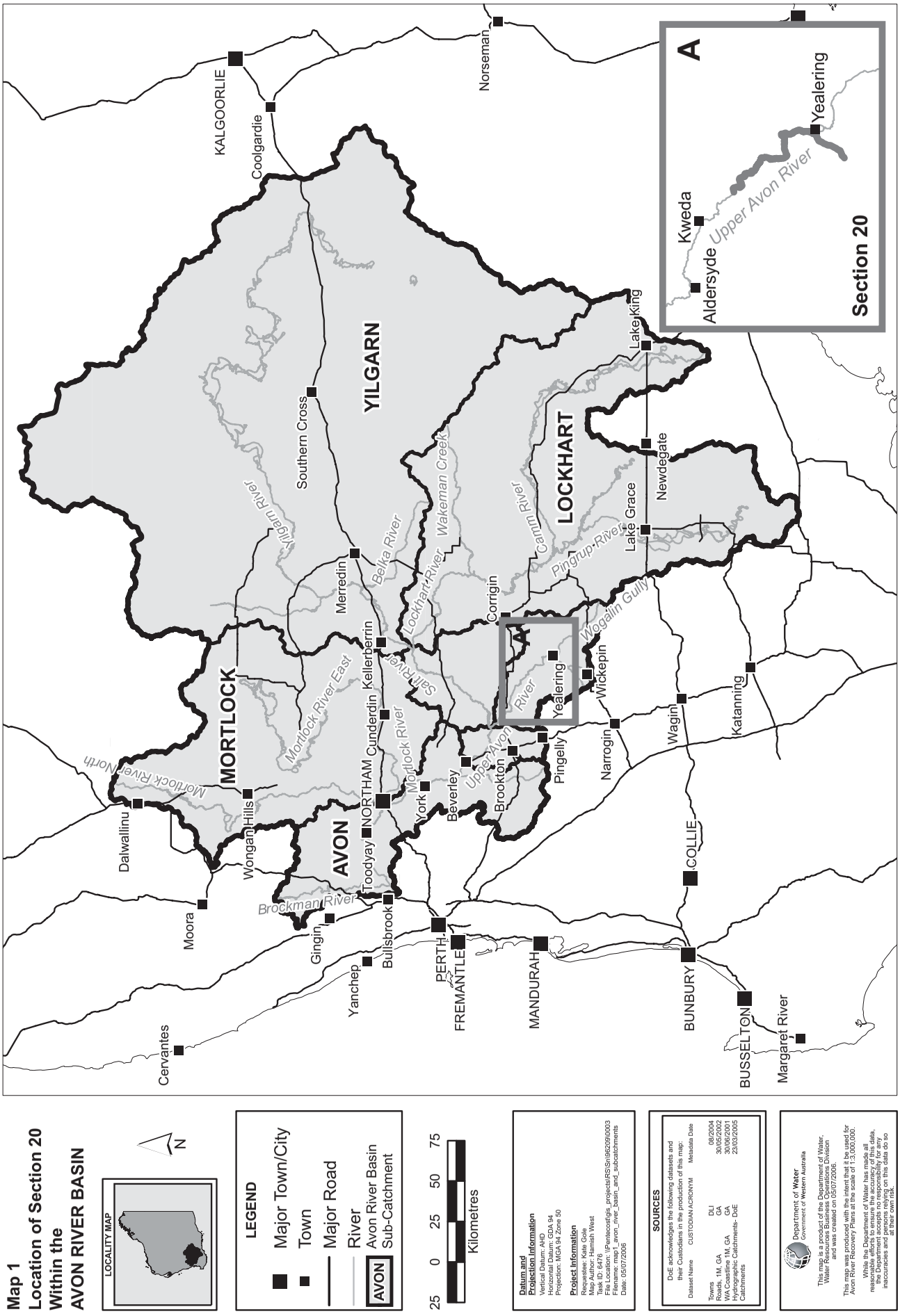

Map 1: Location of Section 20 Within the Avon River Basin

1 Introduction

1.1 Managing the Avon River

The Avon River is one of Western Australia's major river systems. It provides natural drainage for the extensive Avon River Basin which stretches from Dalwallinu in the north, Southern Cross in the north-east and Lake King in the south east – a total area of approximately 120 000 km^2. The Avon discharges to the Swan-Canning estuary near Perth.

One branch of the Avon River originates within the Shire of Wickepin. The catchment area upstream of the confluence with the Salt River at Yenyening Lakes is 3 200 km^2.

Other major tributaries include:

The *Yilgarn River*, which originates north-east of Southern Cross from Lake Seabrook and Lake Deborah and with tributaries to the north and south-east. It flows in a south-westerly direction past Merredin to its confluence with the Lockhart River south of Kellerberrin. The catchment area of the Yilgarn River is 55 900 km^2;

The *Lockhart River*, which originates at Lake Magenta and flows northwest through Newdegate, Kondinin, Corrigin and Bruce Rock. The catchment for this river includes the Camm River (which flows from Lake King through Hyden to Kondinin) and the Pingrup River which originates near Lake Cairlocup and flows north to Lake Grace then into the Lockhart River. The Lockhart River has a total catchment area of 32 400 km^2;

The *South Branch* of the Avon River which flows through Brookton and joins the main channel upstream from the town of Beverley; and

The *Mortlock River system*, which has a catchment area of 16 800 km^2 and joins the Avon River at Northam.

Map 1 shows the location of the Avon River and major tributaries. It also shows the location of the Yealering Lakes Section of the river system.

The main channel of the Avon River downstream from the Yenyening Lakes was originally braided, with many small channels interweaving between thickly vegetated islands, and punctuated by numerous deep, shady pools. Flow in the Avon River usually commences in April after the onset of winter rains and with falling temperatures and evaporation. In most years flow diminishes or ceases before the end of December. A gauging station between Beverley and York (Broun's Farm) shows that the river flows on average for 286 days or 78% of the year while the station at Walyunga (downstream of the Darling Scarp) shows the average flow is 310 days or 85% of the year. These averages do not reflect the extreme variability between years. In a dry year, the river above Broun's Farm contributes only 12% of river flow while in a wet year this can rise to over 40%.

The Avon is now a highly disturbed river system. The riverine ecosystem has been altered due to clearing of the catchment for agriculture and establishment of towns adjacent to the river. Significantly, the river bed was deliberately disturbed under the River Training Scheme undertaken from 1958-72. This involved:

- Removal of channel vegetation and debris to a width of 60 metres;
- Removal of dead trees, logs and debris which impaired the river flow;
- Ripping of the river bed to induce erosion of a deeper watercourse; and
- Removal of minor kinks and bends in the river.

These works were undertaken for almost the entire length of the river channel from Deepdale Pool, downstream from Toodyay, to as far upstream as Aldersyde. The purpose of the works was to reduce flooding in towns and on farms in the floodplain. A major effect has been to double stream flow velocity that has mobilised sediments and filled river pools.

A survey of the river channel from the Yenyening Lakes down to the Avon Valley National Park – a distance of 191 km – has been completed. This shows the condition of the river and the management needs for each of the 18 River Sections. Recovery Plans have been prepared with local communities for each of these sections. A detailed description of the river, including specific assets, is provided in the respective recovery plans. Over 85% of the river is now fenced to control livestock in the riparian zone.

The key river management issues identified for the main channel of the Avon River include:

- Flooding and floodplain management;
- Channel erosion, bank stability and sedimentation of river pools;
- Algal blooms in river pools and the Swan-Canning estuary;
- Condition of riparian vegetation, including the impacts of fire, salinity and weeds; and
- Public access and recreational opportunities.

The *Avon River Management Programme* was prepared by the Avon River Management Authority in 1999. The functions of this authority are now replaced by the *Avon Waterways Committee*. The Management Programme provides strategies and priorities for river management, including river recovery planning undertaken with local communities for sections of the river.

The recovery planning process is based on a partnership approach that links landholders along the river, government agencies and the broader community to achieve common goals. Planning for the 18 sections of the main channel is now complete. River Recovery Plan sections are shown in Map 2. New initiatives are taken for the upper sections of the Avon River, including the Yealering Lakes section. The Department of Water (DoW – Northam Office) has lead government agency responsibility for river recovery planning in the Avon River Basin. DoW provides resources for the planning processes and will continue to support implementation of the recovery plan in partnership with local community organisations.

1.2 Managing Natural Resources in the Avon River Basin

The *Avon Catchment Council* (ACC) provides leadership for management of natural resources within the Avon River Basin. ACC is a non-statutory organisation based on partnership arrangements between community, governments and industry to ensure sustainable use or enhancement of water, land, vegetation and other landscape assets.

ACC has recently completed the *Avon Natural Resource Management Strategy* and the *Avon Investment Plan*. The strategy provides direction and priorities for actions required for targeted resource condition change. The Investment Plan identifies the resources required to implement the actions. The strategy and plan are accredited for Commonwealth and State funding under the National Action Plan for Salinity and Water Quality (NAP) and the continuation of the Natural Heritage Trust (NHT2).

Map 2
AVON RIVER River Pools and Recovery Sections

N

LEGEND

- Major Town/City
- Town
- Minor Town
- Road
- River
- 3 Section Number
- Avon River Sections
- Pools
- AVON National Action Plan Boundaries for Salinity and Water Quality

6 0 6 12 18

Kilometres

Datum and Projection Information

Vertical Datum: AHD
Horizontal Datum: GDA 94
Projection: MGA 94 Zone 50

Project Information

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Map Author: Hamish West
Task ID: 6476
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Filename: map2_river_recovery_plan_sections
Date: 05/07/2006

SOURCES

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Dataset Name	CUSTODIAN ACRONYM	Metadata Date
Towns	DLI	08/2004
Roads, 1M, GA	GA	30/05/2002
WA Coastline 1M, GA	GA	30/06/2001
National Action Plan Boundaries for Salinity and Water Quality	DEH	10/02/2005

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Government of Western Australia

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While the Department of Water has made all reasonable efforts to ensure the accuracy of this data, the Department accepts no responsibility for any inaccuracies and persons relying on this data do so at their own risk.

Map 2: Avon River River Pools and Recovery Sections

The ACC has initiated regional-scale projects in accordance with the priorities of the regional strategy and investment plan. Management of water resources, including river and lake systems, is a high priority.

1.3 The Need for a Recovery Plan

The Yealering Lake System is recognised nationally as an important wetland system. The biodiversity, land and water assets of the region are also recognised at the regional scale through the *Avon Natural Resource Management Strategy*. Locally, the town of Yealering is located on the northern bank of Lake Yealering. This lake provides for water-based recreation and is central to the landscape character of the local district. The lakes form the headwaters to the Avon River.

A Recovery Plan is required because these important assets are threatened in many ways, but particularly by salinity.

2 Description of the Yealering Lakes Section

The Yealering Lakes section of the Avon River differs to other river management sections in that it is focussed on management of the lakes and includes the major tributaries and their surface water catchments. Map 3 shows the location and boundary of the management area.

The Yealering Lakes section is located within the Shires of Corrigin and Wickepin, approximately 250 km south-east of Perth. The town of Yealering and Lake Yealering are approximately 30 km north-east of the town of Wickepin. Nonalling Nature Reserve, which contains Nonalling Lake, Brown Lake and White Water Lake, is located 5 km north of Lake Yealering. The Yealering Nature Reserve is south of the lake.

The management area is approximately 100 000 ha. The Lake Yealering System is 775 ha in area.

2.1 The Lakes

There are four significant lakes within the Yealering Lakes System, shown on Map 5:

Lake Yealering – area of 160 ha and the adjacent shallow lakes (known locally as the ‘swamp’) with an area of 240 ha,

Brown Lake – area of 130 ha and adjacent ‘satellite’ lakes with an area of 60 ha,

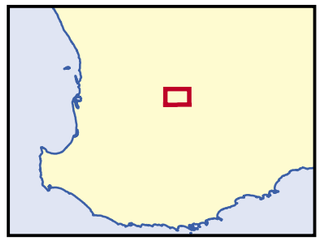
White Water Lake – area of 140 ha,

Nonalling Lake – area of 25 ha.

