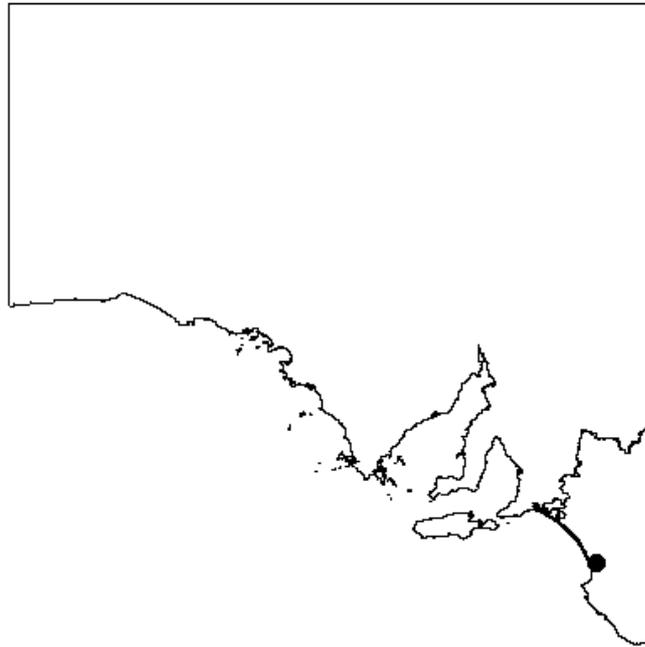

A BIOLOGICAL SURVEY OF THE WEST AVENUE RANGE SOUTH AUSTRALIA IN DECEMBER 1999



By
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Biodiversity Survey and Monitoring
National Parks and Wildlife, South Australia
Department for Environment and Heritage, South Australia

2002

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CARTOGRAPHY AND MAP DESIGN

Tim J. Hudspith

All geographical data came from the Statewide Map Library,
Environmental Data Base of South Australia

Cover photograph: A seasonal wetland (dry phase) - typical of wetlands along the West Avenue Watercourse.

Photo. Hafiz Stewart (NPWSA)

The West Avenue Range Biological Survey

PREFACE

A Biological Survey of the West Avenue Range, South Australia is a further product of the Biological Survey of South Australia.

The program of systematic biological surveys to cover the whole of South Australia arose out of a realisation that an effort was needed to increase our knowledge of the remaining vascular plants and vertebrate fauna of South Australia and to encourage its conservation.

Over the last 18 years, there has been a strong commitment to the Biological Survey by Government and an impressive dedication from hundreds of volunteer biologists.

By 2015, It is anticipated that the Biological Survey will achieve complete statewide coverage.

The Biological Survey of South Australia will be an achievement for which we can be very proud. We will have substantially improved our knowledge of the biodiversity of South Australia to enable biologists in the future to measure the direction of long-term ecological change. This will greatly enhance our ability to adequately manage nature conservation into the future.



JOHN HILL
MINISTER FOR ENVIRONMENT AND CONSERVATION

The West Avenue Range Biological Survey

ABSTRACT

An eight-day survey of the vegetation and vertebrate fauna of the West Avenue Range was undertaken in December 1999. This resulted in the recognition of:

- 296 plant species (49 introduced),
- 20 mammal species (7 introduced),
- 108 bird species (4 introduced),
- 16 species of reptile and 4 species of frog.

In addition, a further 13 plant and 2 reptile species have been recorded from the study area on other occasions. If all plant and animal records are considered then the West Avenue Range supports 27 species of plant, 12 species of bird, 2 species of mammal and 1 species of reptile of conservation significance. The West Avenue Range also supports seven vegetation communities of conservation significance.

The current data demonstrates that the West Avenue Range supports a variety of species and communities of conservation significance. It is recommended however, that further biological research is needed in order to gain a more complete understanding of the ecology of this interesting area.

Any major change in the water regime or quality (turbidity, nutrient levels, pollution) or a rise in salinity may be detrimental to the long-term viability of many of the plant and animal species of conservation significance found in the West Avenue Range and Watercourse. Consequently, it is recommended that new drainage works should only proceed if they are designed and constructed in a way that minimises any potentially adverse impacts on the flora and fauna of the West Avenue Range. Furthermore it is recommended that if new drainage works are constructed then vegetation and water monitoring programs should be instigated prior to drain construction to assist in determining the direction of short, medium and long term ecological change.

ACKNOWLEDGMENTS

Unlike previous Biological Surveys in this series, the data contained in this report was collected over an eight day period of field work undertaken in response to the need by the Department for Environment and Heritage, to acquire specific biological information for the West Avenue Range area. This information was needed to assist in making land management decisions likely to affect the flora and fauna of the West Avenue Range, particularly the installation of further drainage works associated with the central catchment of the Upper South East Dryland Salinity and Flood Management Plan. Consequently, a small team of biologists was supervised by the survey coordinator, Hafiz Stewart. All members made a notable contribution to the effectiveness of this survey.

Field work

Vegetation survey

Tim Croft, Hafiz Stewart and Reece Pedler collected plant specimens during the survey.

Vertebrate survey

The vertebrate survey entailed obtaining records for all mammals (m), reptiles (r) and birds (b) present at all survey sites during the survey. These records were obtained by Andrew Freeman and Hafiz Stewart (m), Graham Armstrong (r) and by Lynn and Reece Pedler and Hafiz Stewart (b).

Specimen identification

Plants: Tim Croft identified all plant species in the field. Collected specimens were verified by Rosemary Taplin and lodged in the collections of the State Herbarium.

Mammals: Andrew Freeman identified all mammal species in the field. Collected specimens were verified by Cath Kemper and Martine Long and then lodged in the collections of the SA Museum.

Reptiles: Graham Armstrong identified all reptile species in the field. Collected specimens were verified by Mark Hutchinson and lodged in the collections of the SA Museum.

Birds: Lynn Pedler identified all bird species in the field, with assistance from Reece Pedler. Collected specimens were verified by Maya Penck and lodged in the collections of the SA Museum.

Vegetation mapping

Tim Hudspith mapped and designed the vegetation map using ESRI ARC/INFO GIS software. Tim Croft assisted with the vegetation mapping fieldwork and provided generous amounts of much appreciated advice.

Editing

Tim Hudspith edited this report.

Proof reading

Tim Hudspith, Tony Robinson, Robert Brandle, Brenton Gear, Tim Croft and Hafiz Stewart, all proof read either chapters or the entire report.

Other

Thanks to Brenton Gear for providing advice, direction, support and background information used to write part of the introduction. Thanks to Tim Croft for generously providing expert advice in relation to plant species and communities and other advice. Thanks to Robert Brandle for helping with the location maps and providing general advice. Thanks also to all land managers for their assistance particularly Pip Rasenburg who provided accommodation during the vegetation mapping fieldwork.

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INTRODUCTION

Since 1971 the South Australian Department for Environment and Heritage (DEH) has been conducting systematic biological surveys of the vegetation and vertebrate fauna of large regions of the state as part of the Biological Survey of South Australia. The aim of these surveys is to document the range of biological variation across the state to improve long-term natural resource management.

Up to mid 2001, 13 major regions have been studied by what is now the Biodiversity Survey and Monitoring Section, Biodiversity Strategies Branch, National Parks and Wildlife, South Australia of DEH. These regions are: the Offshore Islands (excluding Kangaroo Island) (1971 - 1982), South-East Coast (1982 - 1983), Nullarbor Plain (1984), Gawler Ranges (1985), Yellabinna (1987), Kangaroo Island (1989 - 1990), Murray Mallee (1990 - 1991), South Olary Plains (1991 - 1992), South East (1991 & 1997), Stony Deserts (1994 - 1997), North Olary Plains (1995 - 1996), Coastal Dunes and Clifftops (1996 - 1998) and Flinders Ranges (1997 - 2000). Other comparable surveys conducted by consultants or NGOs under the auspices of the Biological Survey of South Australia include: Cooper Creek (1983 & 1991), Breakaways Reserve (1986), Chowilla (1988), Strzelecki Dunefields (1988 - 1992), Tallaringa Area (1988 & 1993), Kulliparu Conservation Park (1990), Lake Newland Conservation Park (1991), Gammon Ranges National Park (1993), Diamantina River Area (1994), Mt Brown (1994 & 1997), Gum Lagoon Conservation Park (1995 - 1996) and Lake Eyre South (1996 - 1997). Generally the boundaries of these surveys have been based on the Environmental Regions and the Environmental Associations described and mapped for South Australia by Laut *et al.* (1977).

Surveys involving vegetation sampling analysis and mapping only have been completed, or are in progress, in conjunction with the Department for Transport, Urban Planning and the Arts (DTUPA) for the Mid-North (1991 - 1998), Western Murray Flats (1992 & 1999), Burra Hills (1994 - 1995), Yorke Peninsula (1994 - 2000), Upper Mid-North and Northern Spencer Gulf (1996), Northern Adelaide Plains (1996) and the Gawler Ranges (2001).

Ongoing vegetation and vertebrate surveys are being conducted in the Anangu Pitjantjatjara Lands (1991 -), Sandy Deserts (1997 -), Mt Lofty Ranges (2000 -) and Eyre Peninsula (2001 -).

More recently, a number of specific surveys have been undertaken in response to the need for detailed biological information on particular areas. These include: the Biological Survey of Yumbera Conservation Park (Owens *et al.*, 1995b), which assessed the potential impact of the proposed mineral explorations for the Park, the Box and Buloke Grassy Woodlands (Stokes, 1996), which collected biological information required to develop management recommendations for the conservation of these remnant woodlands, the Grasslands and Grassy Woodlands of the Lofty Block Bioregion (Robertson, 1998), which focused on vegetation associations of conservation significance, a survey of coastal dune and cliff-top vegetation (Oppermann, 1999) and the Biological Surveys of Messent Conservation Park (Owens *et al.*, 1995a), Deep Swamp (Stewart, 1996), Tilley Swamp (Stewart *et al.*, 1998a) and Bunbury Conservation Reserve and Stoneleigh Park Heritage Agreement (Stewart *et al.*, 1998b) which assessed the likely biological impacts of proposed drains through these areas as part of the Upper South East Dryland Salinity and Flood Management Plan (1993).

The Biological Survey of the West Avenue Range was also undertaken in response to the need for detailed biological information for a specific area. The survey was carried out from December 6th to the 13th 1999.

The location and characteristics of the West Avenue Range

The West Avenue Range is located approximately 35km north-north-east of Kingston in the South East of South Australia (Figure 1).

The South East has a cool, moist climate with long mild summers. Evaporation in the summer months greatly exceeds precipitation. Mean annual rainfall for the West Avenue Range is between 500mm and 800mm and mean annual evaporation is estimated to be 1700mm (Laut *et al.*, 1977).

The West Avenue Range falls mainly within the Avenue Plains Environmental Association (1.4.2) but grades, in a westerly and easterly direction, into the Lucindale Environmental Association (1.4.1). The Avenue Plains Environmental Association is described by Laut *et al.* (1977) as being “an elongated narrow interdunal plain with numerous small swamps or lakes and occasional outcrops of calcarenite”. Laut *et al.* (1977) describe the Lucindale Environmental Association as being “low parallel calcarenite dune ridges trending north-north-west, separated by narrow interdunal plains with occasional swamps”.

A chain of wetlands, known as the West Avenue Range Watercourse, is located within the study area. The watercourse extends from “north of the Blackford Drain to Henry Creek” (South Eastern Wetlands Committee, 1985). This watercourse includes Smith Swamp, Double Swamp and several other smaller unnamed ephemeral wetlands. These wetlands are mainly located on the low-lying flats in the centre and at the eastern side of the study area. In drier times Shiny Swamp-mat (*Selleria radicans*) or Round-leaf Wiltonia (*Wiltonia rotundifolia*) cover these wetlands, while occasionally Redgum (*Eucalyptus camaldulensis*) but more often Swamp Paper-bark (*Melaleuca halmaturorum* ssp. *halmaturorum*) or Short-leaf Honey-myrtle (*Melaleuca brevifolia*) over Smooth Cutting-grass (*Gahnia filum*) surround them.

A calcareous dune dominates the western side of the study area. Coastal Mallee (*Eucalyptus diversifolia*) Dune Stringybark (*E. arenacea*) and Pink Gum (*E. fasciculosa*) vegetation communities are associated with this dune.

The water regime of the West Avenue Range

The regional perspective

The water regime of much of the South East has been significantly affected since the arrival of Europeans.

The construction of a complex network of public and private drains has dried out most of the former wetlands of the region. Indeed, it is estimated that only 2% of pre-European wetlands now remain (State of the Environment Report for South Australia, 1998).

The South East has also undergone excessive clearance of deep rooted perennial native vegetation and replacement with shallow rooted annual crops and pasture, which has led to a “significant increase in groundwater recharge rates” (Webb, 1993). Consequently water-tables have risen and this has caused problems such as dryland salinity and higher volume, more saline surface flows, which are briefly discussed below.

Dryland salinity can render agricultural land unproductive and kill remnant native vegetation. Webb (1993) describes how in the 1980s areas of Swamp Paper-bark (*Melaleuca halmaturorum* ssp. *halmaturorum*) and Short-leaf Honey-myrtle (*Melaleuca brevifolia*) were killed as a consequence of increasing soil salinity. The loss of these overstorey species led to a “reduction in the diversity and health” of the associated understorey species (Webb, 1993).

Webb (1993) suggests that since the 1980s, increased surface flows have meant some wetlands have received greater volumes of occasionally saline water at higher frequencies, which can detrimentally affect these ecologically significant areas.

The local perspective

The water regime of the West Avenue Range has also undergone changes following European settlement. Smith Swamp is now rarely fully inundated due to the construction of an embankment in the north east of the swamp. The embankment has retarded water flows, which has facilitated cropping and grazing. Rising groundwater did not pose a threat to this area in the early 1990s (Nicolson, 1993).

Double Swamp historically received surface flows from the Bakers Range, Marcollat and West Avenue Range Watercourses. After Double Swamp was filled water then flowed down Henry Creek and north along the Tilley Swamp Watercourse and eventually into Salt Creek (Nicolson, 1993). In the late 1890s the Bakers Range drain and a number of cuttings were constructed. These works improved flows but since then other drains have gradually reduced the “extent of surface flows to Double Swamp”, which now “only receives water from the local catchment and from the West Avenue Range Watercourse” (Nicolson, 1993). Water from this watercourse flows downstream through Double Swamp and into the Henry Creek. In the early 1990s groundwater data suggested that during summer groundwater was close to the surface in the vicinity of Double Swamp, thus dryland salinity may also pose a threat to this area (Nicolson, 1993).

The biological and ecological significance of the West Avenue Range

The regional perspective

The West Avenue Range is located in the South East Region of South Australia, which has high biological diversity, due to its variety of habitats. These include grasslands, shrublands, woodlands and forest as well as saline, brackish and freshwater wetlands. The flora and fauna of the region is generally typical of south-eastern Australia, with many species at their western limit, while its northern boundary is the southern limit of the mallee scrubs. This creates, in a number of cases, a unique mix of species. The region provides habitat for 77% of the State’s bird, 53% of the State’s mammal and 42% of the State’s plant species, although comprising only around 2% of the State’s land area (Croft *et al.*, 1999).

Since European settlement 82.5% of the region has been developed for agriculture or commercial forestry, the most extensively cleared of any of the State’s regions, except for the Mount Lofty Ranges. Only 13% of the native vegetation remains. However, some authors argue even less native vegetation remains. Indeed, Jensen (1993) suggests as little as 7% remains.

The remaining areas of native vegetation play a crucial role in maintaining the region’s high biodiversity. Only 25% of the remaining native vegetation is conserved in State Government reserves, with a further 15% privately conserved under Heritage Agreements. The majority of the region’s remaining native vegetation (60%) occurs on private land, much in degraded condition due to

disturbance, such as domestic stock grazing, preventing regeneration of new plants.

Less than 2% of pre-European settlement wetlands remain in the South East and little of this area is in original condition (State of the Environment Report for South Australia, 1998). Most of these wetlands have been drained and modified, with the remaining areas now considered of high conservation significance. Two areas, the Coorong and Bool and Hacks Lagoons, are listed as Wetlands of International Importance under the Ramsar Convention. It is significant to note that Australia played a key role in developing the Ramsar convention and “was one of the first signatories” (Australian Nature Conservation Agency) and that the Ramsar convention now recognises the concept of ecologically sustainable development (ESD).

The region’s wetlands provide important habitat for waterbird species, including breeding areas, or overwintering feeding areas for migratory wader species subject to International Migratory Bird Agreements between Australia and Japan and the People’s Republic of China (JAMBA and CAMBA).

The freshwater and brackish wetlands of the region provide habitat for native fish species, three of which are listed as ‘threatened’ nationally (Endangered Species Protection Act, 1992).

The region is characterised by a relatively high number of aquatic invertebrate species including two rare species *Boeckella nyoraensis* and *Boeckella spinosa*. (Walsh and Croft, unpublished draft).

A number of threatened plant species, and regionally rare plant communities are also found in the South East.

The local perspective

The West Avenue Range Watercourse was identified as one of the key wetland areas for the South East (Australian Nature Conservation Agency). The area provides habitat for a range of species of conservation significance. The West Avenue Range supports 27 plant species of conservation significance, including six considered to be of State conservation significance. The study area also supports seven vegetation associations of conservation significance including four regionally ‘endangered’ and three regionally ‘vulnerable’ communities.

The West Avenue Range supports 12 birds of conservation significance including a population of Malleefowl (*Leipoa ocellata*), which is a nationally listed ‘vulnerable’ bird and considered to be ‘vulnerable’ (NPW Act, 1972) in South Australia. Many of these birds of conservation significance are associated with the *Melaleuca* spp. shrubland found in the low-lying flats in the centre and to the east of the study area. These plant communities are vulnerable to changes in the water regime, water quality or rises in salinity (Webb, 1993).

The study area also supports one reptile of conservation significance, the Heath Goanna (*Varanus rosenbergi*) and two mammals of conservation significance, the Red-necked Wallaby (*Macropus rufogriseus*) and Common Wombat (*Vombatus ursinus*).

The land tenure of the West Avenue Range

The study area is private land, however much of this is managed under Heritage Agreements.

The background to the Biological Survey of the West Avenue Range

After European settlement the South East underwent excessive clearance of deep rooted perennial native vegetation and replacement with shallow rooted annual crops and pasture, which led to a “significant increase in groundwater recharge rates” (Webb, 1993). Consequently water tables rose and this led to dryland salinity and increased surface flows, which degraded the productivity of agricultural land and adversely affected areas of remnant native vegetation.

The Upper South East Dryland Salinity and Flood Management Plan Steering Committee prepared an environmental impact statement (EIS) focusing on these issues in the Upper South East (USE). The State Government officially recognised this document in 1995 and the Commonwealth Minister for Agriculture approved Commonwealth funds in 1996. State Cabinet then approved an integrated package of measures designed to address the issues of dryland salinity and flood management. These measures included extra drainage, saltland agronomy, revegetation and wetland rehabilitation. The Commonwealth Government approved funds on certain conditions including protection of threatened species, maintenance of the ecological character of the hypersaline southern lagoon of the Coorong and implementation of an environmental monitoring program.

In 1996 an ‘Environmental Monitoring and Assessment Program’ was prepared by the Upper South East Scheme to ensure adequate environmental monitoring was instigated, to establish baseline data, observe and record any environmental impacts from the Scheme, and feedback results into environmental management systems. This program included water quality / hydrological / biological monitoring in the Coorong, wetland and drain ecosystem monitoring in the Upper South East and identification of the conservation values of remnant habitat potentially affected by further drainage works.

Remnant habitat was examined in relation to any new proposed drainage routes. Several areas were identified as requiring baseline ecological surveys and these were: Messent Conservation Park, Deep Swamp, Tilley Swamp, Bunbury Conservation Reserve, Stoneleigh Park Heritage Agreement, East Avenue Swamps, Gum Lagoon Conservation Park, Mt Penny (Cavanagh) Wetlands and the West Avenue Range Watercourse. The

Department for Environment and Heritage and the Nature Conservation Society of South Australia have undertaken most of these biological surveys on behalf of the USE Scheme. Completed surveys so far include: Messent CP, Deep Swamp, Tilley Swamp, Gum Lagoon CP, Bunbury CR and Stoneleigh HA. Future decisions on final drainage routes will determine whether further surveys at Mt Penny, East Avenue and other locations in the Northern and Central Catchments are required.

At the time of publication, the Bald Hill Drain was being planned. This drain will provide groundwater drawdown and surface water drainage along the West Avenue Flat, to the east of the range. It is proposed that this drain will collect waters from the Winpinmerit Drain and across the West Avenue Flat, direct flows to Henry Creek (Figure 2) and then on to the Tilley Swamp Watercourse or Morella Basin. The final design and location of this drain has not been determined but it is likely to be approximately 2m deep and located in the centre or eastern portion of the flat.

Due to the extremely level nature of the West Avenue Flat this drain has the potential to achieve significant drawdown either side of the drain and capture most of the surface waters within the watercourse catchment. Without careful design and the construction of wetland management infrastructure, this drain has the potential to decrease vegetation health within the *Melaleuca* spp. shrublands (Stewart, 2001) and reduce inundation of the West Avenue Watercourse wetland ecosystems.

A Biological Survey of the West Avenue Range was conducted in December 1999 in order to provide information on the conservation values of remnant native vegetation within the West Avenue Watercourse and gather other biological information. The results of this survey are contained in this report. This data will assist in the design of the Bald Hill Drain, contribute to the surface water management objectives for West Avenue Watercourse and support the development of a vegetation health monitoring program.