Photo 1: Lake Yealering from the air (Associate Professor Jenny Davis, Murdoch University)

Map 3
YEALERING LAKES SYSTEM Section

LOCALITY MAP



LEGEND

- Town
- Local Road - Sealed
- Local Road - Other
- Section 20
- Watercourse
- Subcatchment
- Local Government Authorities
- Crown Reserve
- Catchment

Datum and Projection Information

Vertical Datum: AHD
Horizontal Datum: GDA 94
Projection: MGA 94 Zone 50

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Dataset Name	CUSTODIAN ACRONYM	Metadata Date
Hydrographic Catchments - Catchments	DoE	23/03/2005
Hydrographic Catchments - Subcatchments	DoE	23/03/2005
Hydrography, linear(hierarchy)	DoE	13/04/2005
Road Centreline, DLI	DLI	01/04/2004
Cadastre	DLI	01/12/2005
Local Government Authorities	DLI	08/07/2004
CALM Managed Lands and Waters	CALM	01/07/2005
Localities, AUSLIG	AUSLIG	01/01/1997

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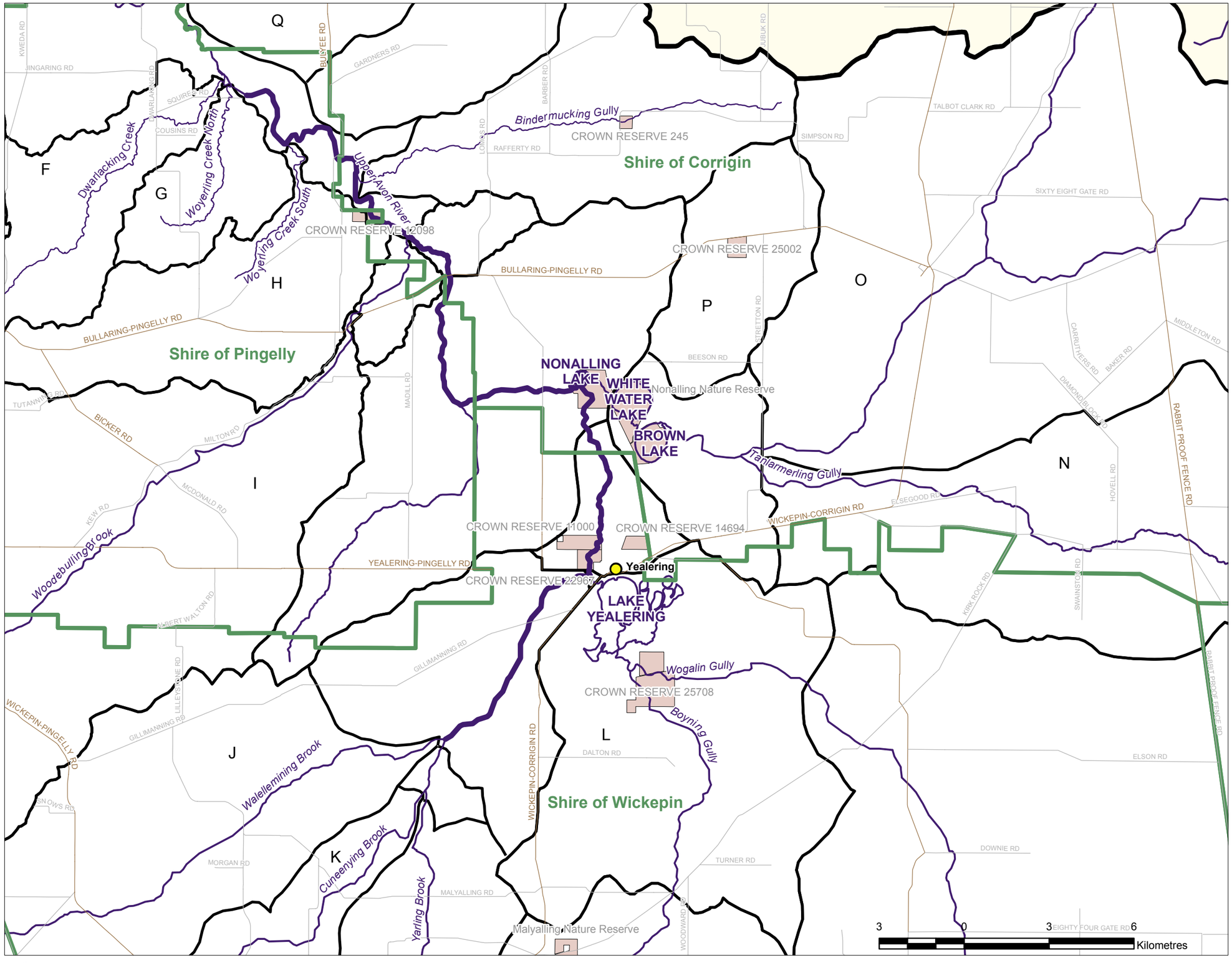
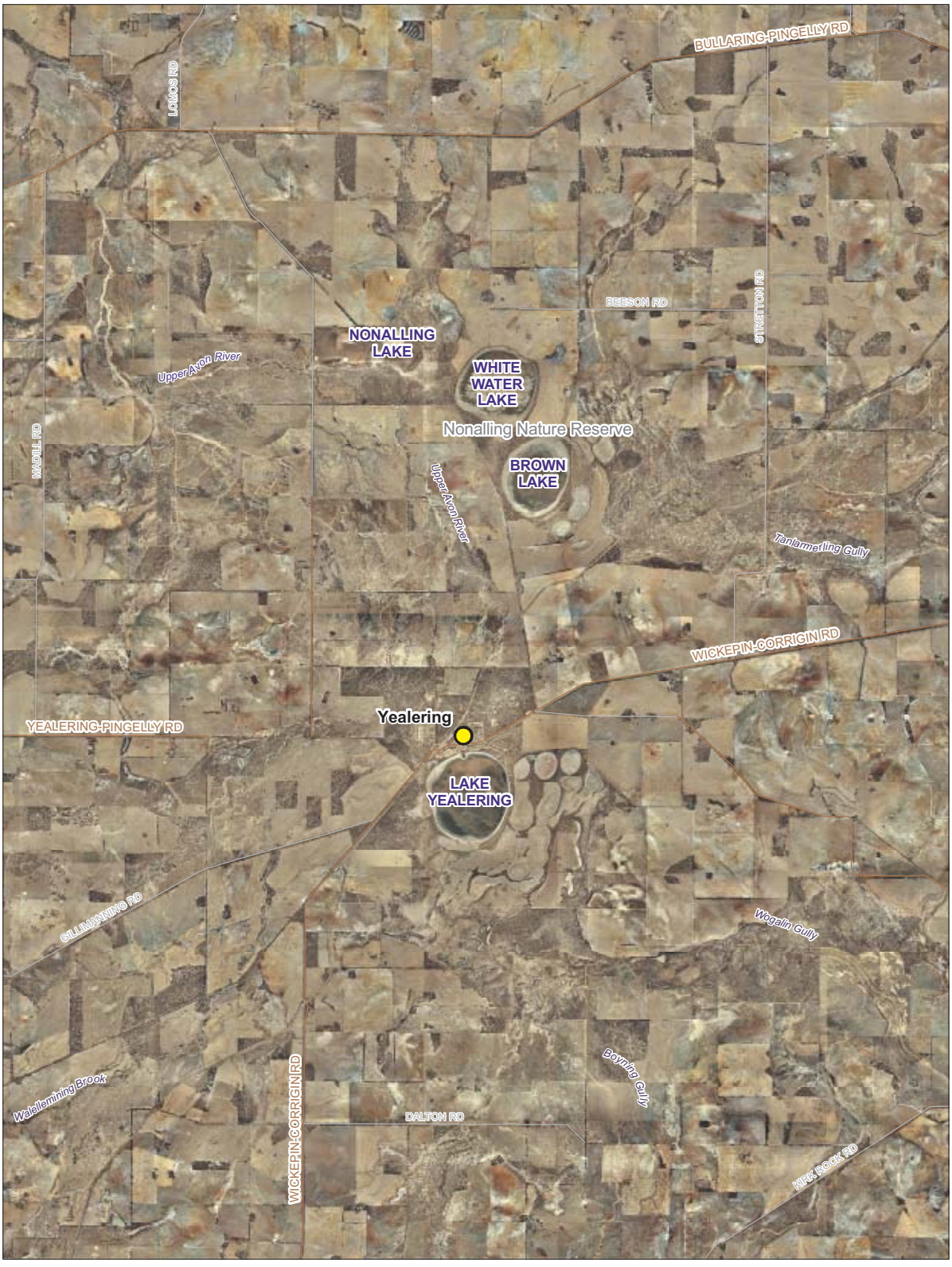


Map 3: Yealering Lakes System Section

Map 4
Lakes in the Yealering Lakes Section



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Hydrographic Catchments - Subcatchments	DoE	23/03/2005
Hydrography, linear(hierarchy)	DoE	13/04/2005
Road Centreline, DLI	DLI	01/04/2004
Cadastre	DLI	01/12/2005
Local Government Authorities	DLI	08/07/2004
CALM Managed Lands and Waters	CALM	01/07/2005
Localities, AUSLIG	AUSLIG	01/01/1997

LOCALITY MAP

N

2 0 2 4

Kilometres

LEGEND

- Towns
- Local Road - Sealed
- Local Road - Other

Datum and Projection Information

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Map 4: Lakes in the Yealering Lakes Section

Hydrology

Inflow to the lakes is from small tributaries that discharge first into winter-wet flats. Inflow to Lake Yealering is from Wogolin (map code M) and Boyning Gully (map code L) catchments south-east of the lake. These creeks discharge through the 'swamp' (Photo 2). The lake fills first then backfills the smaller lakes of the 'swamp'. Yarling Brook, Cuneenying Brook (map code K) and Walellemining Brook (map code J) catchments are confluent and flow into Lake Yealering through the 'outlet' on the north-western side when the stream flow level is higher than the lake level (Photo 3). Otherwise stream flow from Cuneenying Brook is to the Avon River.

The tributaries to Lake Yealering are considered to be the headwaters of the Avon River. The waterway is known as the Avon River downstream from their confluence and Lake Yealering.

Nonalling Lake, White Water Lake and Brown Lake are filled by unnamed tributaries to the north and north-east of these lakes (map code of N, O and P). White Water Lake and Brown Lake are considered to be hydrologically connected (surface and groundwater) but are probably disconnected from Nonalling Lake. The three northern lakes are not connected to Lake Yealering.

A limited study of the tributaries indicates that Boyning Gully may have the highest flow rate and Walellemining Brook may have the highest salt concentration (Pelham-Thorman et al., 1976). This study suggests that 57% of the inflow to Lake Yealering is from the Wogolin and Boyning catchments.

Lake Yealering has variable period of inundation. It did not dry out during the years 1982-5 and 1989-92 (eight out of thirteen years). The northern lakes did not dry out in 1984 (one to four years out of thirteen).

The maximum depth of Lake Yealering is 2.56 m (recorded in July 1983). The average depth during September is 1.55 m. Nonalling Lake has a maximum depth of 1.62 m and a September average depth of 0.94 m. The depth of other lakes ranges between these two.

Salinity in Lake Yealering was recorded at 267 000 mg/L TSS (ie over 7 times sea water salinity) in January 1981. The lowest recorded salinity was 430 mg/L TSS (ie water quality suitable for drinking) in September 1983. The average salinity in September is 32 700 mg/L TSS. Table 1 details a salinity classification, with typical values for seawater as a comparison, for different salinity units.

The lake was shown to be stratified (more

Table 1: Salinity classification

Classification	mg/L	mS/m	mS/cm	grains/gallon
Fresh	0 – 550	0 – 100	0 – 1	0 – 38
Marginal	550 – 1100	100 – 200	1 – 2	38 – 77
Brackish	1100 – 5000	200 – 900	2 – 9	77– 346
Low saline	5000 – 11000	900 – 2000	9 – 20	346 – 770
High saline	11000 – 30000	2000 – 4500	20 – 45	770 – 1733
Hyper-saline	30000 – 88000	4500 – 12200	45 – 122	1733 – 4697
Sea water	**35 000**	**6363**	**64**	**2450**

Photo 2: Shallow lakes adjacent to Lake Yealering (the 'swamp')

Photo 3: Avon River – stream flow from Cuneenying Brook and outflow from Lake Yealering

saline at depth) by Pelham-Thorman et al. (1976) although it is expected that the water body would become well mixed by wind especially as it shallows.

Nonalling Lake had a salinity recording of 38 300 mg/L TSS in January 1981 and was as low as 1760 mg/L TSS in July 1983. The September average for this lake is 12 800 mg/L TSS.

Nutrient levels in the lakes are not well known. While there are no records of algal blooms or eutrophication, there are local reports of mal-odours. It is likely that the pungent smell is due to decaying biomass in the lake rather than algal blooms.

Water pH for all lakes was within the range of pH 7-10.4 (neutral to slightly alkaline).

The influence of groundwater on the lakes is not known. It is clear from vegetation decline that salinity in the lakes has increased in recent time. This may be due to the increased salt concentration of inflow or due to longer periods of inundation with increased surface water runoff from agricultural catchments. Alternatively, there may be increasing saline discharge to the bed of the lakes due to rising groundwater tables. This appears to be occurring in adjacent agricultural land and if so, is likely to also occur in the lakes. There has been no prior detailed assessment of salinity risk or the changing hydrological processes affecting the lake system.

Appendix 1 contains the water quality and depth information from monitoring undertaken by the Department of Conservation and Land Management for the period 1978-2004.

Landform

The lakes are described as connected sump lands located in a broad valley filled with alluvial (river-derived) and lacustrine (lake-derived) deposits.

Biodiversity Values[1]

Australia is recognised as one of the world's 12 most biologically diverse countries and the south-west of Western Australia is identified as one of 25 biodiversity 'hotspots' where there is exceptionally rich biota and high endemism, particularly for wildflowers, at risk from threatening processes. The Avon Wheatbelt IBRA region (Thackway and Cresswell, 1995), which includes the Lake Yealering System, is also one of 15 biodiversity 'hotspots' that have been identified as nationally important.

The Lake Yealering System is classified as a Wetland Type B8 (inland wetland – seasonal/intermittent saline lakes) in the Directory of Important Wetlands in Australia (Environment Australia, 2001). The lake system (Directory code: WA004) is one of 5 wetlands listed as important nationally within the Avon Wheatbelt IBRA region (Interim Biogeographical Regionalisation of Australia, Thackway and Cresswell, 1995) and is approximately 10% of the total area of important wetlands within this IBRA region. The Yealering Lakes System is one of 28 wetlands classified as B8 in Western Australia and one of 79 in Australia. There are a total of 120 important wetlands in Western Australia and 851 wetlands are listed nationally.

The criteria listed for classification of the Lake Yealering System as nationally important are:

- Seasonal and irregular rivers and streams;
- Inland deltas (permanent);

[1] Information derived from the *Directory of Important Wetlands in Australia Third Edition* (Environment Australia, 2001) which includes data from RAOU (now Birds Australia) and CALM bird surveys undertaken 1981-91.