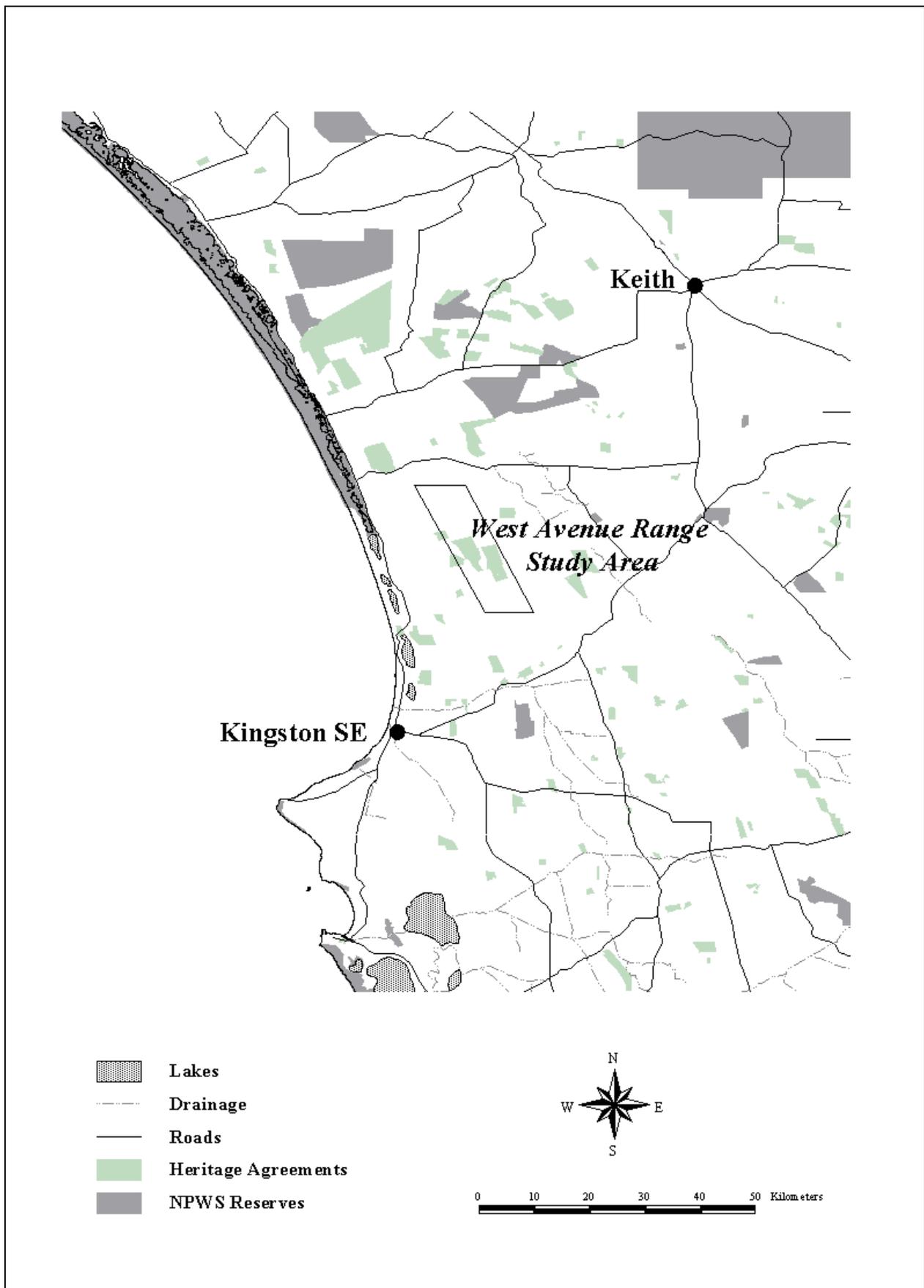


Figure 1. The location of the West Avenue Range in relation to NPWS reserves and Heritage Agreement areas.
Map by Robert Brandle.



**Figure 2. The Henry Creek, West Avenue Range, December 1999.
Photo. Hafiz Stewart.**

METHODS

Copley and Kemper (1992) explain the rationale behind regional Biological Surveys in detail and so only a brief explanation will be provided here.

The West Avenue Range Biological Survey was conducted in patches of remnant vegetation in the agricultural district of South Australia, where much of the natural vegetation and its associated vertebrate fauna has been fragmented by clearance and undergone substantial habitat modification for agriculture. For this reason a number of alterations to the methods adopted in the previous regional surveys for extensive areas of natural vegetation were required. More recently, a number of specific Biological Surveys (Owens *et al.* 1995a,b, Stokes, 1996, Stewart, 1996, Stewart *et al.*, 1998a,b and Robertson, 1998) have been undertaken and these have provided a methodology which ensured data collected in this survey was comparable with data collected in previous broad-scale surveys.

The Biological Survey of the West Avenue Range was designed with the following aims:

- 1) To investigate and collate all previously existing information on the biota of the West Avenue Range.
- 2) To undertake a Biological Survey of the West Avenue Range in order to determine the presence of all flora and fauna, using standard and repeatable methodologies. This entailed providing both the SA Museum and State Herbarium with voucher specimens collected during the survey, and entering all the collected data onto the South Australian Survey Databases.
- 3) To establish permanent sampling sites to collect baseline data, and monitor changes to the flora and fauna of the West Avenue Range over time.
- 4) To prepare a 1:20 000 scale vegetation map of the study area.
- 5) To make this information available to assist in making any land management decisions likely to affect the flora and fauna of the West Avenue Range.

Site selection and nomenclature

The fundamental concept behind all of the regional surveys conducted, as part of the Biological Survey of South Australia to date, has been that they are based on

intensive sampling at a series of 'quadrats' which are representative of the biological and geographical diversity of the study area.

Since this survey was designed to assist in making any land management decisions likely to affect the flora and fauna of The West Avenue Range, some changes were made to the quadrat selection process. Due to the smaller size, and more intensive nature of the survey, only one group of nine quadrats was selected, all of which were sampled intensively over an eight-day period from December 6th to the 13th, 1999.

For the purposes of nomenclature, a group of quadrats is referred to as a 'camp'. Each camp is assigned a three-letter code, which usually relates to the mapsheet name or a significant feature found in the local area, such as a mountain. For this survey several camp names were used. These camp names were named after the following 1:50 000 mapsheets: 'GYP GYP', 'DUFFIELD' and 'TILLEY SWAMP'. Consequently, quadrats located on the 'GYP GYP' mapsheet were given a code starting with the letters 'GYP'. Each quadrat was then assigned a number. The 'GYP' quadrats were assigned the numbers 5 to 8 because the numbers 1 to 4 had been used on previous surveys, which also utilised the camp name of 'GYP'. The 'DUF' quadrats were assigned the numbers 1 to 4 and the 'TIL' quadrat was assigned the number 9 because the numbers 1 to 8 had been used on previous surveys, which also utilised the camp name of 'TIL'.

Within each quadrat a representative area of habitat was surveyed and this area is referred to as a 'patch'. Thus for this survey, patch 01 at quadrat 03, camp 'DUF' was labelled 'DUF00301'. For ease of interpretation 'DUF00301' was also referred to in lay terms as 'survey site 3'. This report uses this general terminology from time to time.

An attempt was made to locate at least one quadrat in each of the major habitat types. Some habitats were sampled more than once in relation to their abundance and relative conservation importance. Quadrat selection was also based on ease of access. Survey equipment is heavy, bulky and difficult to transport so in general most quadrats were located in close proximity to roads or tracks.

Where practical, quadrats were only placed in areas of habitat greater than four hectares (200m x 200m). This was done in an effort to minimise any 'edge' effect associated with neighbouring habitat types or cleared areas. Each quadrat was usually placed in the centre of the habitat being sampled. Figure 13 (contained in a pocket attached

to the inside back cover of this report) illustrates the distribution of survey sites.

Data collection

At each site a 30m x 30m representative patch of vegetation was chosen for sampling. All vascular plants present within the patch were recorded and representative voucher specimens were collected and labelled for later verification at the State Herbarium. All data on the plant species, including life stage, cover/abundance and vegetation association description were recorded on standard data sheets. Details on the overstorey height, canopy depth and diameter, and canopy cover were also recorded, as well as a description of the location and physical environment of each patch and quadrat. Table 1 lists the vegetation associations sampled at each of the nine quadrats.

All quadrats were also sampled for the presence of vertebrates and invertebrates. At each quadrat (except for TIL00901 where no formal trapping took place) a 60m line of six pitfall traps, linked together by a 30cm high mesh fence, were established. Each pitfall trap consisted of a 455mm x 380mm sheet of white, high impact polystyrene joined into a cylinder using a slotted H section plastic strip (HM12). Consequently, the pitfall traps had a diameter of 125mm and a depth of 380mm. Pitfall traps were used to capture small animals. Any captured animals were collected as soon as possible, usually in the early morning, to minimise any stress.

A line of 15 Elliott traps, also used to capture small animals, were set in association with each pitfall line and sampled the same habitat within the quadrat. A possum/cat size trap was placed at each end of the Elliott trap line. Any animals captured in these traps were also collected as soon as possible. A line of 6 micro-pitfalls, consisting of plastic vials measuring 80mm x 20mm, and filled with 70% alcohol, were placed parallel to the main pitfall line. These micro-pitfalls were used to trap invertebrates. Once trap-lines were established they were maintained for four nights.

Vertebrates were also sampled by manually searching each of the nine survey sites at least once during the survey period. Two harp traps, used to capture bats, were also set up within the survey area for a total of five nights (Figure 3).

A small amount of vehicle spotlight searching was attempted but the demands of quadrat sampling and specimen processing did not allow this to be undertaken in a systematic way.

Birds were recorded for each quadrat. An expert observer spent from one to several hours during the best bird observation times (early morning and evening) recording all birds within, or flying over, the quadrat during the search period. An attempt was made to put the same amount of search effort into each quadrat during the best observation times.

Observations of some plants and vertebrates encountered outside quadrats were recorded on a separate 'opportunistic' data sheet.

At least one specimen of each small mammal and reptile species recorded for the survey area was preserved as a museum specimen. Larger species, which had been collected from the general region in the past and did not present any identification problems, were not collected.

Samples of liver tissue were taken from all vertebrate specimens collected and these were temporarily stored in liquid nitrogen. These tissue samples are now permanently stored at the South Australian Museum (SAM).

Invertebrates were collected from the micro-pitfall and larger vertebrate pitfall traps or opportunistically around each quadrat. These samples were also lodged with SAM.

A permanent photographic monitoring point was established at each of the nine survey sites using two 1.4m long steel posts placed 10m apart (Figures 4 - 12).

A summary of the sampling effort over the whole survey is given in Table 2. The number of individual observations during the survey is shown in Table 3.



Figure 3. Andrew Freeman checking Harp Traps, which were used to capture bats during the Biological Survey of the West Avenue Range, December 1999.
Photo. Hafiz Stewart.

Table 1. Flora and fauna sampling quadrats established in the West Avenue Range study area, December 1999.

Survey site code	Vegetation association
DUF00101	<i>Eucalyptus diversifolia</i> Mallee
DUF00201	<i>Eucalyptus arenacea</i> Low open woodland
DUF00301	<i>Melaleuca brevifolia</i> Low shrubland
DUF00401	<i>Eucalyptus leucoxylon</i> Low open woodland
GYP00501	<i>Melaleuca brevifolia</i> Low shrubland
GYP00601	<i>Selleria radicans</i> Herbland
GYP00701	<i>Melaleuca halmaturorum</i> Tall shrubland
GYP00801	<i>Eucalyptus fasciculosa</i> Low woodland
TIL00901	<i>Melaleuca lanceolata</i> Low woodland

Table 2. Trapping and spotlighting effort during the West Avenue Range Biological Survey, December 1999.