Map 5
YEALERING LAKES SYSTEM Floodplain and Salt Affected Areas

LOCALITY MAP

LEGEND

- Local Road - Sealed
- Towns
- Local Government Authorities
- Areas at Risk of Becoming Saline
- Recent Saline Areas (1995-1998)
- Older Saline Areas (1989-1991)
- Year 2000 Bush Mask
- Landsat TM Band 5 Background

Datum and Projection Information

Vertical Datum: AHD
Horizontal Datum: GDA 94

Project Information

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Map Author: Hamish West
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File Location: \\Pentecost\gis_projects\RS\Sn\96209\0003\
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SOURCES

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Road Centreline, DLI	DLI	01/04/2004
Towns	DLI	08/2004
Local Government Authorities	DLI	08/07/2004
Geographic Names	DLI	15/07/2005
Salinity Mapping LM 25m	DLI	11/2001

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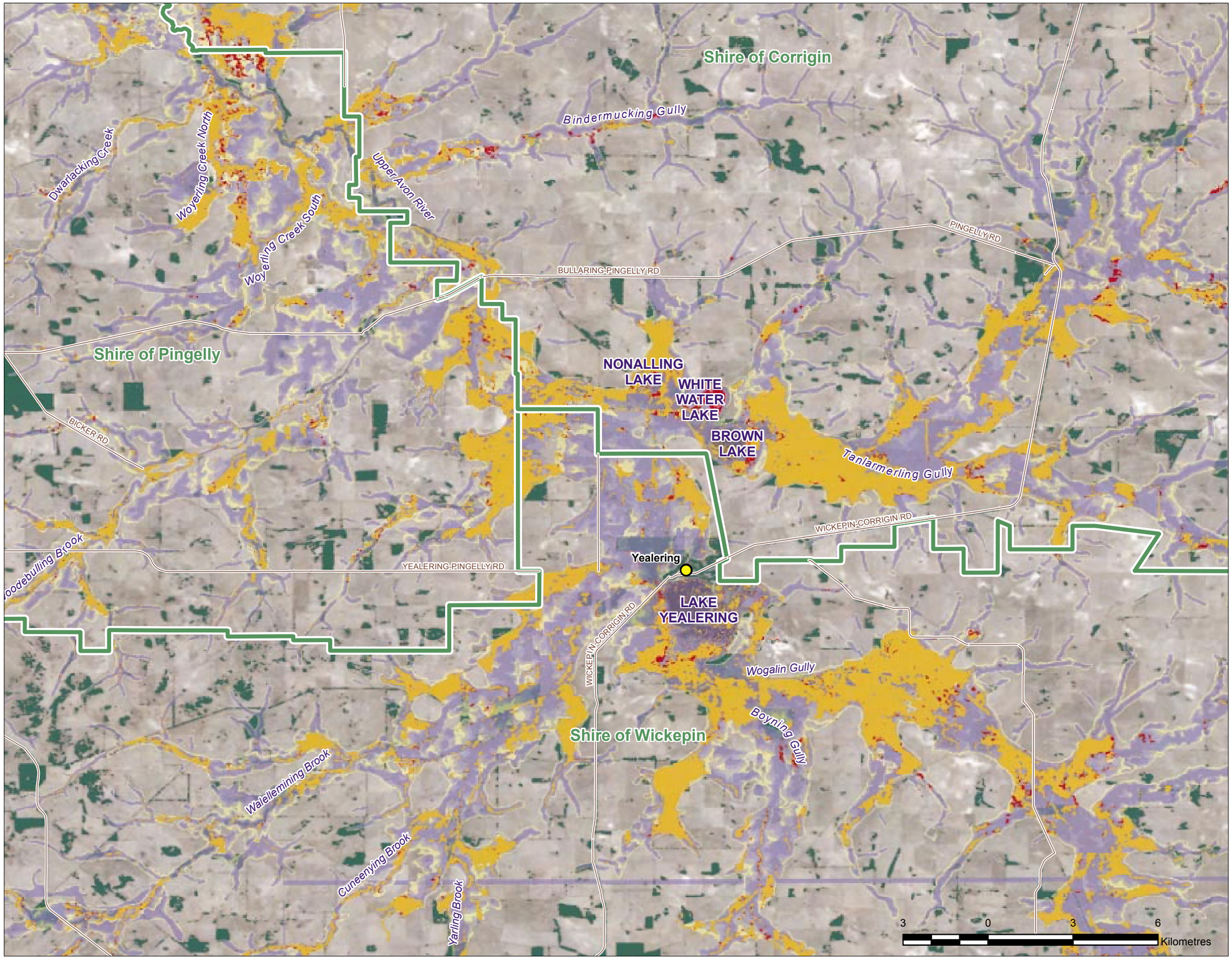

Map 5: Yealering Lakes System Floodplain and Salt Affected Areas

- Riverine floodplains; includes river flats, flooded river basins, seasonally flooded grassland, savanna and palm savanna;
- Permanent freshwater lakes (> 8 ha); includes large oxbow lakes; and
- Seasonal/intermittent freshwater lakes (> 8 ha), floodplain lakes.

The lakes provide significant drought refuge for water birds in the agricultural inland of south-western Australia. The lakes were formerly of open woodland vegetation and were probably relatively fresh. Stags from trees killed by increased inundation and salinity remain in the lakes. The fringing vegetation is also open woodland (*Casuarina obesa* and *Melaleuca* spp.) with low shrubland dominated by samphire (*Sarcocornia* and *Halosarcia* spp.) understorey (Photo 4). There are no records of threatened flora or fauna species in the lake system.

Forty-two bird species have been recorded for the lake system, including 33 species at White Water Lake. Some species, for example Blue-billed Duck (*Oxyura australis*), occur only when the lakes are deeper than average (eg 2 m) and the water quality is fresh/brackish (as occurred in spring, 1983). Up to seven Freckled Duck (*Stictonetta naevosa*) were recorded through spring 1983, when at least one pair possibly bred in inundated live open-scrub between White Water Lake and Brown Lake. One Freckled Duck was recorded at Lake Yealering in November 1991. Two Hooded Plover (*Thinornis rubricollis*) were at White Water Lake in July 1982.

Breeding water birds include:

- Pacific Heron (*Ardea pacifica*);
- Little Pied Cormorant (*Phalacrocorax melanoleucos*);

Photo 4: Samphire shrubland dominates the Lake Yealering fringing vegetation

- Silver Gull (*Larus novaehollandiae*) – bred at White Water Lake and/or Brown Lake in spring 1983;
- Black Swan (*Cygnus atratus*);
- Pink-eared Duck(*Malacorhynchus membranaceus*); and
- Eurasian Coot (*Fulica atra*) – breed throughout the system.

The highest number of waterbirds counted was 13 493 (waterfowl only) at Lake Yealering in March 1992. A total of 11 134 waterbirds were recorded at Brown Lake in March 1991 and 3 204 at White Water Lake in September 1982. The total number of waterbirds for the lake system in March 1991 was 18 118 and 19 523 in March 1992.

The most abundant species are:

- Grey Teal (*Anas gibberifrons*) – approximately 10 500 recorded in March, 1991 in Brown Lake;
- Banded Stilt (*Cladorhynchus leucocephalus*) – 2 880 recorded in September, 1982 at White Water Lake; and
- Australian Shelduck (*Tadorna tadornoides*) – 1 556 recorded in March 1991 at Lake Yealering.

The site is also regionally significant for the Red-kneed Dotterel (*Erythrogonys cinctus*) (150 recorded in November 1984 at White Water Lake). Information from bird surveys is contained in Appendix 2.

The biodiversity survey of the Western Australian agricultural zone (Keighery et al., 2004) included Nonalling Lake as a survey site (Site Code: SPS011) but not the other significant lakes of the Yealering Lakes System.

The Yealering Lakes System is also recognised as a 'medium' level waterscape asset with high existing or short-term threat (SIF, WA State Government, 2003) and as an asset of national, regional and local significance in the *Avon NRM Strategy* (ACC, 2005)

Current research

The Lake Yealering system is one part of a regional research project undertaken through Murdoch University. Current studies include assessment of the aquatic and riparian environments and will provide an understanding of ecosystem processes as well as measures of soil and water physical and chemical properties. Joanne O'Connor commenced a PhD in 2004 investigating the ecological processes in primary and secondary saline wetlands. Victoria Hartill completed an Honours project in 2005 on the effects of salinity on fringing vegetation of primary and secondary salinised lakes. Lake Yealering is considered to be a productive wetland system as indicated by submerged macrophytes (*Ruppia* spp.). The adjacent lakes of the 'swamp' are now hyper-saline and are less biologically productive (Assoc. Prof. Jenny Davis and Dr Jane Chambers, pers. comm.).

The recent survey of biodiversity in the agricultural zone of Western Australia (Keighery et al., 2004) has shown the potential high risk to biota in the Wheatbelt due to increased salinity, particularly in valley floor positions where most wetlands are located. This study indicates that the composition of biological communities in wetlands is affected by salinity, especially with salt concentrations greater than 10-20 000 mg/L TSS.

2.2 Adjacent Landscape

The Yealering Lakes sub-region is one of nine Land Resource sub-regions within the Avon River Basin (DAWA, 2003). It occurs on granites and gneisses in the central 'Wheatbelt' and the Great Southern district.

Table 2: Tributary characteristics for the Yealering Lakes Section

Code	Tributary name	Area (km^2)	Relief (m AHD)	Channel gradient (m/km)	Length (km)
F	No name provided.	40.7	360-260	6.2	16.1
G	Woyerling Creek (North)	18.5	270-260	1.3	7.7
H	Woyerling Creek (South)	37.9	340-260	4.8	16.8
I	Woodebulling Creek	164.0	410-260	4.1	36.6
J	Wallellemining Brook	128.3	400-280	5.5	21.7
K	Cuneenying Brook	87.8	410-280	7.3	17.8
L	Boyning Creek	143.8	340-280	2.3	25.7
M	Wogolin Gully	253.9	330-280	2.4	20.7
N	Tanbarmering	88.9	320-270	3.6	13.9
O	No name provided.	146.0	270-260	0.5	19.4
P	No name provided.	34.2	280-270	0.1	10.0
Q	No name provided.	76.8	N/A	N/A	16.0

The towns of Corrigin, Kulin, Wickepin and Yealering are located within the sub-region.

The annual rainfall for Yealering is 375 mm and annual evaporation is approximately 1900 mm.

The sub-region is characterised by low relief landscapes. Grey lateritic gravelly sandplain soils are found on uplands originally vegetated by diverse heath, and sandy duplex soils are found in flat valleys (2-3 km wide), originally vegetated by salmon gum (*Eucalyptus salmonophloia*) and wandoo (*Eucalyptus wandoo*) woodland. The majority of lakes within the sub-region were fresh prior to clearing.

The tributary catchments for the Yealering Lakes Section are shown on Map 3. The area and relief for each tributary catchment and the gradient length of stream channels is shown in Table 2.

The extent of salinity within the Yealering Lakes sub-region is currently 5.6% of agricultural land (the extent for the Avon River Basin is 4.5%). It is estimated that this could increase to 19.1% (over 25% for the Avon River Basin) based on information derived from the *Land Monitor Project.* This project was undertaken by State Government agencies in 2002 and linked digital elevation modelling to aerial photography and satellite imagery with calibration for local landform.

Sub-surface soil compaction is a significant land management issue identified for the Yealering Lakes sub-region (DAWA, 2003).

2.3 River Channel and Floodplain

The condition of the river channel and riparian zone within the Yealering Lakes section is not well known. River pools are not considered locally to be significant. A survey of foreshore condition (after Pen and Scott, 1995) is proposed.

The floodplain is broad and generally poorly defined. Most of the floodplain is currently in use for agriculture although

considerable areas are now salt-affected. The extent of salinity is expected to increase significantly within the floodplain. Processes of salinity relevant to the lakes and floodplain are described in the *Yenyening Lakes Management Strategy 2002-2012* (WRC and CALM, 2002).

2.4 Land Tenure and Use

The land area of Lake Yealering (including the lunettes with fringing vegetation) is vested with the Shire of Wickepin (Recreation Reserve 9610). Adjacent land is privately owned and generally used for agriculture. Several smaller properties are privately owned for conservation or recreation use.

Nonalling Lake, White Water Lake and Brown Lake are contained within the Nonalling Nature Reserve (Reserve 24428) managed by CALM for the WA Conservation Commission.

Lake Yealering is important locally and within the region for water-skiing and other water sports, including a protected swimming area. Brown Lake and White Water Lake were previously popular for duck-shooting. This is now banned in Western Australia.

The town of Yealering is located on the northern bank of Lake Yealering. A caravan park, golf course and rifle range (now disused) are also located on the banks of the lake.

Agricultural use of land is primarily for low rainfall cereal cropping and grazing.

Many farmers are aiming to implement sustainable farming practices. Some have adopted new production options to control salinity or increase productivity of salt-affected land. The Facey Group provides leadership for sustainable farm practice within the Shire of Wickepin. Landholders with property associated with the Lake Yealering System are listed in Appendix 3.

3 Developing the Recovery Plan

The Recovery Plan for the Yealering Lakes section of the Avon River is one of a series of recovery plans developed in association with local communities along the main channel and tributaries of the Avon River system by the Department of Water (DoW) (Northam Office). This section is closely linked to the Aldersyde-Kweda Section River Recovery Plan (DoW, 2006).

3.1 The Planning Process

The recovery planning process commenced with a reconnaissance-scale field survey and an initial meeting (April, 2005) with local community and Shire representatives to provide scope for the range of management issues to be addressed. This was followed by a well-publicised public meeting held in the Yealering Community Centre (April, 2005) at which the range of environmental, social and economic values were developed and the key threatening processes identified. The outcomes of the public meeting are listed in Appendix 4. A small interim Steering Committee was appointed to provide local direction for the planning process.