Survey site code	Pit trap nights	Elliott trap nights	Vehicle spotlight hours	Harp trap nights
DUF00101	24	60		
DUF00201	24	60		
DUF00301	24	60		
DUF00401	24	60		
GYP00501	24	60		
GYP00601	24	60		
GYP00701	24	60		
GYP00801	24	60		
TIL00901	0	0		
Opportunistic			4.75	10
Totals	192	480	4.75	10

Table 3. Total number of individual plant and vertebrate species recorded during the West Avenue Range Biological Survey, December 1999.

Plants	296
Mammals	20
Birds	108
Reptiles	16
Amphibians	4

Data management

All collected specimens were lodged with the appropriate institutions for verification and were added to their collections if required. The State Herbarium received all collected plant specimens and the vertebrate and invertebrate specimens were lodged with SAM. Any corrections to specimen identification were transferred to the original data sheets and the data was entered on the Opportunistic and Survey databases administered by the Biodiversity Survey and Monitoring Section of DEH.

Vegetation mapping

Due to the relatively small number of vegetation quadrats sampled in this survey a PATN analysis, used to define floristic groups for most other surveys, was not attempted. Instead, a 1:20 000 scale vegetation map of the West Avenue Range area was created based on previous regional mapping, data collected from survey sites, fieldwork and the interpretation of 1:40 000 scale colour aerial photography, reproduced at 1:20 000 scale. Tim Hudspith, using ESRI ARC/INFO GIS software produced the final map, which is reproduced at 1:40 000 scale for this report (Figure 13). This map is contained in a pocket attached to the inside back cover of this report.

RESULTS

VEGETATION

Previous studies

Some pre-existing information on the vegetation of the West Avenue Range district was available prior to undertaking this survey. This information came from Heritage Agreement assessments undertaken by the Native Vegetation Conservation Section (DEH) and survey site data collected during the South East Regional Flora Survey, conducted in September 1991.

Regional floristic vegetation mapping

Regional floristic vegetation mapping at 1:40 000 scale existed for the South East prior to this survey (Heard, 1999). This regional mapping was completed following the regional native vegetation survey in 1991, and subsequent data analysis and research. A report detailing the South East regional survey and mapping is currently in preparation (Foulkes and Heard, in prep). However, it was thought that a more detailed, larger scale vegetation map, focusing on the West Avenue Range, would be of benefit for this study.

Local floristic vegetation mapping

Due to the relatively small number of vegetation quadrats sampled in this survey a PATN analysis, used to define floristic groups for most other surveys, was not attempted. Instead, a 1:20 000 scale vegetation map of the West Avenue Range area was created based on previous regional mapping, data collected from survey sites, fieldwork and the interpretation of 1:40 000 scale colour aerial photography, reproduced at 1:20 000 scale. Tim Hudspith, using ESRI ARC/INFO GIS software produced the final map, which is reproduced at 1:40 000 scale for this report (Figure 13). This map is contained in a pocket attached to the inside back cover of this report.

West Avenue Range vegetation communities

Twelve floristic plant communities were recognised in this study. Six of these communities were associated with calcareous ridges (*Eucalyptus fasciculosa* Low woodland, *E. leucoxylon* ssp. *stephaniae* Low open woodland, *E. arenacea* Low open woodland, *Melaleuca lanceolata* var. *lanceolata* Low woodland, *E. diversifolia* Open mallee and *Calytrix tetragona* Low shrubland). The other six were largely intergrading communities associated with areas subject to seasonal waterlogging or inundation (*Eucalyptus camaldulensis* Woodland, *E. viminalis* ssp. *cygnetensis* Very open woodland, *Leptospermum*

lanigerum Tall closed shrubland, *Melaleuca halmaturorum* ssp. *halmaturorum* Tall shrubland, *Melaleuca brevifolia* Low shrubland and *Selliera radicans* Herbland). (Refer to Table 4 and Figure 13).

Vegetation communities of conservation significance

Of the twelve vegetation communities defined in this report, seven are considered to be of high conservation significance at the regional level (Croft *et al.*, 1999, Croft and Carpenter, 2001) and these are discussed below.

Eucalyptus camaldulensis Woodland

Within the study area this community occurs as thin bands one to two trees deep, around some of the wetlands. However, adjacent Taylors Road it constitutes a bigger area, which can be mapped at a relatively large scale. It previously occupied extensive areas in the South East, but less commonly in the Upper South East. European settlement led to drainage and agricultural development, which resulted in this community being preferentially cleared to make way for pasture and horticulture. As a consequence, most remaining areas have been reduced to scattered trees in otherwise cleared land. This plant community is considered to be regionally 'vulnerable' (Croft *et al.*, 1999).

Eucalyptus fasciculosa Low woodland

This community occurs in areas of red loam and outcropping calcareous substrate in the study area, particularly on the lower slopes near or on islands in the watercourse. The plant community previously occupied extensive areas in the Upper South East, but with post-war development, was selectively cleared to make way for agriculture. It is considered regionally 'vulnerable' (Croft and Carpenter, 2001).

In the study area, the *Eucalyptus fasciculosa* trees are in relatively poor condition, with reduced leaf canopy and dead branches evident. Heavy lerp infestations have been noted on the trees (eg: November 1998), which also carry a heavy mistletoe load. The latter is considered indicative of poor tree health. At times, bridal creeper has smothered the understorey. Numerous other introduced herbaceous and grass species are also prominent in the understorey.

Eucalyptus leucoxylon ssp. *stephaniae* Low open woodland

This association occurs in small areas of sandy loam found in swales or on the lower slopes of the range in the study area. The community is one of the subspecies of *Eucalyptus leucoxylon* Low open woodland in the region and is primarily distributed in the Upper South East and adjacent Lower Murray Mallee. It is a plant community that has been selectively cleared to make way for agriculture following post-war development. It is considered regionally 'vulnerable' (Croft and Carpenter, 2001).

***Eucalyptus viminalis* ssp. *cygnetensis* Very open woodland**

In the study area, small pockets of this plant community were located in lower lying areas of the range over a prominent *Melaleuca brevifolia* understorey. However, most of the plant community has been reduced to scattered trees in cleared land. The plant community was more widely distributed in the Lower South East, becoming much less frequent in the Upper South East. Typically, this plant community has been selectively cleared in the South East, primarily to make way for pine plantations. It is considered regionally to be an 'endangered' plant community (Croft *et al.*, 1999).

***Melaleuca lanceolata* var. *lanceolata* Low woodland**

In the study area, this plant community occupies small areas of red loam and outcropping calcareous substrate on higher land adjacent the watercourses. Generally, the plant community is associated with the red loam and rocky outcrops of the ranges throughout the region, primarily towards the coast. At the time of European settlement, these low woodlands probably contained an open grassy understorey, and as such were readily grazed and modified by early settlers. The plant community has usually been reduced to old remnant trees in otherwise cleared land. It is considered regionally 'endangered' (Croft *et al.*, 1999).

***Leptospermum lanigerum* Tall closed shrubland**

Within the study area this plant community is restricted to stretches of Henry Creek (Figure 2), where it is at its most northerly known location in the region. It is more prevalent in sub-coastal areas of the Lower South East, where it once occupied large areas. However, following European settlement, drainage and pasture development has significantly reduced the extent of this community to a point where it now only occurs in small pockets, which are often subjected to grazing by cattle. The plant community is considered to be regionally 'vulnerable' (Croft *et al.*, 1999).

Although very small in area, this plant community contained the highest number of plant species of high conservation significance of any plant community in the study area. The plant community is susceptible to changes in water regime and quality, and is not considered tolerant of high salinity levels for extended periods.

***Selliera radicans* Herbland**

In the study area, this plant community dominated the deeper parts of the watercourse where water could be expected to remain for the longest period of time. On drying, these areas facilitate the formation of a dense mat of native herbs and small sedges. The plant community is largely restricted to similar situations on the inter-range watercourses of the Upper South East. After European settlement, these areas have changed through drainage and pasture development, a process still continuing due to further drying out of many watercourses. The plant community is considered to be regionally 'endangered' (Croft *et al.*, 1999).

Table 4. Vegetation communities – West Avenue Range.

1. <i>Eucalyptus camaldulensis</i> Woodland.
2. <i>Eucalyptus fasciculosa</i> Low woodland OVER very sparse <i>Lepidosperma congestum</i> (on better developed sandy loams on calcrete).
3. <i>Eucalyptus leucoxylon</i> ssp. <i>stephaniae</i> Low open woodland OVER sparse <i>Acacia longifolia</i> var. <i>sophorae</i> OVER mid dense to sparse <i>Xanthorrhoea caespitosa</i> , <i>Vittadinia gracilis</i> (on better developed sandy loams on calcrete).
4. <i>Eucalyptus viminalis</i> ssp. <i>cygnetensis</i> Very open woodland OVER <i>Melaleuca brevifolia</i> (on localised depressions in the calcareous ridges).
5. <i>Eucalyptus arenacea</i> Low open woodland OVER a diverse shrub layer of <i>Baeckea behrii</i> , <i>Leptospermum myrsinoides</i> , <i>Hibbertia</i> sp., <i>Allocasuarina muelleriana</i> ssp. <i>muelleriana</i> , <i>Banksia</i> sp. and <i>Hakea rostrata</i> (on sand of calcareous ridges).
6. <i>Melaleuca lanceolata</i> var. <i>lanceolata</i> Low woodland OVER <i>Danthonia</i> sp. (on red loam on calcrete).
7. <i>Eucalyptus diversifolia</i> Open mallee OVER very sparse <i>Calytrix tetragona</i> , <i>Thomasia petalocalyx</i> , <i>Hibbertia riparia</i> (at the base of calcareous ridges adjoining swamp vegetation).
8. <i>Leptospermum lanigerum</i> Tall closed shrubland OVER herbs and sedges of <i>Hydrocotyle plebeya</i> and <i>Montica australasica</i> .
9. <i>Melaleuca halmaturorum</i> ssp. <i>halmaturorum</i> Tall shrubland OVER <i>Xanthorrhoea caespitosa</i> , <i>Brachyloma ciliatum</i> , <i>Hibbertia sericea</i> (on sandy loams), (Community 7-DENR SE Regional Survey).
10. <i>Calytrix tetragona</i> Low shrubland OVER sparse low shrubs of <i>Cheiranthra alternifolia</i> .
11. <i>Melaleuca brevifolia</i> Low shrubland OVER very sparse <i>Baumea juncea</i> , <i>Juncus kraussii</i> , (± <i>Gahnia filum</i> , <i>Sarcocornia quinqueflora</i> , <i>Schoenus nitens</i> , <i>Sporobolus virginicus</i>) (more saline areas subject to more frequent and prolonged waterlogging, and infrequent inundation) (Community 22-DEH SE Regional Survey).
12. <i>Selliera radicans</i> Herbland (associated with the flats).