The 'vision' and 'management objectives' for the Recovery Plan were developed with the interim Steering Committee and a range of management response actions were proposed during a following meeting (July 2005). Some of the options were assessed in the field on several occasions.

The recommended actions were discussed at a final public meeting held in Yealering (November 2005).

The Department of Water has led the planning process with participation by those with interest in the local community, the Shire of Wickepin, the Facey Group, CALM and the Avon Catchment Council (ACC). The outcomes expected are to have a Recovery Plan that is understood and endorsed locally, and for a Recovery Team to be formed with local community and government representation and with support from State Government agencies and the ACC.

The Facey Group offers an opportunity for coordinated implementation of management actions.

3.2 A 'Vision' for the future

The 'vision' developed by the interim Steering Committee to provide direction for management actions for outcomes by 2025 is that:

> *'The lakes near Yealering are recognised as the source of the Avon River. They are also recognised as wetlands of national importance that are managed as an integrated part of catchments being farmed with sustainable practices. Lake Yealering provides prolonged recreational opportunities for the region and is attractive to tourists. The nature conservation values of the lakes are increasing through local interest and care. The threatened impacts of salinity and occasional flooding on the town of Yealering, farms and roads or rail adjacent to the lakes is reduced. Reconstructed ecosystems, including some commercial options, are established in priority sections of the Avon River channel and floodplain downstream from the lakes and major tributaries.'*

The 'vision' for the Yealering Lakes Section Recovery Plan combines environmental and social expectations with productive

agricultural land use in the catchments of tributaries to the lakes. It addresses concerns about changing landscapes and seeks new opportunities for integrated management processes, including reconstructed ecosystems that may provide farm production benefits. The 'vision' recognises the need for multiple-asset management (ie managing land, water and biodiversity assets) and the national, state, regional and local priorities for natural resource management.

3.3 Key Issues for Management

The key management issues raised through public meeting processes (22 April 2005) are listed in the table below.

Table 3: Key issues for management in the Yealering Lakes Section

Salinity	• Concern about rising water tables under the town of Yealering (Existing groundwater monitoring records to be obtained by DoW), What impact on water supplies? • Affect of increasing lake salinity and rising groundwater on the fringing vegetation to the lakes. • Potential for substantial increase in salinity on farm land adjacent to the lakes. • Priority for risk reduction of salinity in the valley floor is recognised.
Stream flow continuity	• Problems with sedimentation of the flow channel. The area upstream of White Water Lake is identified. • Concern about the effect of road crossings (eg Squires Road bridge). • Deep drainage proposals need to be linked with flow continuity of the Avon River channel.
Lake Yealering water level	• Community want high water levels in lake for a longer period (to extend the recreation opportunity). Preferred depth is approximately 2.5 metres. Note – increased water levels are not being considered due to the potential for increased flooding and salinity. • Stream flow from northwest tributary diverted from Lake Yealering by earthworks on private property to reduce road and rail flooding (constructed during early 1980s?). • Concern about inflow through the natural lake outlet (due to stream flow diversion) and the impacts of sedimentation near the outlet and within the lake. • Concern about inundation of two 'gap areas' where water ponds at high levels and may be causing increased salinity in these areas. • General interest in sediment management options (dredging the lake over-all or in selected sections, sediment removal from the outlet). • Weed growth in Lake Yealering is related to water depth (the weed may be a *Ruppia* spp.). The weed reduces recreation opportunities (but also may increase water bird food and habitat). What options to control the weed?
Flooding	• January 2000 flood event effectively defines area at risk to inundation. • Concern about increased salinity following flood inundation.
River Pools	• No pools were identified as being particularly valued.
Fire	• Not an issue particularly related to river or lake management.
Weeds and feral animals	• Weeds include bridal creeper, spiny rush, soursob, cape tulip, couch (and the potential for increased sedimentation build-up – stabilising sediments may be an advantage in some areas). • Samphire is not a weed but is considered troublesome due to sediment entrapment. • Feral animals include rabbits and foxes. • Increasing numbers of kangaroos is a concern to some people.

Riparian zone vegetation management	• Fencing to restrict livestock access to the river is considered good management but the key issue is where to place the fence with the floodplain being very extensive in some sections. Concern also about the potential impact of floods on river fencing. • Most riparian vegetation is salt-affected. Some interest in rehabilitation with commercial species or natural ecosystem reconstruction. • General aim should be to improve the condition of riparian vegetation.
River crossings and public access	• Not considered to be a significant issue.
Nutrients and pollution	• Rubbish tips – both private and public (including one adjacent to Lake Yealering).

3.4 Local Management Objectives

The management objects for the Yealering Lakes Section Recovery Plan are:

Objective 1: The number of bird species breeding within the environment of the lakes is increased;

Objective 2: The period of water-based recreation in Lake Yealering is extended by 10%;

Objective 3: The annual number of over-night tourists has increased by 50%;

Objective 4: Five Landcare groups and the Yealering Lakecare group, coordinated through the Facey Group, are effectively implementing actions of a strategic catchment-scale assets management plan (Local Area Plan);

Objective 5: The assessed risk of salinity in the floodplain and land adjacent to the lakes is reduced by 50% and salt-affected land is productive; and

Objective 6: Near-natural ecosystems are re-established on 20 km of priority sections of the river and tributaries.

The time period for achieving these Management Objectives is 10 years (ie by 2016).

4 Proposed Management Actions

The actions required to achieve the Management Objectives are listed below. Some actions for one objective will also contribute to other objectives. The implementation of all of the following actions is subject to the availability of funding and regional priorities through the Avon Catchment Council Natural Resource Management Strategy and Investment Plans.

The priority for actions and the extent to which each action is implemented should be established by an assessment of *risk* (ie of the threatening processes) and of *feasibility* (ie the potential for the action to effectively achieve the intended outcomes).

4.1 Proposed Actions for Biodiversity Management

The Yealering Lakes System is recognised as a nationally important wetland (section 2.1) particularly for water bird refuge during summer and drought. Lake Yealering was previously fresher than at present. Increasing salinity or periods of inundation have caused decline in the open woodland vegetation in the lakes and fringing vegetation. This reduces habitat value for birds and other fauna. However, the lake remains productive with colonisation of seagrass (*Ruppia* spp.) that is a food source for water birds.

The objective for maintaining or enhancing biodiversity values is set for bird species that breed within the lakes system with the understanding that habitat value improvement to achieve this will provide other ecosystem benefits.

The proposed management actions are intended for implementation primarily at Lake Yealering. The northern lakes are contained within the Nonalling Nature Reserve which is managed by CALM. Management of all lakes within the Yealering Lakes System should be integrated for consistent beneficial outcomes.

Objective 1: *The number of bird species breeding within the environment of the lakes is increased.*

Risk Assessment:

- Salinity is affecting the habitat value of some areas of fringing and adjacent vegetation. This is particularly important in the area of natural vegetation west of Lake Yealering (Photo 5). Groundwater levels are not monitored in this area at risk, however it is expected that the decline in vegetation condition will continue without significant intervention.
- The quality of water may be causing algal blooms or eutrophic conditions in some parts of lakes although the potential for this to occur is unknown. The risk may be higher following runoff from a summer storm event.
- The biological assemblage in the water body of Lake Yealering will decline if salinity increases. Records of salinity show that salinity has a range from being many times greater than seawater to being relatively fresh. This suggests that the existing biota is relatively resilient to salinity fluctuations. The risk will increase if the prolonged period of inundation with high salinity levels is increased (above 10-20 000 mg/L TSS). A preferred monitoring target is for water quality to be less than 7 000 mg/L TSS for 2-3 months during spring to maintain biological diversity and production although based on previous water

Photo 5: Decline in vegetation west of Lake Yealering

quality monitoring (Appendix 1), this will be difficult to achieve. A more achievable target of 20 000 mg/L is proposed. Maintenance of fresh surface flows to the lake and the capacity for flushing through the lake is important.

- The plant growth in Lake Yealering (*Ruppia* spp.) is considered a hazard for water skiing and may cause mal-odours during summer, it is significant with a productive lake system for habitat value (food source).

Proposed Actions:

1. Develop base-line information for bird species diversity, richness, breeding and habitat value (based on existing data from CALM, Birds Australia and local records);
2. Establish regular long-term bird surveys and habitat condition monitoring;
3. Develop base-line information for water quality (salinity, nutrients, turbidity) and link to an on-going water quality monitoring program, including stream flow in significant tributaries to the lakes (Note: salinity risk for fringing vegetation is linked to Objective 5). An annual monitoring target of having the water quality in Lake Yealering maintained at less than 20 000 mg/L TSS for 2-3 months during spring is proposed;
4. Establish the preferred 'environmental water requirements' for Lake Yealering (considering the water quality of tributaries, the period of inundation and the frequency of flushing);
5. Assess options for increased fresh flow from tributaries (eg from Boyning Gully – linked to Objective 4), reducing sediment and nutrient flows from tributaries (eg by sediment detention

in one or more shallow lakes in the 'swamp') and reduced saline inflows (eg from Cuneenying Brook); and

6. Identify priority areas of fringing vegetation with potential for recovery or enhancement (eg the 'swamp', the two 'gap' areas of Lake Yealering and the vegetation west of the lake). Management responses are linked to Objective 5.

Feasibility Assessment:

The impact of salinity on the Yealering Lakes System is substantial and the potential for recovery of the original wetland condition is very limited. However the lake system retains significant biodiversity values that can be protected or enhanced. Increased fresher stream flow from contributing catchments can be an expected outcome of integrated surface water management. Inflow of more saline stream flow (eg backflow from Cuneenying Brook through the lake) can be controlled with simple flow control structures.

Change to fringing vegetation to the lakes is too advanced for recovery to original ecosystem values. The degraded natural vegetation west of Lake Yealering could recover if groundwater levels were reduced. Groundwater pumping is one option that could be considered. Disposal of discharge water is a major consideration. The options to be considered are disposal to the lake, disposal to the Avon River (although this is not flowing continuously) or temporary discharge to detention pondage with controlled winter release.

4.2 Proposed Actions for Water-based Recreation

Lake Yealering provides opportunities for recreation for the Yealering community and for many others within the region. Water skiing is popular although the opportunity is limited by water depth in the lake (a depth of 1.5 m or more is preferred). Water was occasionally pumped into an earth-wall tank for swimming (Photo 6). There are now concerns about public health risks due to water quality although there are no measures of nutrients or other contaminants that may cause public health problems.

Water skiing is an activity that is suitable for families in the Wheatbelt. There are few similar opportunities of interest for younger people within the region. The community would like to increase the opportunity for water-based recreation. They recognise that increasing the depth of water in Lake Yealering is not feasible without major earthworks to increase the banks or lower the lake bed. The additional risk to fringing vegetation and adjacent farmland from increased water depth is understood.

However, the community would like to prolong the period over which the depth of water in the lake remains suitable for water skiing.

Objective 2: *The period of water-based recreation in Lake Yealering is extended by 10%.*

Risk Assessment:

Prolonged inundation of Lake Yealering may not significantly increase the risk to biological productivity especially if the water body is relatively fresh (ie less than 7 000 mg/L TSS). The risk would increase if the lake was not able to have a dry period. A period of up to 2-3 years without a dry lake bed may also be of low risk. The risk would be considerably higher if the water body was of high salinity (> 10 000 mg/L TSS) for a prolonged period of lake inundation.

Photo 6: Community facilities for swimming in Lake Yealering.

Proposed Actions:

1. Develop base-line information for the current hydro-period of Lake Yealering (linked with Action 4 for Objective 1);
2. Assess options for increasing environmental flows to the lake. The options include stream diversion (eg with gates to increase flow from Cuneenying Brook into the lake), increased surface runoff from tributaries (eg from Boyning Gully – linked to Objective 4) and discharge from engineering options for salinity control to the lake;
3. Evaluate the hydro-period benefits and risks from additional groundwater discharge to the lake; and
4. Arrange on-going monitoring for lake hydro-period and water quality.

Feasibility Assessment:

The current hydro-period of Lake Yealering is not clearly documented, however it may be assumed that an additional 30 days annually with water levels suitable for skiing would meet community expectations. This would require replacement of evaporative loss during this period (approximately 8 300 m^3/day), a total volume of approximately 250 000 m^3. The total volume of the lake (based on the average September depth of 1.55 m) is 2 500 000 m^3. The additional volume required is about 10% of the average September volume.

Diversion of water from Cuneenying Brook to Lake Yealering is feasible with relatively simple gate or temporary sand bag structures. However, limited assessment of stream flow water quality shows this

source is probably greater than 10 000 mg/L TSS. If used for increased lake volume, the additional annual salt load would be approximately 2 500 tonnes. The total salt load of the lake at the preferred maximum water quality of 7 000 mg/L TSS is 17 500 tonnes. The additional inflow would increase the salt load by 14.3%. The salinity of the average September water body would then be increased to approximately 16 000 mg/L TSS which exceeds the critical level (approximately 10 000 mg/L TSS) above which biological community composition is expected to decline.

Increasing water levels in the lake by drainage for salinity control is probably not feasible without supplementary pumping due to inadequate gradient in the valley floor. The risks due to sedimentation could be increased. The salinity of discharge water may be higher than 10 000 mg/L TSS.

Groundwater pumping is an option that could provide additional production and environmental benefits. However, over 300 pumps (assuming a discharge rate of 25 kL/day) would be required to replace evaporate losses for 30 days. The capital cost of these would exceed $2.5m. Operating costs and maintenance would be additional. The quality of groundwater pumped would probably be greater than 10 000 mg/L TSS.