Plant species at the West Avenue Range

The survey recorded a total of 296 plant taxa within the study area from both formal sites and opportunistic collections (Appendix I). A further 12 plant taxa were recorded in a brief botanical survey of the Parakie Wetlands in early November 1998, and another plant species was recorded in March 2001.

As such, the twelve plant communities support at least 309 plant taxa. Of these 309 species, 49 are introduced and 260 are native and 27 of these native species are considered to be of high conservation significance at either the State and/or Regional level (*National Parks & Wildlife Act 1972*, Lang and Kraehenbuehl, 2000).

It is significant to note that sampling was undertaken in early December and March when most ephemeral species such as orchids and Liliaceae species are usually dying off or not evident. For this reason, the lists of species recorded for the study area (Appendix I) probably do not represent all the plant species of the West Avenue Range.

Plants of State and/or Regional conservation significance

This survey recorded six taxa of State significance (*National Parks & Wildlife Act 1972*) and a further 22 taxa of Regional significance (Lang and Kraehenbuehl, 2000). No plants of National significance were recorded.

Below are brief descriptions of all species of conservation significance so far recorded for the study area. As some species have different ratings at a State and Regional level, both listings are given.

Narrow-leaf Blown-grass (*Agrostis billardiera* var. *filifolia*)

A low, annual grass usually growing to 0.15m but occasionally up to 0.6m high, flowering September to December. Its South Australian distribution is limited to the South East and Southern Lofty botanical regions. Elsewhere it is recorded from Victoria and Tasmania.

In this survey it was recorded from the low lying plant communities of *Melaleuca brevifolia* Low shrubland (DUF00301) and *Selliera radicans* Herbland (GYP00601). It is listed as 'rare' for the State under Schedule 9, *National Parks and Wildlife Act 1972* (2000 update).

Austral Bugle (*Ajuga australis* form A)

A small perennial or annual herb typified by erect branching stems up to 30cm high. It flowers from September to December. Due to taxonomic difficulties, its Australian distribution is poorly known. However, in South Australia it has a wide distribution occurring in the Flinders Ranges, Eyre and Yorke Peninsula, Southern Lofty, Northern Lofty, and Kangaroo Island botanical regions.

In the South East, it is often recorded from *Eucalyptus fasciculosa* or *E. leucoxydon* woodlands on consolidated dune ridges with red loam and outcropping calcareous substrate. In this survey, it was opportunistically recorded from *Melaleuca lanceolata* var. *lanceolata* Low open woodland, located on a ridge with red loam soil. Lang and Kraehenbuehl (2000) consider this species to be regionally 'uncommon'. Populations of *A. australis* form A are known to be conserved in Padthaway, Mount Scott, Tilley Swamp and Aberdour Conservation Parks.

As the site where the plant was recorded is located on a ridge, it is not likely to be affected by drainage changes.

Showy Firebush (*Apalochlamys spectabilis*)

A tall erect biennial shrub of the daisy family, which grows up to 2.0m high and flowers from January to March. It can become locally common following disturbance such as fire. In South Australia it is recorded from Eyre Peninsula, Yorke Peninsula, Southern Lofty, Kangaroo Island and the South East botanical regions, particularly near the coast. Elsewhere it is recorded from more coastal areas of New South Wales, Victoria and Tasmania. Lang and Kraehenbuehl (2000) consider this species to be regionally 'uncommon'.

A few hundred dying off plants were recorded in the study area in March 2001 along a track adjacent new fencing through *Eucalyptus arenacea* Low open woodland. It is thought that the species prefers sandy habitats in disturbed sites. As it is a short-lived biennial species occurring on higher well-drained ground, it is not likely to be affected by changes in water flow.

Swamp Daisy (*Brachycome basaltica* var. *gracilis*)

A perennial herb growing up to 60cm high, flowering mostly September to January, but may be found flowering anytime of the year. In South Australia it is recorded from the Murray (associated with the River Murray) and the South East botanical regions. Elsewhere, it is recorded from Queensland, New South Wales and Victoria. The subspecies is listed as 'rare' for the State under Schedule 9, *National Parks and Wildlife Act 1972* (2000 update) and regionally as 'endangered' (Lang and Kraehenbuehl, 2000).

In this survey it was recorded from the *Leptospermum lanigerum* Tall closed shrubland opportunistic site associated with the Henry Creek watercourse (Figure 2). This is the site where it is proposed that water might

be diverted to increase flows. The species and its habitat are mostly associated with reasonably freshwater systems, and it is not considered tolerant of high salinity levels over extended periods. As such, this subspecies is likely to be adversely affected by increased water flow with higher salinity levels.

Coast Daisy (*Brachycome parvula* var. *parvula*)

A perennial herb growing up to 15cm high, flowering October to November. In South Australia it is recorded only from the South East botanical region, but elsewhere it is recorded from Victoria and Tasmania. It is listed as 'rare' for the State under Schedule 9, *National Parks and Wildlife Act 1972* (2000 update).

In this survey the subspecies was recorded from lower lying areas with *Melaleuca halmaturorum* ssp. *halmaturorum* Tall shrubland (opportunistic collection) and *Melaleuca brevifolia* Low shrubland (GYP00501). As such, it is thought that the species would be adversely affected by changes in water flows.

Small Leek-lily (*Bulbine semibarbata*)

A low perennial herb with succulent leaves growing 5-30cm high. It flowers September to November. In South Australia it is widely distributed in the Nullarbor, Gairdner-Torrens, Flinders Ranges, Eastern Pastoral, Eyre Peninsula, Murray, Yorke Peninsula, Southern Lofty, Kangaroo Island and South East botanical regions. It is recorded elsewhere in Australia from Western Australia, New South Wales, Victoria and Tasmania. Lang and Kraehenbuehl (2000) consider this species to be regionally 'uncommon'.

Although not recorded during this survey, it was recorded from the *Selliera radicans* Herbland of the flats in November 1998, within the study area. This is an area likely to be unfavourably affected by water flow changes.

Native Centella (*Centella cordifolia* s str.)

A perennial small herb with creeping branches rooting at the nodes, flowering December to March. In South Australia it is recorded from the Flinders Ranges, Eyre Peninsula, Northern Lofty, Murray, Southern Lofty, Kangaroo Island and South East botanical regions. Elsewhere it is recorded from Western Australia, Victoria, New South Wales, Tasmania, Queensland, Asia and the Pacific Islands. Lang and Kraehenbuehl (2000) consider this species to be regionally 'rare'.

In this survey it was recorded at the opportunistic *Leptospermum lanigerum* Tall closed shrubland site associated with Henry Creek (Figure 2). This is the area proposed for directed increased water flow and this may have a deleterious affect on the species. The species is not considered tolerant of high salinity levels, as it typically occurs in freshwater wetlands in higher rainfall areas.

Hand-flower (*Cheiranthra alternifolia*)

A small perennial shrub growing to 50cm high, flowering September to November. In South Australia it is widely distributed in all the agricultural botanical regions. However, elsewhere it is only recorded from Victoria and from historical records from Western Victoria. These old records date from before 1890. As such it is probably extinct in that State. Lang and Kraehenbuehl (2000) consider this species to be regionally 'rare'.

In this survey, the species was recorded from the opportunistic site of *Calytrix tetragona* Low shrubland on red loam. As this plant community is associated with the calcareous rise system, it is not likely to be negatively affected by changes in water flows.

Small Milkwort (*Comesperma polygaloides*)

A small erect perennial sub-shrub or herb with a woody root stock growing 10-20cm tall, flowering October to March (Jessop *et al.*, 1986). In South Australia the species is recorded from the Murray Mallee, Southern Lofty and South East botanical regions. Elsewhere it is recorded from Western Australia and Victoria. Lang and Kraehenbuehl (2000) consider this species to be regionally 'uncommon'.

The species was opportunistically recorded from *Melaleuca brevifolia* Low shrubland during the survey. As such, the species is likely to be negatively affected by changes in the water regime (eg: increases in salinity or changes to the duration and timing of flooding).

Long-hair Plume-grass (*Dichelachne crinita*)

A tall, tufted perennial grass growing up to 1.2m high, flowering October to December. In South Australia it is widely distributed and is recorded from the Flinders Ranges, Eyre Peninsula, Northern Lofty, Murray Mallee, Yorke Peninsula, Southern Lofty, Kangaroo Island and the South East. Elsewhere, it is recorded from a wide range of habitats in all Australian States except the Northern Territory. In the South East it is known from diverse, widely separated areas including Piccaninnie Ponds, Penola, Bangham, Messent and Mary Seymour Conservation Parks.

The species was recorded from a variety of habitats during the survey. It was recorded from *Melaleuca brevifolia* Low shrubland (DUF00301), and opportunistically from *Eucalyptus viminalis* ssp. *cygnetensis* Very open woodland, *Eucalyptus diversifolia* Open mallee, *Melaleuca halmaturorum* var. *halmaturorum* Tall shrubland, and *Calytrix tetragona* Low shrubland. Lang and Kraehenbuehl (2000) consider this species to be regionally 'uncommon'.

Although the grass species was recorded from higher areas such as the calcareous ridges, it was mostly observed in the lower lying habitats where it is likely to be affected by changes in water flow.

Prostrate Blue Devil (*Eryngium vesiculosum*)

A prostrate perennial herb regrowing annually from underground tubers, flowering December to February. In South Australia it is recorded from widespread locations in the North West, Murray, Southern Lofty, Kangaroo Island and the South East botanical regions. Elsewhere it is recorded from Victoria and Tasmania. It is listed as 'rare' under Schedule 9, *National Parks and Wildlife Act 1972* (2000 update).

The species was recorded opportunistically from an open flat with *Selliera radicans* Herbland and from *Melaleuca halmaturorum* var. *halmaturorum* Tall shrubland in the south of the study area. Both areas occur in low lying places along the watercourse and so are likely to be affected by changes in water flow.

Hairy Speedwell (*Veronica calycina*)

A perennial herb with stems 5-40cm long arising from stolons, flowering late October to December (Jessop *et al.*, 1986). In South Australia it is recorded from Kangaroo Island and the South East botanical regions, sparsely present in shady sites in eucalypt forest and woodland, and occasionally shrublands or marshy situations. Elsewhere it is recorded from all Australian States except the Northern Territory. Lang and Kraehenbuehl (2000) consider this species to be regionally 'uncommon'.

A few plants were recorded in *Eucalyptus fasciculosa* woodland during the survey (TIL1001 and opportunistically). As this plant community is typically associated with the calcareous rises, it is not expected to be affected by changes in water flow.

Pennywort (*Hydrocotyle plebeya*)

A perennial herb, growing 8-20cm high, with a creeping stem, rooting at the lower nodes. It flowers December to April. In South Australia it is recorded from the Southern Lofty and South East botanical regions, but elsewhere only from Western Australia. Lang and Kraehenbuehl (2000) consider the species to be regionally 'uncommon'.

In this survey it was recorded at the *Leptospermum lanigerum* Tall closed shrubland opportunistic site associated with Henry Creek. This is the area proposed for directed and increased water flow. This may have a deleterious affect on the species. The species is not considered tolerant of high salinity levels, as it typically grows in freshwater wetlands in higher rainfall areas. In the Lower South East it is also usually associated with *Leptospermum lanigerum* Tall shrubland and related habitats.