Options to excavate the lake bed to increase water depth by 0.5 m could cost in excess of $3m (local community estimates) and would result in 800 000 m^3 of spoil for disposal. The environmental impact on the lake and adjacent land would be considered unacceptable. Partial excavation could be more feasible but still expensive and with environmental risk.

The most feasible option for increased inflow to Lake Yealering is by increased surface water runoff from tributary catchments (eg Boyning Gully).

4.3 Proposed Actions for Eco-tourism

The Yealering community takes pride in being one of Australia's few rural towns situated on the banks of a naturally occurring wetland. The caravan park and golf course are characterised by being adjacent to Lake Yealering. The community want to retain this distinctive character. The potential to attract tourists for diversified enterprises within the community through promotion of the nationally important wetland is recognised.

Objective 3: *The annual number of over-night tourists has increased by 50%.*

Risk Assessment:

Tourism is a key opportunity for the Yealering community but may be limited by poor water quality, short recreational period or by being of low profile.

The risk of additional visitation by tourist with an interest in the environmental values of Lake Yealering is low.

Proposed Actions:

1. Develop base-line information for tourist visitation;
2. Identify key eco-tourist and water-based recreational requirements (eg bird observation, walk opportunities);
3. Develop and implement an eco-tourism promotional plan; and
4. Monitor tourist visitation and responses.

Feasibility Assessment:

While the distinctive image of a rural community with active involvement in a wetland (for conservation and recreation) is desirable, attracting eco-tourists in sufficient numbers to provide an economic benefit will require considerable effort in development of facilities and promotion.

More people may be attracted by increased opportunities for water skiing, however this could detract from the interests of eco-tourists. Multiple-benefit tourism planning would be required to integrate recreational use and eco-tourism.

4.4 Proposed Actions for Integrated Catchment Management

Land management planning and development of sustainable farming systems has been significant in the Shire of Wickepin. The Facey Group now provides leadership and direction for sustainable production and natural resource management within the Shire.

Investment in natural resource management (NRM) through the Avon Catchment Council is to be delivered through regional-scale projects linked to Local Area Plans (based on local government authority boundaries). The opportunity exists for preparation of a 'Local Area Plan' for the Shire of Wickepin that integrates the actions of the Yealering Lakes Section Recovery Plan with natural resource and farming system management within tributary catchments. Support for existing or renewed group processes will be required. Boyning Gully and Wogolin Gully catchments are a priority for Lake Yealering. The tributary catchments for the lakes within the Nonalling Nature Reserve are also important.

The Local Area Plan should have targets set to increase stream flow to the lakes with low salt load.

The opportunity to provide support for a Yealering Lakecare group should also be developed through the Local Area Plan.

Objective 4: *Five Landcare groups and the Yealering Lakecare group coordinated through the Facey Group are effectively implementing actions of a strategic catchment-scale assets management plan (Local Area Plan).*

Risk Assessment:

Farmer-based groups are keen to increase productivity and reduce salinity risk. The off-site impacts of increased nutrient loss, salinity or sedimentation could increase without appropriate on-site and off-site planning.

Proposed Actions:

1. Review Landcare and Lakecare group structures within the catchments of the lakes (ie identifying existing effective group initiatives and additional group requirements);
2. Prepare a Local Area Plan for multi-asset management (arranged through the Avon Catchment Council);
3. Assess options for increased low-salinity stream flow to Lake Yealering and opportunities to reduce salinity of land adjacent to the lakes;
4. Develop cost-share arrangements for implementation of proposed works, considering public and private benefits; and
5. Monitor the rate of implementation and indicators of resource condition change.

Feasibility Assessment:

Group development and support can be arranged through the organisational structure of the Facey Group.

The rate at which 'on-ground' actions for lake benefit are implemented will be determined largely by cost-share arrangements.

4.5 Proposed Actions for Salinity Risk Management

The impact of salinity on the lake system and adjacent land is evident. The extent to which salinity may increase is currently unknown. Some landholders have undertaken extensive works to reduce salinity risk (eg with revegetation) or increase salt land productivity. The extent to which appropriate works are being implemented could be substantially increased.

Commercial tree crops provide one option with salinity control benefits. Integrated surface and groundwater control within the tributary catchments is also significant. Potential use of groundwater pumping to protect or recover agricultural land and natural vegetation values should be considered.

Objective 5: *The assessed risk of salinity in the floodplain and land adjacent to the lakes is reduced by 50% and salt-affected land is productive.*

Risk Assessment:

Valley floor salinity is expected to increase significantly without further management intervention however a quantified salinity risk assessment has not been undertaken. Increased salinity will further impact on farm land, the lakes and community infrastructure.

Proposed Actions:

1. Arrange a salinity risk assessment for the valley floor and tributary catchments to the Lake Yealering System (including field survey, application of geophysics and groundwater investigations);
2. Develop a catchment water balance model for management decision support which shows potential surface runoff and salt load for a range of landscape management scenarios;
3. Evaluate salinity management options (including comprehensive engineering or comprehensive plant-based options);
4. Prepare a salinity response plan (including environmental, social and economic impact assessment) for priority areas (based on asset values and site responsiveness) linked to the Local Area Plan;
5. Develop cost-share arrangements for implementation of proposed works; and
6. Monitor the rate of implementation and indicators or resource condition (eg groundwater response, salinity in water bodies).

Feasibility Assessment:

A quantified salinity risk assessment will provide the basis for assessment of the feasibility of intervention actions for salinity control. This assessment should show:

- The extent to which salinity may increase (ie to what extent is the valley floor approaching a new hydrological equilibrium?);
- The time period to full extent of salinity impact; and
- The predicted response to intervention actions.

The salinity risk assessment will identify the scale of works required to achieve a 50% salinity risk reduction. Decisions about the hydrological efficiency and cost-effectiveness of these actions should be based on the salinity risk assessment.

4.6 Proposed Actions for River and Floodplain Management

The Avon River downstream from the Yealering Lakes System is not well recognised as a functioning river ecosystem. Riparian vegetation is this section is significantly altered or degraded. The floodplain is generally broad and

poorly defined. Flood flows during January 2000 indicate the extent of the functional floodplain.

The length of the Avon River within the Yealering Lakes Section (ie from Lake Yealering to Squires Road) is approximately 30 km.

Objective 6: *Near-natural ecosystems are re-established on 10 km of priority sections of the river and tributaries.*

Risk Assessment:

Remnant vegetation in the river channel environment and tributaries is continuing to degrade due to salinity, grazing and weeds.

Proposed Actions:

1. Conduct foreshore surveys of the Avon River downstream from the Lake Yealering System to identify priority areas for reconstructed ecosystems;
2. Evaluate near-natural ecosystem and commercial species options for revegetation in priority areas adjacent to waterways;
3. Prepare a riparian ecosystem reconstruction plan linked to the proposed Local Area Plan;
4. Develop cost-share arrangements for implementation of proposed works; and
5. Monitor the rate of implementation (eg the area revegetated) and indicators of resource condition (eg natural species regeneration).

Feasibility Assessment:

Some sections of the Avon River channel are probably too degraded for ecosystem recovery. The proposed foreshore and channel condition survey will identify the sections of the river that have retained riparian vegetation in reasonable condition. These sections should be a priority for protection and enhancement.

5 Implementation of the Recovery Plan

The proposed lead role for implementation of actions for each management objective of the Yealering Lakes Section Recovery Plan is identified in Table 4.

Coordination of implementation of all actions is to be provided by the Facey Group. The Department of Water (DoW) in partnership with the Avon Catchment Council (ACC) has provided leadership in preparation of the Recovery Plan and will continue to take a key role for implementation. In a similar way, the Department of Conservation and Land Management (CALM) and the Shire of Wickepin have key roles for implementation of actions.

The Yealering Lakes Section Recovery Plan should be linked with the following management plans or initiatives:

- River Recovery Plan, Foreshore and Channel Assessment Aldersyde-Kweda Section 19 (DoW, 2006);
- Management of the Nonalling Nature Reserve (CALM);
- On-going water bird surveys and wetland monitoring (undertaken by CALM);
- Other State and National wetland management initiatives;
- Town and infrastructure planning for Yealering (Shire of Wickepin);
- Existing catchment and Landcare groups (Facey Group);
- The Avon NRM Strategy and Investment Plan (ACC, 2005); and
- Proposed Local Area Plan (Facey Group).

Actions for ongoing monitoring for the Yealering Lakes System should be linked to existing research and monitoring initiatives, conducted by CALM and Murdoch University.

Partnership arrangements between the Facey Group (representing all key roles for implementation) and the ACC should be developed for investment in a regional-scale project for management of the Yealering Lakes System and associated catchments. Management of the lakes as wetlands of national importance should be recognised as being of high regional priority.

Table 4: Proposed Actions and Lead Roles for the Yealering Lakes Section Recovery Plan

Objective 1: *The number of bird species breeding within the environment of the lakes is increasing.*

Code	Action	Lead role	Comments
1.1	Develop base-line information for bird species diversity, richness, breeding and habitat value.	CALM	Based on existing data from CALM, Birds Australia and local records.
1.2	Establish regular long-term bird surveys and habitat condition monitoring.	CALM	Potential long-term role for *Birds Australia*.
1.3	Develop base-line information for water quality (salinity, nutrients, turbidity) and link to an on-going water quality monitoring program, including stream flow in significant tributaries to the lakes.	DoW	Note: salinity risk for fringing vegetation is linked to Objective 5. An annual monitoring target of having the water quality in Lake Yealering maintained at less than 7000 mg/L TSS for 2-3 months during spring is proposed.
1.4	Establish the preferred 'environmental water requirements' for Lake Yealering (considering the water quality of tributaries, the period of inundation and the frequency of flushing).	DoW	
1.5	Assess options for increased fresh flow from tributaries (eg from Boyning Gully), reducing sediment and nutrient flows from tributaries (eg by sediment detention in one or more shallow lakes in the 'swamp') and reduced saline inflows (eg from Cuneenying Brook).	Facey Group	Link to Action for Objective 4.
1.6	Identify priority areas of fringing vegetation with potential for recovery or enhancement (eg the 'swamp', the two 'gap' areas of Lake Yealering and the vegetation west of the lake).	DoW	Management responses are linked to Objective 5.

***Objective 2**: The period of water-based recreation in Lake Yealering is extended by 10%*

Code	Action	Lead role	Comments
2.1	Develop base-line information for the current hydro-period of Lake Yealering.	DoW	Linked with Action 1.4. Current Murdoch University research is relevant.
2.2	Assess options for increasing environmental flows to the lake. The options include stream diversion (eg with gates to increase flow from Cuneenying Brook into the lake), increased surface runoff from tributaries (eg from Boyning Gully) and discharge from engineering options for salinity control to the lake.	DoW/ Facey Group	Linked to Objective 4.
2.3	Evaluate the hydro-period benefits and risks from additional groundwater discharge to the lake.	DoW	Link with Murdoch University research.
2.4	Arrange on-going monitoring for lake hydro-period and water quality.	DoW	

***Objective 3:** The annual number of over-night tourists has increased by 50%.*

Code	Action	Lead responsibility	Comments
3.1	Develop base-line information for tourist visitation.	Shire of Wickepin	
3.2	Identify key eco-tourist and water-based recreational requirements (eg bird observation, walk opportunities).	Shire of Wickepin	
3.3	Develop and implement an eco-tourism promotional plan.	Shire of Wickepin	
3.4	Monitor tourist visitation and responses.	Shire of Wickepin	

***Objective 4:** Five Landcare groups and the Yealering Lakecare group coordinated through the Facey Group are effectively implementing actions of a strategic catchment-scale assets management plan (Local Area Plan).*

Code	Action	Lead responsibility	Comments
4.1	Review Landcare and Lakecare group structures within the catchments of the lakes (ie identifying existing effective group initiatives and additional group requirements).	Facey Group	
4.2	Prepare a Local Area Plan for multi-asset management (arranged through the Avon Catchment Council).	Facey Group	
4.3	Assess options for increased low-salinity stream flow to Lake Yealering and opportunities to reduce salinity of land adjacent to the lakes.	Facey Group	
4.4	Develop cost-share arrangements for implementation of proposed works, considering public and private benefits.	Facey Group	
4.5	Monitor the rate of implementation and indicators of resource condition change.	Facey Group	

***Objective 5:** The assessed risk of salinity in the floodplain and land adjacent to the lakes is reduced by 50% and salt-affected land is productive.*

Code	Action	Lead responsibility	Comments
5.1	Arrange a salinity risk assessment for the valley floor and tributary catchments to the Lake Yealering System (including field survey, application of geophysics and groundwater investigations).	DoW/Facey Group	
5.2	Develop a catchment water balance model for management decision support which shows potential surface runoff and salt load for a range of landscape management scenarios.	DoW	
5.3	Evaluate salinity management options (including comprehensive engineering or comprehensive plant-based options).	DoW/ Facey Group	
5.4	Prepare a salinity response plan (including environmental, social and economic impact assessment) for priority areas (based on asset values and site responsiveness) linked to the Local Area Plan.	DoW/ Facey Group	
5.5	Develop cost-share arrangements for implementation of proposed works.	Facey Group	
5.6	Monitor the rate of implementation and indicators or resource condition (eg groundwater response, salinity in water bodies).	Facey Group	

***Objective 6:** Near-natural ecosystems are re-established on 10 km of priority sections of the river and tributaries.*

Code	Action	Lead responsibility	Comments
6.1	Conduct foreshore surveys of the Avon River downstream from the Lake Yealering System to identify priority areas for reconstructed ecosystems.	DoW	
6.2	Evaluate near-natural ecosystem and commercial species options for revegetation in priority areas adjacent to waterways.	DoW/ACC (Farm Forestry initiative)	
6.3	Prepare a riparian ecosystem reconstruction plan linked to the proposed Local Area Plan.	DoW/Facey Group	
6.4	Develop cost-share arrangements for implementation of proposed works.	Facey Group	
6.5	Monitor the rate of implementation (eg the area revegetated) and indicators of resource condition (eg natural species regeneration).	Facey Group	

Abbreviations:

CALM Department of Conservation and Land Management

DoW Department of Water

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Appendix 1 – Water Quality and Depth Sampling for Lake Yealering (1978-2004)

(Source: J. A. K. Lane, Department of Conservation and Land Management, Western Australia)

Sample date	Depth gauge (metres)	pH	Salinity (ppm x 1000)
01.06.1978	0.2		
10.10.1978	1.87		
04.11.1978	1.74		14.8
13.11.1978	1.67		15.8
15.01.1979	1.26		23.75
13.03.1979	0.86		39.8
17.05.1979	0.69		55.2
12.07.1979	0.73		49.4
11.09.1979	0.71		48.4
06.11.1979	0.56		77.4
18.01.1980	0		
12.03.1980	0.43		46
13.05.1980	0.16		167
20.07.1980	0.18		98
15.09.1980	0.16		195.2
07.11.1980	0.32		98
12.01.1981	0.15		266.5
12.05.1981	0		
14.07.1981	2.11		5.6
15.09.1981	2.13		6.2
12.11.1981	1.94		7.7
03.02.1982	2.02		9.1
13.03.1982	1.76	9.3	11.65
09.05.1982	1.5		9.567
11.07.1982	1.57	9.4	14.4
12.09.1982	1.7		15.12
08.11.1982	1.61	9.6	17.3
08.01.1983	1.2		24.36
13.03.1983	0.78	8.3	51
14.05.1983	0.52		
15.07.1983	2.56	7.5	1.06
11.09.1983	2.4		0.426
11.11.1983	2.15	9.2	5.25
16.01.1984	1.7	8.7	7.95
11.03.1984	1.26	7.5	11.35
12.05.1984	1.12		13.653
14.07.1984	1.44		13.3
16.09.1984	1.6		11.659
05.11.1984	1.08	8.5	15.5
29.01.1985	0.85		
09.03.1985	0.62	7.3	52
11.05.1985	0.38		87.6
15.09.1985	0.95	7.9	31.7
03.11.1985	0.78	9	43
15.09.1986	1.19	8.3	25
01.11.1986	1.02	8.7	34
14.09.1987	1.23	8.3	21.1
07.11.1987	1.08	9.7	29.8
11.09.1988	1.97	8.4	14.6
06.11.1988	1.79	9.6	21.2
10.09.1989	1.78	9.4	24.7
06.11.1989	1.59	10.1	31
11.09.1990	2.22	9.5	11.4
05.11.1990	2.07	10.2	11.5
17.09.1991	1.32	8.7	19.5
07.11.1991	1.75	9.6	21.7
16.09.1992	2.37	9.4	11.7
10.11.1992		9.8	15.12
17.09.1993	2.25	8.3	16.87
09.11.1993	2.02	7.9	19.46
14.09.1994	2.17	8.4	20.1
09.11.1994	1.912	9.8	24.1
11.09.1995	1.902	8	26.2
08.11.1995	1.88	9.4	28.4
19.09.1996	1.97	8	16.4
05.11.1996	1.725	9.9	20.1
19.09.1997	1.49	8.1	29
06.11.1997	0.79	9.7	37.3
17.09.1998	1.83	8	23.3
09.11.1998	1.6	9.2	26.12
12.09.1999	1.91	8.3	26.5
08.11.1999	1.77	9.8	29.15
14.09.2000	1.7	10.2	25.1
08.11.2000	1.45	9.3	32.9
11.09.2001	1.16	7.9	34.21
08.11.2001	1	7.6	46.78
17.02.2002	0.25		
16.09.2002	0.15	7.7	169.1
04.11.2002	0		
13.09.2003	1.65	9.1	27.95
08.11.2003	1.44	9.5	34.1
16.09.2004	0.55	7.9	150.83
13.11.2004	-0.03	8.8	406

Note: Salinity for September shown in shaded rows.

Appendix 2 – Water Bird Records for the Yealering Lakes System

(Source: RAOU/CALM 1981-85 Wetland Nature Reserve Surveys plus some later survey work in 1986-88 provided by S Halse, CALM).

Wetland	Date of visit	Atlas No	Species name	Scientific name	No. of birds
Nonalling Lake	14 July 81	125	Silver Gull	*Larus novaehollandiae*	2
Nonalling Lake	14 July 81	203	Black Swan	*Cygnus atratus*	14
Nonalling Lake	14 July 81	207	Australian Shelduck (Mountain Duck)	*Anas rhynchotis*	3
Nonalling Lake	14 July 81	211	Grey Teal	*Anas gracilis*	46
Nonalling Lake	14 July 81	212	Australasian (Blue-Winged) Shoveler	*Anas rhynchotis*	11
Nonalling Lake	12 July 82	146	Black-Winged (Pied) Stilt	*Himantopus himantopus*	1
Nonalling Lake	12 July 82	188	White-Faced Heron	*Egretta novaehollandiae*	18
Nonalling Lake	12 July 82	203	Black Swan	*Cygnus atratus*	6
Nonalling Lake	12 July 82	207	Australian Shelduck (Mountain Duck)	*Anas rhynchotis*	19
Nonalling Lake	12 July 82	211	Grey Teal	*Anas gracilis*	290
Nonalling Lake	12 July 82	212	Australasian (Blue-Winged) Shoveler	*Anas rhynchotis*	7
Nonalling Lake	12 July 82	213	Pink-Eared Duck	*Malacorhynchus membranaceus*	50
Nonalling Lake	30 Sept 82	55	Black-tailed Native-Hen	*Gallinula ventralis*	2
Nonalling Lake	30 Sept 82	59	Eurasian Coot	*Fulica atra*	100
Nonalling Lake	30 Sept 82	125	Silver Gull	*Larus novaehollandiae*	1
Nonalling Lake	30 Sept 82	146	Black-Winged (Pied) Stilt	*Himantopus himantopus*	2
Nonalling Lake	30 Sept 82	188	White-Faced Heron	*Egretta novaehollandiae*	2
Nonalling Lake	30 Sept 82	203	Black Swan	*Cygnus atratus*	6
Nonalling Lake	30 Sept 82	211	Grey Teal	*Anas gracilis*	100
Nonalling Lake	30 Sept 82	212	Australasian (Blue-Winged) Shoveler	*Anas rhynchotis*	5
Nonalling Lake	30 Sept 82	213	Pink-Eared Duck	*Malacorhynchus membranaceus*	37
White Water Lake	14 July 81	207	Australian Shelduck (Mountain Duck)	*Anas rhynchotis*	2
White Water Lake	14 July 81	211	Grey Teal	*Anas gracilis*	15
White Water Lake	14 July 81	212	Australasian (Blue-Winged) Shoveler	*Anas rhynchotis*	2
White Water Lake	14 July 81	215	Hardhead (White-Eyed Duck)	*Aythya australis*	2
White Water Lake	13 Mar 82	125	Silver Gull	*Larus novaehollandiae*	1
White Water Lake	13 Mar 82	147	Banded Stilt	*Cladorhynchus leucocephalus*	1
White Water Lake	13 Mar 82	203	Black Swan	*Cygnus atratus*	378

Wetland	Date of visit	Atlas No	Species name	Scientific name	No. of birds
White Water Lake	13 Mar 82	207	Australian Shelduck (Mountain Duck)	*Anas rhynchotis*	1
White Water Lake	12 July 82	138	Hooded Plover (Dotterel)	*Thinornis (Charadrius) rubricollis*	2
White Water Lake	12 July 82	143	Red-Capped Plover (Dotterel)	*Charadrius ruficapillus*	17
White Water Lake	12 July 82	147	Banded Stilt	*Cladorhynchus leucocephalus*	240
White Water Lake	12 July 82	148	Red-Necked Avocet	*Recurvirostra novaehollandiae*	23
White Water Lake	12 July 82	162	Red-Necked Stint	*Calidris ruficollis*	7
White Water Lake	12 July 82	207	Australian Shelduck (Mountain Duck)	*Anas rhynchotis*	3
White Water Lake	12 Sept 82	125	Silver Gull	*Larus novaehollandiae*	1
White Water Lake	12 Sept 82	143	Red-Capped Plover (Dotterel)	*Charadrius ruficapillus*	89
White Water Lake	12 Sept 82	147	Banded Stilt	*Cladorhynchus leucocephalus*	2880
White Water Lake	12 Sept 82	162	Red-Necked Stint	*Calidris ruficollis*	19
White Water Lake	12 Sept 82	207	Australian Shelduck (Mountain Duck)	*Anas rhynchotis*	206
White Water Lake	12 Sept 82	211	Grey Teal	*Anas gracilis*	9
White Water Lake	29 Sept 83	59	Eurasian Coot	*Fulica atra*	100
White Water Lake	29 Sept 83	100	Little Pied Cormorant	*Phalacrocorax varius*	2
White Water Lake	29 Sept 83	110	Whiskered Tern	*Chlidonias hybridus*	2
White Water Lake	29 Sept 83	125	Silver Gull	*Larus novaehollandiae*	2
White Water Lake	29 Sept 83	179	Sacred (White) Ibis	*Threskiornis molucca*	1
White Water Lake	29 Sept 83	189	Pacific (White-Necked) Heron	*Ardea pacifica*	5
White Water Lake	29 Sept 83	203	Black Swan	*Cygnus atratus*	1
White Water Lake	29 Sept 83	207	Australian Shelduck (Mountain Duck)	*Anas rhynchotis*	3
White Water Lake	29 Sept 83	211	Grey Teal	*Anas gracilis*	61
White Water Lake	29 Sept 83	212	Australasian (Blue-Winged) Shoveler	*Anas rhynchotis*	28
White Water Lake	29 Sept 83	213	Pink-Eared Duck	*Malacorhynchus membranaceus*	27
White Water Lake	29 Sept 83	214	Freckled Duck	*Stictonetta naevosa*	7
White Water Lake	29 Sept 83	215	Hardhead (White-Eyed Duck)	*Aythya australis*	22
White Water Lake	29 Sept 83	217	Musk Duck	*Biziura lobata*	1
White Water Lake	14 Oct 83	59	Eurasian Coot	*Fulica atra*	50
White Water Lake	14 Oct 83	100	Little Pied Cormorant	*Phalacrocorax varius*	2
White Water Lake	14 Oct 83	125	Silver Gull	*Larus novaehollandiae*	2
White Water Lake	14 Oct 83	189	Pacific (White-Necked) Heron	*Ardea pacifica*	1
White Water Lake	14 Oct 83	202	Maned (Wood) Duck	*Chenonetta jubata*	1
White Water Lake	14 Oct 83	203	Black Swan	*Cygnus atratus*	15
White Water Lake	14 Oct 83	207	Australian Shelduck (Mountain Duck)	*Anas rhynchotis*	5
White Water Lake	14 Oct 83	211	Grey Teal	*Anas gracilis*	122

Wetland	Date of visit	Atlas No	Species name	Scientific name	No. of birds
White Water Lake	14 Oct 83	212	Australasian (Blue-Winged) Shoveler	*Anas rhynchotis*	7
White Water Lake	14 Oct 83	213	Pink-Eared Duck	*Malacorhynchus membranaceus*	40
White Water Lake	14 Oct 83	214	Freckled Duck	*Stictonetta naevosa*	2
White Water Lake	14 Oct 83	215	Hardhead (White-Eyed Duck)	*Aythya australis*	105
White Water Lake	14 Oct 83	217	Musk Duck	*Biziura lobata*	3
White Water Lake	05 Nov 83	59	Eurasian Coot	*Fulica atra*	1
White Water Lake	05 Nov 83	97	Little Black Cormorant	*Phalacrocorax sulcirostris*	1
White Water Lake	05 Nov 83	100	Little Pied Cormorant	*Phalacrocorax varius*	3
White Water Lake	05 Nov 83	132	Red-Kneed Dotterel	*Erythrogonys cinctus*	2
White Water Lake	05 Nov 83	182	Yellow-Billed Spoonbill	*Platalea flavipes*	1
White Water Lake	05 Nov 83	188	White-Faced Heron	*Egretta novaehollandiae*	10
White Water Lake	05 Nov 83	189	Pacific (White-Necked) Heron	*Ardea pacifica*	1
White Water Lake	05 Nov 83	202	Maned (Wood) Duck	*Chenonetta jubata*	4
White Water Lake	05 Nov 83	203	Black Swan	*Cygnus atratus*	5
White Water Lake	05 Nov 83	207	Australian Shelduck (Mountain Duck)	*Anas rhynchotis*	4
White Water Lake	05 Nov 83	208	Pacific Black Duck	*Anas superciliosa*	6
White Water Lake	05 Nov 83	211	Grey Teal	*Anas gracilis*	60
White Water Lake	05 Nov 83	212	Australasian (Blue-Winged) Shoveler	*Anas rhynchotis*	1
White Water Lake	05 Nov 83	213	Pink-Eared Duck	*Malacorhynchus membranaceus*	35
White Water Lake	05 Nov 83	214	Freckled Duck	*Stictonetta naevosa*	4
White Water Lake	05 Nov 83	215	Hardhead (White-Eyed Duck)	*Aythya australis*	9
White Water Lake	05 Nov 83	217	Musk Duck	*Biziura lobata*	2
White Water Lake	05 Nov 83	219	Marsh (Swamp) Harrier	*Circus approximans*	1
White Water Lake	16 Jan 84	59	Eurasian Coot	*Fulica atra*	100
White Water Lake	16 Jan 84	146	Black-Winged (Pied) Stilt	*Himantopus himantopus*	1
White Water Lake	16 Jan 84	203	Black Swan	*Cygnus atratus*	4
White Water Lake	16 Jan 84	211	Grey Teal	*Anas gracilis*	600
White Water Lake	16 Jan 84	212	Australasian (Blue-Winged) Shoveler	*Anas rhynchotis*	6
White Water Lake	16 Jan 84	213	Pink-Eared Duck	*Malacorhynchus membranaceus*	200
White Water Lake	21 Apr 84	59	Eurasian Coot	*Fulica atra*	58
White Water Lake	21 Apr 84	97	Little Black Cormorant	*Phalacrocorax sulcirostris*	1
White Water Lake	21 Apr 84	101	Darter	*Anhinga melanogaster*	1
White Water Lake	21 Apr 84	187	Great (Large) Egret	*Ardea alba*	6
White Water Lake	21 Apr 84	188	White-Faced Heron	*Egretta novaehollandiae*	6
White Water Lake	21 Apr 84	202	Maned (Wood) Duck	*Chenonetta jubata*	2
White Water Lake	21 Apr 84	203	Black Swan	*Cygnus atratus*	3
White Water Lake	21 Apr 84	207	Australian Shelduck (Mountain Duck)	*Anas rhynchotis*	60