Salt Lawrencia (*Lawrencia spicata*)

An erect sub-fleshy herb growing up to 1.2m high, flowering January to April. In South Australia it is recorded from the Eyre Peninsula, Northern Lofty, Yorke Peninsula, Southern Lofty, Kangaroo Island and the South East botanical regions. Elsewhere it is found in Western

Australia, Victoria and Tasmania. Lang and Kraehenbuehl (2000) consider this species to be regionally 'uncommon'.

The species was opportunistically recorded from *Melaleuca halmaturorum* ssp. *halmaturorum* Tall shrubland, typically associated with watercourses in the Upper South East. As such, it is thought that the species would be affected by changes in water flow.

Cleland's Beard-heath (*Leucopogon clelandii*)

Usually a small low shrub but it can grow up to 30cm high on occasions. It flowers April to September. In South Australia it is recorded from the Eyre Peninsula, Murray, Yorke Peninsula, Southern Lofty, Kangaroo Island and South East botanical regions. Elsewhere it is recorded from western Victoria. It is listed as 'rare' for the State under Schedule 9, *National Parks and Wildlife Act 1972* (2000 update).

The species was opportunistically recorded from *Melaleuca brevifolia* Low shrubland associated with lower lying areas, and *Calytrix tetragona* Low shrubland associated with an area of red loam soils on a calcareous rise. The population on the calcareous rise would probably not be affected by changes in water flows. However, the larger *Melaleuca brevifolia* Low shrubland population is found on lower lying areas. This population is expected to be very sensitive to changes in water flow.

Nodding Beard-heath (*Leucopogon woodsii*)

Small shrub 20-40cm high, flowering February to June. In South Australia it is recorded from the Eyre Peninsula, Murray, Yorke Peninsula, Southern Lofty, Kangaroo Island and South East botanical regions. Elsewhere it is recorded from Western Australia and Victoria. Lang and Kraehenbuehl (2000) consider this species to be regionally 'uncommon'.

The species was recorded from *Eucalyptus arenacea* Low open woodland (DUF00201) on deep sand. As this plant community is typically associated with the calcareous rises, it is not likely to be affected by changes in water flow.

Sword Mat-rush (*Lomandra sororia*)

A small perennial herb with leaves up to 40cm high, flowering October to November. In South Australia it is recorded from the Southern Lofty, Northern Lofty, Murray and South East botanical regions, while elsewhere in Australia it is only recorded from western Victoria. In the South East it is typically found in eucalypt woodlands. Lang and Kraehenbuehl (2000) consider the species to be regionally 'uncommon'.

The species was recorded in *Eucalyptus leucoxyloides* ssp. *stephaniae* Low open woodland (DUF00401) located on a loam and surface calcareous substrate rise.

As such, changes in water flow are not likely to affect this species.

Slender Honey-myrtle (*Melaleuca gibbosa*)

A shrub usually growing about 1.0m high in the Upper South East, but in favourable conditions up to 3.0m. It flowers October to February. In South Australia it is recorded from the Eyre Peninsula, Yorke Peninsula, Kangaroo Island and South East. Elsewhere it is recorded from Victoria and Tasmania. Lang and Kraehenbuehl (2000) consider this species to be regionally 'rare'.

The species was opportunistically recorded from *Melaleuca brevifolia* Low shrubland during the survey. Such low-lying areas would likely be affected by changes in water flow. *Melaleuca gibbosa* seems particularly sensitive to changes in water regimes such as increased salinity level, groundwater and water flow changes.

White Purslane (*Montia australasica*)

A low growing tufted herb, at times forming a groundcover carpet, growing to 3cm high. It flowers November to March. In South Australia it is recorded from the Murray, Southern Lofty, Kangaroo Island and South East botanical regions. Elsewhere it is only recorded from Victoria. It is listed as 'rare' for the State under Schedule 9, *National Parks and Wildlife Act 1972* (2000 update).

The species was recorded at the opportunistic *Leptospermum lanigerum* Tall closed shrubland site associated with Henry Creek. This is the area proposed for directed increased water flow, which is likely to have a deleterious affect on the species. The species is not considered tolerant of high salinity levels, as it typically grows in freshwater wetlands of higher rainfall areas, usually associated with *Eucalyptus camaldulensis* Woodland.

Salt Pratia (*Pratia platycalyx*)

A low growing perennial herb, rooting at the nodes, flowering December to March. In South Australia it is recorded from the Murray (associated with the River Murray and lower lakes), Kangaroo Island and the South East botanical regions. Elsewhere it is recorded from Victoria and Tasmania. Lang and Kraehenbuehl (2000) consider this species to be regionally 'uncommon'.

The species was recorded at the opportunistic *Leptospermum lanigerum* Tall closed shrubland site associated with Henry Creek. This is the area proposed for directed and increased water flow. However, the species is tolerant of a range of salinity levels, and may be less affected than other species not considered tolerant of higher salinity levels (eg: *Montia australasica*, *Senecio biserratus*).

Jagged Groundsel (*Senecio biserratus*)

An erect annual herb growing 0.6 to 1.0m high, flowering October to March. In South Australia, it is restricted to

wetter areas of the South East botanical region, while elsewhere it is recorded from New South Wales, Victoria, Tasmania and New Zealand. Lang and Kraehenbuehl (2000) consider this species to be 'uncommon' for the State and Region.

The species was recorded at the opportunistic *Leptospermum lanigerum* Tall closed shrubland site associated with Henry Creek. This area is proposed for directed increased water flow, which is likely to have a deleterious affect on the species. The species is not considered tolerant of high salinity levels, as it usually occurs in more freshwater wetlands of the higher rainfall areas.

Heath Spear-grass (*Stipa exilis*)

A tufted erect perennial grass, growing up to 0.6m high and flowering October to December. In South Australia it is widely distributed in the agricultural regions, being recorded from the Eyre Peninsula, Northern Lofty, Murray, Yorke Peninsula, Southern Lofty, Kangaroo Island and South East botanical regions. Elsewhere, it is recorded from Western Australia, and limited locations in Victoria. Lang and Kraehenbuehl (2000) consider the species to be regionally 'rare'.

The species was recorded from *Eucalyptus leucoxylon* ssp. *stephaniae* Low open woodland (DUF00401) and *Melaleuca brevifolia* Low shrubland (DUF00301). As such, the species was recorded from both the calcareous ridge system and lower lying areas. While the species is not likely to be affected by changes in water flow in the higher areas, it is expected to be negatively affected in the lower lying sites.

Spear-grass (*Stipa trichophylla*)

A tufted erect perennial grass, growing up to 0.6m high and flowering August to December. In South Australia it is widely distributed in most botanical regions except the Nullarbor, Gairdner-Torrens and Kangaroo Island botanical regions. Elsewhere it is recorded from Western Australia, the Northern Territory, New South Wales and a few limited locations in western Victoria. Lang and Kraehenbuehl (2000) consider this species to be regionally 'rare'.

The species was recorded from *Melaleuca brevifolia* Low shrubland (DUF00301), and would likely be affected by changes in water flow.

Mallee Fringe-lily (*Thysanotus baueri*)

A perennial herb growing 15-30cm high, flowering October to January. The leaves regrow annually from underground tubers, usually withering by the time of flowering. In South Australia it is widely distributed in drier habitats from the Nullarbor, Gairdner-Torrens, Flinders Ranges, Eastern, Eyre Peninsula, Northern Lofty, Murray, Yorke Peninsula, Southern Lofty and

South East botanical regions. Elsewhere in Australia it is recorded from Western Australia, New South Wales and Victoria. Lang and Kraehenbuehl (2000) consider this species to be regionally 'indeterminate' (**K**) and to be at least regionally 'rare'.

The species was recorded from the opportunistic *Eucalyptus viminalis* ssp. *cygnetensis* Very open woodland and *Calytrix tetragona* Low shrubland sites. As such, the species grows on both the higher calcareous rises and lower lying areas. The smaller population in the low lying *Eucalyptus viminalis* ssp. *cygnetensis* Very open woodland may be affected by changes in water regime. However, the larger population located in the *Calytrix tetragona* Low shrubland is not likely to be affected by changes in water flow.

Scrub Nettle (*Urtica incisa*)

A perennial herb growing up to 1.0m high, which may be found flowering at any time of the year. In South Australia it is recorded from the Murray (associated with the River Murray and lower lakes), Kangaroo Island and South East botanical regions. Elsewhere it is recorded from all States (except the Northern Territory), New Zealand and New Caledonia. Lang and Kraehenbuehl (2000) consider this species to be regionally 'uncommon'.

The species was recorded at the opportunistic *Leptospermum lanigerum* Tall closed shrubland site associated with Henry Creek. This is the area proposed for directed increased water flow, which is likely to have a deleterious affect on the species. *Urtica incisa* is not considered tolerant of high salinity levels, as it typically grows in freshwater wetlands.

Yellow-wash Bluebell (*Wahlenbergia luteola*)

A perennial herb with a thickened tap root usually growing 30cm, but occasionally up to 60cm high. It flowers October to March. In South Australia it is recorded from the Flinders Ranges, Eyre Peninsula, Northern Lofty, Murray, Yorke Peninsula, Southern Lofty, and the South East botanical regions. Elsewhere it is recorded from New South Wales and Victoria. Lang and Kraehenbuehl (2000) consider this species to be regionally 'indeterminate' (**K**) and to be at least regionally 'rare'.

The species was recorded from an opportunistic *Eucalyptus diversifolia* Open mallee site associated with rocky red loam soils. It is a species typically associated with the calcareous ridge system, and as such would probably not be affected by changes in water flow.

Silky Wiltonia (*Wiltonia humilis* var. *humilis*)

A small prostrate shrub growing up to 10cm high, flowering mainly in spring and summer. In South Australia it is recorded from the Nullarbor, Eyre Peninsula, Murray, Yorke Peninsula, Southern Lofty, Kangaroo Island and South East. Elsewhere it is recorded from Western Australia, Victoria and Tasmania. Lang and Kraehenbuehl (2000) consider this species to be regionally 'uncommon'.

The species was opportunistically recorded from *Melaleuca halmaturorum* ssp. *halmaturorum* Tall shrubland, and *Melaleuca brevifolia* Low shrubland (GYP00501). Both plant communities are associated with the low-lying watercourses and as such the species is likely to be affected by changes in water flow.



Figure 4. DUF00101 *Eucalyptus diversifolia* Mallee.
Photo. Hafiz Stewart



Figure 5. DUF00201 *Eucalyptus arenacea* Low open woodland.
Photo. Hafiz Stewart



**Figure 6. DUF00301 *Melaleuca brevifolia* Low shrubland.
Photo. Hafiz Stewart**



**Figure 7. DUF00401 *Eucalyptus leucoxyton* Low open woodland.
Photo. Hafiz Stewart**



Figure 8. GYP00501 *Melaleuca brevifolia* Low shrubland.
Photo. Hafiz Stewart



Figure 9. GYP00601 *Selliera radicans* Herbland.
Photo. Hafiz Stewart



**Figure 10. GYP00701 *Melaleuca halmaturorum* Tall shrubland.
Photo. Hafiz Stewart**



**Figure 11. GYP00801 *Eucalyptus fasciculosa* Low woodland.
Photo. Hafiz Stewart**



**Figure 12. TIL00901 *Melaleuca lanceolata* Low woodland.
Photo. Hafiz Stewart**

The West Avenue Range Biological Survey

MAMMALS

This survey represents the first systematic mammal trapping of this part of the West Avenue Range. The specimens collected from this survey are the first to be lodged in the collections of the South Australian Museum.

A total of 20 mammal species (7 introduced) were recorded during the survey. Of these only two species are considered of conservation significance in South Australia.

It is likely that several more bat species, the Western Pygmy Possum (*Cercartetus concinnus*) and the Silky Mouse (*Pseudomys apodemoides*) also occur in the study area.

Species of conservation significance

Common Wombat (*Vombatus ursinus*)

The Common Wombat is a nocturnal burrowing herbivore distributed from the northern border of New South Wales, south along the temperate coast to Salt Creek in South Australia. Although, this species has been undergoing a reduction in distribution since the Pleistocene period, European settlement has exacerbated this decrease (McIlroy, 1995). Presently, in the south east of South Australia the Common Wombat exists in isolated populations on the eastern sides of dunes where sufficient cover, and perennial native grasses and sedges are found (Mallet and Cooke, 1986, Croft and Carpenter, 2001). Mallet and Cooke (1986) suggest this may be because the native perennial grasses the Common Wombat feed on might be dependent on the existence of shallow ground water, allowing for fresh growth during summer.

Although the Common Wombat is considered to be 'common' at the national level, it is listed as 'vulnerable' in the *National Parks and Wildlife Act 1972* (2000 update) in South Australia and in the South East (Robinson *et al.*, 2000, Croft and Carpenter, 2001).

The Common Wombat remains moderately well conserved within the Reserve system having been recorded from seven Conservation Parks, two National Parks, five Native Forest Reserves and at least one Heritage Agreement area in the South East in the last ten years. (Based on data collected during the South Coast Biological Survey and the South East Biological Survey).

Evidence of Wombats were recorded from four survey sites (DUF00101, DUF00401, GYP00801 and TIL00901), and several opportunistic locations during the survey. Fresh scats and signs of burrowing were recorded at the four survey sites. These sites were located

between Henry Creek Road in the north to Robertson Road in the southern section of the study area. Several dead Wombats have been observed opportunistically on the Henry Creek Road during previous surveys.

As the proposed drain alignment is positioned outside of the areas of remnant native vegetation and to the east of the sand dune the Wombats were recorded from, the drain is unlikely to impact this species.

Red-necked Wallaby (*Macropus rufogriseus*)

The Red-necked Wallaby has a wide distribution from southern Queensland through the temperate east coast of Australia to the south east of South Australia and Tasmania. At a National level this species is considered to be 'common' with a distribution that has remained largely unchanged since European settlement (Calaby, 1995).

However, this is not the case in the South East, where the distribution of this species has markedly declined since European settlement. This wallaby is now only found in larger remnants of native scrub, which have been left uncleared for agriculture (Aitken, 1983, Best and Croft, 1995). At a State level, and in the South East *M. rufogriseus* is considered to be 'rare' (Robinson *et al.*, 2000, Croft and Carpenter, 2001).

Populations of the Red-necked Wallaby have been recorded from Fairview, Martin Washpool, Bangham and Big Heath Conservation Parks, at Kingston, in the 'Deepwater' property, and at Deep Swamp (Owens *et al.*, 1995a, Stewart, 1996, Stewart *et al.*, 1998a,b).

Red-necked wallabies were recorded opportunistically on six occasions during the survey, including four animals recorded while spotlighting on the edge of the wetland/woodland interface in *Eucalyptus diversifolia* Low open mallee and *E. fasciculosa* Open woodland. It is likely that this species occurs all along the West Avenue Range.

As the species has survived to date in the study area, and because the proposed drain will be positioned outside of native vegetation remnants, it is unlikely to seriously impact upon this local population of Red-necked Wallabies.

Other mammal species recorded during the survey

Several other native mammal species were captured or observed during the survey (Appendix II). These were

the Little Pygmy Possum (*Cercartetus lepidus*), Common Brushtail Possum (*Trichosurus vulpecula*), Short-beaked Echidna (*Tachyglossus aculeatus*), Western Grey Kangaroo (*Macropus fuliginosus*), Kangaroo (*Macropus* sp.), White-striped Freetail-bat (*Tadarida australis*), Lesser Long-eared Bat (*Nyctophilus geoffroyi*), Gould's Wattled Bat (*Chalinolobus gouldii*), Chocolate Wattled Bat (*C. morio*), Southern Forest Bat, (*Vespadelus regulus*) and the Little Forest Bat (*Vespadelus vulturnus*). All of these species are classified as 'common' at the State level and in the South East (Robinson *et al.*, Croft and Carpenter 2001).

In addition to the above, seven species of introduced mammals were recorded during this survey (Appendix II). These were the Red Fox (*Vulpes vulpes*), Sheep (*Ovis aries*), Feral Cat (*Felis catus*), Fallow Deer (*Cervus dama*), Rabbit (*Oryctolagus cuniculus*), Brown Hare (*Lepus capensis*) and House Mouse (*Mus domesticus*). It is worthy of mention that dozens of Fallow Deer were observed in the study area during the survey (and again during the vegetation mapping field trip) and they appear to be increasing in number in the local area and in the South East in general.

Note: just prior to printing this report the authors were made aware of the presence of another introduced mammal, the Red Deer (*Cervus alaphus*), which had been observed in the Henry Creek.

The West Avenue Range Biological Survey

BIRDS

A total of 108 bird species were recorded from either the nine survey sites or opportunistically during the Biological Survey of the West Avenue Range (Appendix III). Of the total known avifauna for the West Avenue Range 12 species are of conservation significance (Table 5) and one bird is of other interest. These species are discussed below.

Species of conservation significance

Malleefowl (*Leipoa ocellata*)

The Malleefowl (Figure 14) is a Nationally listed 'vulnerable' bird and is considered 'vulnerable' in South Australia (*NPW Act, 1972*). The species is a mound building bird (Figure 15). It is distributed widely across southern Australia and is associated with low woodland and mallee habitats. Populations have generally declined due to the clearance, degradation and fragmentation of habitat, associated with agriculture. Competition from introduced herbivores (livestock, rabbits) and predation (mainly by foxes) has also had an adverse affect on populations.

In the South East, Malleefowl occur in small numbers in larger areas of mallee and low woodland habitats. The low lying *Melaleuca* spp. habitats are also likely to be used for foraging, as has been observed elsewhere in the region. These *Melaleuca* spp. habitats may be adversely affected by changes in the water regime or quality as a consequence of further drainage.

In this survey the species was recorded from three sites (DUF00101, *Eucalyptus diversifolia* Open mallee, DUF00201, *E. arenacea* Low open woodland and DUF00401, *E. leucoxylon* Low open woodland). The species was also recorded opportunistically within Heritage Agreement 902 and the Parakie Wetlands.

Brown Quail (*Coturnix ypsilophora*)

This Quail is occasionally reported as either an infrequent visitor to northern areas of the State, or more regularly in the South East, where resident populations may exist. The species may often be overlooked due to superficial similarities with the Stubble Quail (*Coturnix pectoralis*) and Painted Button-Quail (*Turnix varia*) and the usually poor opportunities for detailed observations of birds, which have been flushed out of vegetation.

Observations at three locations were made in *Melaleuca brevifolia* and *M. halmaturorum* Low and Tall shrubland over *Gahnia* spp. and sedges (DUF00601, Section 151 Landseer and Section 49 Landseer). A brood of at least six small downy young

were seen with adults at the latter location. Preferred habitats for this species include seasonally wet grasslands or shrubs, sedges and tall grasses fringing wetlands. These low-lying habitats may be affected by changes in water regime or quality associated with drainage. The species is rated as 'vulnerable' for the State.

Blue-winged Parrot (*Neophema chrysostoma*)

The Blue-winged Parrot is a small, mobile and poorly known species breeding in a limited area of south-eastern Australia and dispersing widely into the inland during autumn-winter (Blakers *et al.*, 1984). In South Australia, it breeds in Stringybark forests and adjacent Red gum woodlands, including scattered trees, occurring in the south-east of the State, extending only as far north as Naracoorte. In winter it disperses widely as far as the north-east of the State, with concentrations in the saltmarshes and dunes along the South East and Coorong coast. The small number of birds observed, mainly in *M. brevifolia* Low shrubland in December, may represent early post breeding dispersal. The species is rated as 'vulnerable' for the State.

Painted Button-quail (*Turnix varia*)

This button-quail is sparsely yet widely distributed in mallee and woodland habitats in southern Australia, where leaf litter and a shrub understorey are available. The species has declined due to habitat clearance to make way for agriculture and degradation of remaining habitats by introduced herbivores. Its presence can often be detected by its feeding scrapes, round bare patches 10–15cm across where litter has been moved aside.

Two observations were made in *M. halmaturorum* Tall shrubland (DUF00701 and Section 49 Landseer). This type of habitat may be adversely affected by changes to the water regime or quality associated with drainage. The species is rated as 'vulnerable' for the State.

Yellow-tailed Black-Cockatoo (*Calyptorhynchus funereus*)

This large cockatoo feeds on the flowers and seeds of *Banksia* spp. and the seeds of *Hakea* spp. and introduced *Pinus* spp. Even isolated patches of pines are visited (such as those in the study area, mainly planted near farm buildings). Large hollows in old Eucalypts are required for breeding and birds will forage many kilometres from their nests.

A single opportunistic sighting of a pair was noted in November. These birds may have been *en route* to a breeding area since no suitable large hollows were seen in the study area. The species is rated as 'vulnerable' for the State.

Southern Emu-wren (*Stipiturus malachurus*)

This tiny, cryptic, State rated 'rare' species occurs in areas with a dense, low, diverse, shrub stratum. The Southern Emu-wren (Figure 16) has declined where such habitats have been either cleared to make way for agriculture or degraded due to grazing or drainage.

Small numbers were recorded in *M. brevifolia* Low shrubland at two sites (DUF00301, DUF00501) as well as several opportune records in similar extensive habitat along the eastern edge of the study area, close to the site of the proposed drain. The species was also recorded in *M. halmaturorum* Tall shrubland 1.5km east of DUF00501 and in patchy 1m high *M. brevifolia* Low shrubland at Section 151 Landseer. These habitats are likely to be adversely affected by changes to the water regime or quality (such as a rise in salinity) brought about by drainage.

Beautiful Firetail (*Staganopleura bella*)

This finch is distributed widely, although in small numbers, in coastal areas of the South East in places where dense vegetation is found (Figure 17). It feeds mainly on the seeds of a variety of native sedges (Read, 1994), which tend to occur in low-lying areas. These areas are likely to be affected by changes in water regime or quality related to drainage.

The species was recorded at only one survey site (DUF00501) in *Melaleuca brevifolia* Low open shrubland and opportunistically in Red Gum (*Eucalyptus camaldulensis*) Open woodland fringing dried wetlands and in Pink Gum (*E. fasciculosa*) Open woodland on Newry Station. The species has a State rating of 'rare'.