Wetland	Date of visit	Atlas No	Species name	Scientific name	No. of birds
White Water Lake	21 Apr 84	208	Pacific Black Duck	*Anas superciliosa*	10
White Water Lake	21 Apr 84	211	Grey Teal	*Anas gracilis*	40
White Water Lake	21 Apr 84	212	Australasian (Blue-Winged) Shoveler	*Anas rhynchotis*	121
White Water Lake	21 Apr 84	213	Pink-Eared Duck	*Malacorhynchus membranaceus*	10
White Water Lake	23 June 84	59	Eurasian Coot	*Fulica atra*	50
White Water Lake	23 June 84	97	Little Black Cormorant	*Phalacrocorax sulcirostris*	20
White Water Lake	23 June 84	100	Little Pied Cormorant	*Phalacrocorax varius*	30
White Water Lake	23 June 84	125	Silver Gull	*Larus novaehollandiae*	2
White Water Lake	23 June 84	187	Great (Large) Egret	*Ardea alba*	6
White Water Lake	23 June 84	188	White-Faced Heron	*Egretta novaehollandiae*	5
White Water Lake	23 June 84	203	Black Swan	*Cygnus atratus*	18
White Water Lake	23 June 84	838	Unidentified Duck		10
White Water Lake	22 July 84	59	Eurasian Coot	*Fulica atra*	10
White Water Lake	22 July 84	97	Little Black Cormorant	*Phalacrocorax sulcirostris*	4
White Water Lake	22 July 84	100	Little Pied Cormorant	*Phalacrocorax varius*	100
White Water Lake	22 July 84	125	Silver Gull	*Larus novaehollandiae*	6
White Water Lake	22 July 84	187	Great (Large) Egret	*Ardea alba*	11
White Water Lake	22 July 84	188	White-Faced Heron	*Egretta novaehollandiae*	1
White Water Lake	22 July 84	203	Black Swan	*Cygnus atratus*	4
White Water Lake	22 July 84	207	Australian Shelduck (Mountain Duck)	*Anas rhynchotis*	2
White Water Lake	22 July 84	208	Pacific Black Duck	*Anas superciliosa*	10
White Water Lake	22 July 84	211	Grey Teal	*Anas gracilis*	12
White Water Lake	22 July 84	838	Unidentified Duck		100
White Water Lake	16 Sept 84	58	Purple (Western) Swamphen	*Porphyrio porphyrio*	16
White Water Lake	16 Sept 84	59	Eurasian Coot	*Fulica atra*	250
White Water Lake	16 Sept 84	100	Little Pied Cormorant	*Phalacrocorax varius*	30
White Water Lake	16 Sept 84	125	Silver Gull	*Larus novaehollandiae*	8
White Water Lake	16 Sept 84	146	Black-Winged (Pied) Stilt	*Himantopus himantopus*	12
White Water Lake	16 Sept 84	187	Great (Large) Egret	*Ardea alba*	7
White Water Lake	16 Sept 84	188	White-Faced Heron	*Egretta novaehollandiae*	8
White Water Lake	16 Sept 84	203	Black Swan	*Cygnus atratus*	350
White Water Lake	16 Sept 84	207	Australian Shelduck (Mountain Duck)	*Anas rhynchotis*	200
White Water Lake	16 Sept 84	211	Grey Teal	*Anas gracilis*	30
White Water Lake	16 Sept 84	215	Hardhead (White-Eyed Duck)	*Aythya australis*	15
White Water Lake	03 Oct 84	55	Black-tailed Native-Hen	*Gallinula ventralis*	1
White Water Lake	03 Oct 84	59	Eurasian Coot	*Fulica atra*	300
White Water Lake	03 Oct 84	97	Little Black Cormorant	*Phalacrocorax sulcirostris*	1
White Water Lake	03 Oct 84	100	Little Pied Cormorant	*Phalacrocorax varius*	40
White Water Lake	03 Oct 84	125	Silver Gull	*Larus novaehollandiae*	8
White Water Lake	03 Oct 84	146	Black-Winged (Pied) Stilt	*Himantopus himantopus*	14

Wetland	Date of visit	Atlas No	Species name	Scientific name	No. of birds
White Water Lake	03 Oct 84	178	Glossy Ibis	*Plegadis falcinellus*	2
White Water Lake	03 Oct 84	187	Great (Large) Egret	*Ardea alba*	2
White Water Lake	03 Oct 84	188	White-Faced Heron	*Egretta novaehollandiae*	6
White Water Lake	03 Oct 84	203	Black Swan	*Cygnus atratus*	300
White Water Lake	03 Oct 84	207	Australian Shelduck (Mountain Duck)	*Anas rhynchotis*	150
White Water Lake	03 Oct 84	208	Pacific Black Duck	*Anas superciliosa*	8
White Water Lake	03 Oct 84	211	Grey Teal	*Anas gracilis*	150
White Water Lake	03 Oct 84	212	Australasian (Blue-Winged) Shoveler	*Anas rhynchotis*	50
White Water Lake	03 Oct 84	215	Hardhead (White-Eyed Duck)	*Aythya australis*	300
White Water Lake	25 Nov 84	55	Black-tailed Native-Hen	*Gallinula ventralis*	12
White Water Lake	25 Nov 84	59	Eurasian Coot	*Fulica atra*	300
White Water Lake	25 Nov 84	125	Silver Gull	*Larus novaehollandiae*	4
White Water Lake	25 Nov 84	132	Red-Kneed Dotterel	*Erythrogonys cinctus*	150
White Water Lake	25 Nov 84	146	Black-Winged (Pied) Stilt	*Himantopus himantopus*	300
White Water Lake	25 Nov 84	147	Banded Stilt	*Cladorhynchus leucocephalus*	12
White Water Lake	25 Nov 84	151	Little (Whimbrel) Curlew	*Numenius minutus*	2
White Water Lake	25 Nov 84	179	Sacred (White) Ibis	*Threskiornis molucca*	1
White Water Lake	25 Nov 84	188	White-Faced Heron	*Egretta novaehollandiae*	15
White Water Lake	25 Nov 84	203	Black Swan	*Cygnus atratus*	200
White Water Lake	25 Nov 84	207	Australian Shelduck (Mountain Duck)	*Anas rhynchotis*	150
White Water Lake	25 Nov 84	211	Grey Teal	*Anas gracilis*	100
White Water Lake	24 Feb 85	143	Red-Capped Plover (Dotterel)	*Charadrius ruficapillus*	300
Lake Brown	14 July 81	207	Australian Shelduck (Mountain Duck)	*Anas rhynchotis*	3
Lake Brown	11 July 82	207	Australian Shelduck (Mountain Duck)	*Anas rhynchotis*	3
Lake Brown	12 July 82	125	Silver Gull	*Larus novaehollandiae*	4
Lake Brown	12 July 82	203	Black Swan	*Cygnus atratus*	6
Lake Brown	12 July 82	207	Australian Shelduck (Mountain Duck)	*Anas rhynchotis*	2
Lake Brown	12 July 82	211	Grey Teal	*Anas gracilis*	200
Lake Brown	30 Sept 82	59	Eurasian Coot	*Fulica atra*	100
Lake Brown	30 Sept 82	62	Hoary-headed Grebe	*Poliocephalus poliocephalus*	10
Lake Brown	30 Sept 82	125	Silver Gull	*Larus novaehollandiae*	3
Lake Brown	30 Sept 82	132	Red-Kneed Dotterel	*Erythrogonys cinctus*	1
Lake Brown	30 Sept 82	146	Black-Winged (Pied) Stilt	*Himantopus himantopus*	53
Lake Brown	30 Sept 82	188	White-Faced Heron	*Egretta novaehollandiae*	3
Lake Brown	30 Sept 82	203	Black Swan	*Cygnus atratus*	40
Lake Brown	30 Sept 82	207	Australian Shelduck (Mountain Duck)	*Anas rhynchotis*	3
Lake Brown	30 Sept 82	208	Pacific Black Duck	*Anas superciliosa*	2

Wetland	Date of visit	Atlas No	Species name	Scientific name	No. of birds
Lake Brown	30 Sept 82	211	Grey Teal	*Anas gracilis*	600
Lake Brown	30 Sept 82	212	Australasian (Blue-Winged) Shoveler	*Anas rhynchotis*	50
Lake Brown	29 Sept 83	59	Eurasian Coot	*Fulica atra*	150
Lake Brown	29 Sept 83	125	Silver Gull	*Larus novaehollandiae*	1
Lake Brown	29 Sept 83	179	Sacred (White) Ibis	*Threskiornis molucca*	1
Lake Brown	29 Sept 83	188	White-Faced Heron	*Egretta novaehollandiae*	1
Lake Brown	29 Sept 83	189	Pacific (White-Necked) Heron	*Ardea pacifica*	1
Lake Brown	29 Sept 83	202	Maned (Wood) Duck	*Chenonetta jubata*	2
Lake Brown	29 Sept 83	203	Black Swan	*Cygnus atratus*	1
Lake Brown	29 Sept 83	207	Australian Shelduck (Mountain Duck)	*Anas rhynchotis*	9
Lake Brown	29 Sept 83	211	Grey Teal	*Anas gracilis*	49
Lake Brown	29 Sept 83	213	Pink-Eared Duck	*Malacorhynchus membranaceus*	22
Lake Brown	29 Sept 83	215	Hardhead (White-Eyed Duck)	*Aythya australis*	5
Lake Brown	29 Sept 83	820	Unidentified Grebe		50
Lake Brown	05 Nov 83	189	Pacific (White-Necked) Heron	*Ardea pacifica*	1
Lake Brown	28 Jan 84	202	Maned (Wood) Duck	*Chenonetta jubata*	20
Lake Brown	28 Jan 84	203	Black Swan	*Cygnus atratus*	12
Lake Brown	28 Jan 84	207	Australian Shelduck (Mountain Duck)	*Anas rhynchotis*	300
Lake Brown	28 Jan 84	208	Pacific Black Duck	*Anas superciliosa*	240
Lake Brown	28 Jan 84	211	Grey Teal	*Anas gracilis*	2000
Lake Brown	28 Jan 84	212	Australasian (Blue-Winged) Shoveler	*Anas rhynchotis*	6
Lake Brown	28 Jan 84	213	Pink-Eared Duck	*Malacorhynchus membranaceus*	200
Lake Brown	28 Jan 84	216	Blue-Billed Duck	*Oxyura australis*	1
Lake Brown	21 Apr 84	59	Eurasian Coot	*Fulica atra*	503
Lake Brown	21 Apr 84	60	Great Crested Grebe	*Podiceps cristatus*	6
Lake Brown	21 Apr 84	62	Hoary-headed Grebe	*Poliocephalus poliocephalus*	100
Lake Brown	21 Apr 84	100	Little Pied Cormorant	*Phalacrocorax varius*	1
Lake Brown	21 Apr 84	106	Australian Pelican	*Anas rhynchotis*	3
Lake Brown	21 Apr 84	125	Silver Gull	*Larus novaehollandiae*	8
Lake Brown	21 Apr 84	180	Straw-Necked Ibis	*Threskiornis spinicollis*	1
Lake Brown	21 Apr 84	187	Great (Large) Egret	*Ardea alba*	19
Lake Brown	21 Apr 84	188	White-Faced Heron	*Egretta novaehollandiae*	9
Lake Brown	21 Apr 84	203	Black Swan	*Cygnus atratus*	6
Lake Brown	21 Apr 84	207	Australian Shelduck (Mountain Duck)	*Anas rhynchotis*	6
Lake Brown	21 Apr 84	208	Pacific Black Duck	*Anas superciliosa*	4
Lake Brown	21 Apr 84	211	Grey Teal	*Anas gracilis*	63
Lake Brown	21 Apr 84	212	Australasian (Blue-Winged) Shoveler	*Anas rhynchotis*	60

Wetland	Date of visit	Atlas No	Species name	Scientific name	No. of birds
Lake Brown	21 Apr 84	213	Pink-Eared Duck	*Malacorhynchus membranaceus*	16
Lake Brown	23 June 84	59	Eurasian Coot	*Fulica atra*	100
Lake Brown	23 June 84	61	Australasian (Little) Grebe	*Anas rhynchotis*	1
Lake Brown	23 June 84	100	Little Pied Cormorant	*Phalacrocorax varius*	2
Lake Brown	23 June 84	125	Silver Gull	*Larus novaehollandiae*	3
Lake Brown	23 June 84	187	Great (Large) Egret	*Ardea alba*	2
Lake Brown	23 June 84	188	White-Faced Heron	*Egretta novaehollandiae*	1
Lake Brown	23 June 84	203	Black Swan	*Cygnus atratus*	2
Lake Brown	23 June 84	207	Australian Shelduck (Mountain Duck)	*Anas rhynchotis*	2
Lake Brown	23 June 84	208	Pacific Black Duck	*Anas superciliosa*	2
Lake Brown	23 June 84	210	Chestnut Teal	*Anas castanea*	1
Lake Brown	23 June 84	211	Grey Teal	*Anas gracilis*	60
Lake Brown	23 June 84	217	Musk Duck	*Biziura lobata*	2
Lake Brown	23 June 84	838	Unidentified Duck		2000
Lake Brown	03 Oct 84	59	Eurasian Coot	*Fulica atra*	100
Lake Brown	03 Oct 84	60	Great Crested Grebe	*Podiceps cristatus*	3
Lake Brown	03 Oct 84	97	Little Black Cormorant	*Phalacrocorax sulcirostris*	6
Lake Brown	03 Oct 84	100	Little Pied Cormorant	*Phalacrocorax varius*	6
Lake Brown	03 Oct 84	125	Silver Gull	*Larus novaehollandiae*	10
Lake Brown	03 Oct 84	180	Straw-Necked Ibis	*Threskiornis spinicollis*	1
Lake Brown	03 Oct 84	188	White-Faced Heron	*Egretta novaehollandiae*	5
Lake Brown	03 Oct 84	203	Black Swan	*Cygnus atratus*	40
Lake Brown	03 Oct 84	207	Australian Shelduck (Mountain Duck)	*Anas rhynchotis*	50
Lake Brown	03 Oct 84	208	Pacific Black Duck	*Anas superciliosa*	5
Lake Brown	03 Oct 84	211	Grey Teal	*Anas gracilis*	250
Lake Brown	03 Oct 84	212	Australasian (Blue-Winged) Shoveler	*Anas rhynchotis*	25
Lake Brown	03 Oct 84	213	Pink-Eared Duck	*Malacorhynchus membranaceus*	2
Lake Brown	03 Oct 84	215	Hardhead (White-Eyed Duck)	*Aythya australis*	350
Lake Brown	03 Oct 84	820	Unidentified Grebe		2
Lake Brown	24 Feb 85	106	Australian Pelican	*Anas rhynchotis*	2
Lake Brown	24 Feb 85	143	Red-Capped Plover (Dotterel)	*Charadrius ruficapillus*	100
Lake Brown	24 Feb 85	188	White-Faced Heron	*Egretta novaehollandiae*	15
Lake Brown	24 Feb 85	207	Australian Shelduck (Mountain Duck)	*Anas rhynchotis*	250
Lake Brown	24 Feb 85	838	Unidentified Duck		100
Lake Brown	30 Aug 87	59	Eurasian Coot	*Fulica atra*	20
Lake Brown	30 Aug 87	125	Silver Gull	*Larus novaehollandiae*	2
Lake Brown	30 Aug 87	144	Black-fronted Plover (Dotterel)	*Elseyornis melanops*	8
Lake Brown	30 Aug 87	207	Australian Shelduck (Mountain Duck)	*Anas rhynchotis*	200

Wetland	Date of visit	Atlas No	Species name	Scientific name	No. of birds
Lake Yealering	13 July 86	59	Eurasian Coot	*Fulica atra*	62
Lake Yealering	13 July 86	203	Black Swan	*Cygnus atratus*	250
Lake Yealering	13 July 86	207	Australian Shelduck (Mountain Duck)	*Anas rhynchotis*	4
Lake Yealering	13 July 86	211	Grey Teal	*Anas gracilis*	200
Lake Yealering	19 Oct 86	59	Eurasian Coot	*Fulica atra*	30
Lake Yealering	19 Oct 86	125	Silver Gull	*Larus novaehollandiae*	3
Lake Yealering	19 Oct 86	143	Red-Capped Plover (Dotterel)	*Charadrius ruficapillus*	4
Lake Yealering	19 Oct 86	147	Banded Stilt	*Cladorhynchus leucocephalus*	68
Lake Yealering	19 Oct 86	157	Common Sandpiper	*Actitis hypoleucos*	4
Lake Yealering	19 Oct 86	203	Black Swan	*Cygnus atratus*	4
Lake Yealering	19 Oct 86	207	Australian Shelduck (Mountain Duck)	*Anas rhynchotis*	151
Lake Yealering	19 Oct 86	211	Grey Teal	*Anas gracilis*	4
Lake Yealering	08 Mar 87	157	Common Sandpiper	*Actitis hypoleucos*	4
Lake Yealering	21 June 87	125	Silver Gull	*Larus novaehollandiae*	6
Lake Yealering	21 June 87	147	Banded Stilt	*Cladorhynchus leucocephalus*	44
Lake Yealering	21 June 87	203	Black Swan	*Cygnus atratus*	1
Lake Yealering	21 June 87	207	Australian Shelduck (Mountain Duck)	*Anas rhynchotis*	128
Lake Yealering	21 June 87	211	Grey Teal	*Anas gracilis*	18
Lake Yealering	05 July 87	125	Silver Gull	*Larus novaehollandiae*	4
Lake Yealering	05 July 87	143	Red-Capped Plover (Dotterel)	*Charadrius ruficapillus*	129
Lake Yealering	05 July 87	146	Black-Winged (Pied) Stilt	*Himantopus himantopus*	2
Lake Yealering	05 July 87	147	Banded Stilt	*Cladorhynchus leucocephalus*	10
Lake Yealering	05 July 87	203	Black Swan	*Cygnus atratus*	24
Lake Yealering	05 July 87	207	Australian Shelduck (Mountain Duck)	*Anas rhynchotis*	310
Lake Yealering	05 July 87	211	Grey Teal	*Anas gracilis*	420
Lake Yealering	06 Mar 88	207	Australian Shelduck (Mountain Duck)	*Anas rhynchotis*	13

Appendix 3 – Landholders in the Yealering Lakes Section

Property owner	Lot numbers	Shire
Albert Squires	7354, 6103, 6339	Pingelly
Paula Gent	6102, 6918	Pingelly
David Gent	6517, 6316, 6517, Lot 2 on plan 15119	Corrigin
Jangering Pty Ltd	18004	Pingelly
Malcolm Poultney	7825, 10573	Corrigin
Shelley Nominees Pty Ltd	8428, 26108, 16849	Corrigin
Kenneth Manton	27186	Corrigin
Marjorie Gilchrist	9993	Pingelly
Calogera Carcione	9992, 9995	Pingelly
Shipley Holdings Colin Shipley	10968, 9795, 10974	Wickepin
Colin Shipley	9780, 10979, 9796	Corrigin/ Wickepin
Elizabeth Smidl	8780, 8779, 11182	Corrigin
Shire of Wickepin	Reserves R11000 (6350), R22967(6349), R15672(19893)	Wickepin
Rolvenden Pty Ltd HJ Cork & Son (Lindsay)	9806, 10948, 10925, 9809	Wickepin
Ken Beattie LJ Beattie Family Trust	9812, 10879, 9679	Wickepin
Keith O'Brien	6638, 6637, 5481	Wickepin

Appendix 4 – First Public Workshop Outcomes

Upper Avon River Recovery Planning – Yealering Lakes Section

Workshop Notes

(Workshop held at Yealering Hall on Friday 22 April 2005)

Attendees:

S. Bond	Whippy Dawes	Garry Lally	Lindy Porter
Ken Beattie	David Gent	Alan Leeson	Brian Shipley
Robin Campbell	Ian Hills	Ashley Lewis	
Daniel Cork	Elizabeth Horsfield	Greg Matthews	
Narelle Coxon	Fred Horsfield	Matt Pockran	

Assets, issues and opportunities

Assets	Workshop comments
Lake Yealering	• Includes the 'swamp' adjacent to the lake (note: water in the lake and swamp are connected). • Also includes the wildlife and vegetation associated with the lake. • Listed as a 'wetland of national importance. • Origin of lake name is of interest (to be determined).
White Lake and Brown Lake	• Located downstream of Lake Yealering (not hydrologically connected). • Note that Brown Lake was previously named 'Fresh Lake'. • Included in listing or wetlands of national importance (detail of criteria to be confirmed). • Land tenure is to be determined.
Nonalling Lake	• Managed by CALM.
Avon River	• The Avon River channel does not hold distinctive local values (it is recognised for water discharge function more than for ecological or social values). • The 'source of the Avon' is considered to be either the confluence of several major tributaries, or Lake Yealering. The lake as the source may be the best option to promote.
Agricultural land adjacent to lakes	• Prone to waterlogging and flooding; high potential for salinity.
Yealering – a town on a lake.	• Yealering townsite is located on banks of Lake Yealering (thought to be one of only two similar situations in Australia?). • Significant water-based recreation values (past and present) – important for the local families and the regional community. Supported by a golf course and caravan park. • Heritage values relating to recreational use of the lake (eg the 'Boxing Day' sports and use of the former rifle range). • Potential for tourism.
Areas of bush	• Reserves and private areas of bush highly valued locally (especially the reserve area north-west of Lake Yealering). • Developing a profile for the area that is focused on wildlife and wild lowers is valued. • Once was identified as the 'Home of the White-bellied Sea Eagle' (to be confirmed).

Assets	Workshop comments
Public Infrastructure	• Roads and rail – effects of flooding and salinity on infrastructure. Also potential affect of culverts etc on flow continuity. • Pipelines – potential impact due to salinity or flooding.
Issues	**Workshop comments**
Salinity	• Concern about rising water tables under the town of Yealering (5-6 years monitoring records to be obtained). What impact on water supplies? • Affect of increasing lake salinity and rising groundwater on the fringing vegetation to the lakes (Note – local concern lead to formation of the Yealering Lakecare group in Early 2000). • Potential for substantial increase in salinity on farm land adjacent to the lakes (Note – 6 year records for 12 groundwater observation wells on Corks' property adjacent to Lake Yealering). • Priority for risk reduction of salinity in the valley floor is recognised.
Stream flow continuity	• Some problems with sedimentation of the flow channel. The area upstream of White Lake is identified. • Some concern about the effect of road crossings (eg Squires Road bridge). • Deep drainage proposals need to be linked with flow continuity of the Avon River channel.
Lake Yealering water level	• Community want high water levels in lake for a longer period (to extend the recreation opportunity). Preferred depth is approximately 2.5 metres. Note – higher water levels are not being considered due to the potential for increased flooding and salinity. • Stream flow from northwest tributary diverted from Lake Yealering by earthworks on private property to reduce road and rail flooding (constructed during early 1980s?). • Concern about inflow through the natural lake outlet (due to stream flow diversion) and the impacts of sedimentation near the outlet and within the lake. • Concern about inundation of two 'gap areas' where water ponds at high levels and may be causing increased salinity in these areas. • General interest in sediment management options (dredging the lake over-all or in selected sections, sediment removal from the outlet). • Weed growth in Lake Yealering is related to water depth (the weed may be a *Ruppia* spp.). The weed reduces recreation opportunities (but also note that it may increase water bird food and habitat). What options to control the weed?
Flooding	• January 2000 flood event effectively defines area at risk to inundation. • Concern about increased salinity following flood inundation.
River Pools	• No pools were identified as being particularly valued.
Fire	• Not an issue particularly related to river of lake management.
Weeds and feral animals	• Weeds include Bridal Creeper, Spiny Rush, Soursob, Cape Tulip, Couch (and the potential for increased sedimentation – note that stabilising sediments may be an advantage in some areas). • Samphire is not a weed but is considered troublesome due to sediment entrapment. • Feral animals include rabbits and foxes. • Increasing numbers of kangaroos is a concern to some people.

Issues	Workshop comments
Riparian zone vegetation management	• Fencing to restrict livestock access to the river is considered good management but the key issue is where to place the fence with the floodplain being very extensive in some sections. Concern also about the potential impact of floods on river fencing. • Most riparian vegetation is salt-affected. Some interest in rehabilitation with commercial species or natural ecosystem reconstruction. • General aim should be to improve the condition of riparian vegetation.
River crossings and public access	• Not considered to be a significant issue.
Nutrients and pollution	• Rubbish tips – both private and public (including one adjacent to Lake Yealering).
Opportunities	**Workshop comments**
Integration of 'stakeholders'	• Advantages through integration recognised (role for Shire of Wickepin).
Facey Group	• Provides an opportunity to link river and lake management with agricultural production and general NRM. • Facey group has existing organisational structure that could be effective for many purposes.
Avon Catchment Council (ACC)	• Potential for linking a regional-scale project with assets of national significance into Local Area Plans.
Yealering Progress Association	• Roles to be clarified.
Yealering Lakecare Group	• Could be re-constituted, or linked with the Progress Association.
Catchment groups	• Eg Bindermucking, Yealering, South-east Yealering, Bularing and others.
Oil mallee industry	• Potential for salinity control (demonstrated within the district).
Tourism	• Could be a result of increased focus on lake management. • Dryandra Visitors Centre is an opportunity for information and network links.

Temporary Working Group:

Matt Pockran, Kristy Baker (Facey Group) and any others interested.

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