Slender-billed Thornbill (*Acanthiza iredalei hedleyi*)

This subspecies prefers *M. brevifolia* Low shrubland habitats and is moderately common in the extensive Ngarkat Conservation Park, but may have disappeared from many parts of the South East, where this type of habitat has been degraded or fragmented due to clearing, drainage and grazing. The species is also known from Gum Lagoon Conservation Park, but appears to be in decline in this location (Davies, 2000). The Slender-billed Thornbill was not found in the Tilley Swamp area (Stewart *et al.*, 1998a), but was found in Messent Conservation Park (Owens *et al.*, 1995a) and Deep Swamp (Stewart *et al.*, 1996).

Only two opportune observations were made during this survey despite searching extensive areas of *Melaleuca* spp. Low shrubland. Three birds were seen in remnant patches of *M. brevifolia* Low shrubland in Parkhill, Section 151 Landseer and two more were seen in extensive *M. brevifolia* Low shrubland in a Heritage Agreement located within the study area. These habitats are likely to be adversely affected by changes to the water regime or quality (such as a rise in salinity),

which are sometimes a consequence of clearance and drainage. The species has a State rating of 'vulnerable'.

Black-chinned Honeyeater (*Melithreptus gularis*)

This species occurs sparsely in the South East, where it inhabits large territories in open eucalypt woodlands. Its requirements are poorly understood and populations may be declining as in the Mt Lofty Ranges where critically low numbers remain.

In this survey one opportune observation was recorded. A bird was seen drinking at a soak in a *Eucalyptus camaldulensis*/*E. leucoxylon* Woodland fringing a dried wetland in a Heritage Agreement within the study area. The species has a State rating of 'vulnerable'.

Striated Fieldwren (*Calamanthus fuliginosus*)

This fieldwren (Figure 18) is sedentary in Low open shrubland of Tea-tree over Cutting grass in the South East of South Australia. The species is difficult to observe but can usually be detected by its distinctive territorial song. Observations reported in the South East are near the northern limit of the species distribution. It was not reported in Tilley Swamp (Stewart *et al.*, 1998a). *Calamanthus* sp. were observed in the 42 Mile Crossing area of Coorong National Park and are possibly also this species (G. Carpenter, R. Drummond pers. comm.) but may refer to *C. campestris winiam*, which occurs in drier low shrubland habitats further north (eg: Ngarkat Conservation Park).

In this survey opportune sightings were made in *M. brevifolia* Low shrubland in Section 49 Landseer and in several locations within Section 151 Landseer in *M. brevifolia* and *M. halmaturorum* Low and Tall shrubland. Other sightings were noted in several locations in *M. brevifolia* Low shrubland in a Heritage Agreement within the study area, where a specimen was obtained and later added to the collection of the South Australian Museum (SAM). These *Melaleuca* spp. habitats are likely to be adversely affected by changes to the water regime or quality (such as a rise in salinity). The species has a State rating of 'uncommon' (Carpenter and Reid, 1998).

Hooded Robin (*Melanodryas cuculata*)

This species has a wide distribution in *Acacia* spp. and *Eucalypt* spp. Low open woodlands across inland Australia but appears to be declining in south-eastern Australia with very few observations recorded from the South East of the State in recent years (T. Croft pers. comm.).

In this survey two opportune recordings were made. Three birds were recorded from the eastern edge of the study area in *M. brevifolia* Low shrubland, adjacent to open dry grass pasture (the proposed drain site) and a single bird was recorded in *M. brevifolia* Low shrubland from Section 49 Landseer. These *Melaleuca brevifolia* habitats are likely to be adversely affected by changes to the water regime or quality (such as a rise in salinity). The species has a

Regional rating of ‘uncommon’ (Carpenter and Reid, 1998).

Southern Whiteface (*Aphelocephala leucopsis*)

This widespread species feeds on the ground among short herbage in open habitats. While remaining common in many inland regions, populations have declined in some agricultural areas for unknown reasons but possibly due to habitat fragmentation.

In this survey a single opportune recording was made of four birds feeding on the open dry bed of a wetland along with Yellow-rumped Thornbills and White-fronted Chats. These wetland habitats are likely to be affected by changes to the water regime or quality (such as a rise in salinity). Other open areas, such as the nearby low grassy rises with an overstorey of scattered *Melaleuca lanceolata*, may also provide suitable habitat for whitefaces.

The species has a Regional rating of ‘endangered’ according to Carpenter and Reid (1998).

Other species of interest

Forest Raven (*Corvus tasmanicus*)

This raven is common in the lower south east of South Australia and was recorded at Deep Swamp (Stewart *et al.*, 1996). However, observations during this survey may represent the northern limit of the species distribution in the State, since it was not recorded from Tilley Swamp (Stewart *et al.*, 1998a), which is just north of the study area for this survey.

In this survey its slow, deep calls, large size, massive bill and short tail identified the species. It was recorded from four sites (DUF00101, DUF00601, DUF00701 and DUF00801). Opportune records were all within close proximity of larger trees near recently dried wetlands.

Table 5. Birds of conservation significance recorded during the West Avenue Range Biological Survey, December 1999.

Common name	Scientific name	*AUS	#SA	+REG
Malleefowl	<i>Leipoa ocellata</i>	V		
Brown Quail	<i>Coturnix ypsilophora</i>		V	
Blue-winged parrot	<i>Neophema chrysostoma</i>		V	
Painted Button-quail	<i>Turnix varia</i>		V	
Yellow-tailed Black-Cockatoo	<i>Calyptorhynchus funereus</i>		V	
Southern Emu-wren	<i>Stipiturus malachurus</i>		R	
Beautiful Firetail	<i>Stagonopleura bella</i>		R	
Slender-billed Thornbill	<i>Acanthiza iredalei hedleyi</i>		V	
Black-chinned Honeyeater	<i>Melithreptus gularis</i>		V	
Striated Fieldwren	<i>Calamanthus fuliginosus</i>		U	
Hooded Robin	<i>Melanodryas cuculata</i>			U
Southern Whiteface	<i>Aphelocephala leucopsis</i>			E

* National conservation significance.

State conservation significance according to the Schedules of the SA National Parks and Wildlife Act, 1972.

+ Regional conservation significance according to Carpenter and Reid (1998).

Note: only the highest level of conservation significance is shown for each species.



Figure 14. A pair of Malleefowl photographed while working a mound nest in the West Avenue Range in December 1999.

Photo. Hafiz Stewart.



Figure 15. A Malleefowl mound nest photographed in the West Avenue Range in December 1999.

Photo. Hafiz Stewart.



Figure 16. The ‘rare’ and secretive Southern Emu-wren (*Stipiturus malachurus*) has declined in many areas due to the affects of introduced predators, drainage and habitat clearance.
Photo. Deb Hopton.



Figure 17. A Beautiful Firetail was observed during the Biological Survey of the West Avenue Range in *Melaleuca brevifolia* Low shrubland. Drainage works may have an adverse affect on this type of habitat.
Photo. South Australian Ornithological Association (SAOA).



Figure 18. The Striated Fieldwren (*Calamanthus fuliginosus*) prefers *Melaleuca* spp. shrubland. Drainage works may have an adverse affect on this type of habitat. Photo. Hafiz Stewart.

The West Avenue Range Biological Survey

REPTILES AND AMPHIBIANS

The wetland of the West Avenue Range including the survey area had last been inundated with water in 1994 and at the time of this survey the swamps and water holes had been dry for at least two years. Consequently, there was only scant evidence found of frogs and wetland dependent reptiles. Nevertheless, a total of 16 reptile species and 4 frog species were recorded during the survey (Appendix IV). Of these, 12 reptile and 2 frog species were recorded at one or more of the survey sites and an additional 4 reptile and 2 frog species were recorded at opportunistic locations within the survey area.

Due to the absence of surface water there was no breeding chorus and frogs were difficult to locate. Light rainfall during the survey did stimulate some modest activity from the burrowing species the Meeowing Frog (*Neobatrachus pictus*) (Figure 19) and Bull Frog (*Lymnodynastes dumerili*) (Figure 20) resulting in their capture in pit fall lines at two sites that possessed sandy soils suitable for burrowing. In contrast the Common Froglet (*Crinia signifera*) and Brown Tree Frog (*Litoria ewingi*) (Figure 21) were collected opportunistically from damp soil around the base of a water tank being used to hold water drawn from an active well on the edge of a dry swamp.

Based on published distribution maps (Robinson *et al.*, 2000), additional frog species potentially present in the survey area include the Eastern Sign-bearing Froglet (*Crinia parinsignifera*), Marbled Frog (*Lymnodynastes tasmaniensis*), Suddell's Frog (*Neobatrachus sudelli*), Brown Toadlet (*Pseudophryne bibronii*) and Marbled Toadlet (*Pseudophryne semimarmorata*). There are no specimens in the SA Museum to confirm the presence of any of these species in the survey area. If present, they would be most apparent during breeding events when males are calling from the edges of flooded swamps and temporary wetlands.

The reptile assemblage detected in the survey area comprised 10 species of skink, 2 species of legless lizard and a single species each of elapid snake, goanna and dragon lizard. Colonisation of wetland areas during flood events by the Common Long-necked Tortoise (*Chelodina longicollis*) was evidenced by skeletal and carapace remains in and adjacent to low-lying areas (Figure 22). South Australian Museum records indicate that two additional species of elapid snake were collected from the survey area in 1982 at Smiths Swamp. These were the Eastern Brown Snake (*Pseudonaja textilis*) and the Lowland Copperhead (*Austrelaps superbus*).

The number of reptile species recorded at each site ranged from 1 (remains of the Common Long Neck Tortoise) at site GYP00601 (a dry swamp bed) to seven at site DUF00101 (a sand ridge covered by Coastal Mallee

(*Eucalyptus diversifolia*)). The mean number of reptile species detected over all nine sites was five.

The most frequently observed reptiles (in order of relative abundance) were the following skinks: the Four-toed Earless Skink (*Hemiergis peronii*), Mallee Snake-eye (*Morethia obscura*), Bougainville's Skink (*Lerista bougainvillii*), Eastern Three-lined Skink (*Bassiana duperreyi*), Eastern Stripped Skink (*Ctenotus robustus*) and Sleepy Lizard (*Tiliqua rugosa*). The most ubiquitous species were the Four-toed Earless Skink (*Hemiergis peronii*), recorded at 7 sites and Eastern Three-lined Skink (*Bassiana duperreyi*), which were recorded at 6 sites. Both species were frequently encountered opportunistically in low-lying areas of dry swampland as well as on the sandier soils of the surrounding eucalypt woodland and mallee scrub. Several Sleepy Lizards (*Tiliqua rugosa*) were observed on the edge of the dry swamps presumably feeding on the herbaceous plants that were growing in abundance at the time of the survey.

The majority of the reptiles detected were widespread species commonly found in eucalypt woodland habitats throughout south-eastern South Australia. The assemblage of reptiles, now known to be present in the survey area, is typical for the Upper South East Region of South Australia (Foulkes and Heard, in prep). It is similar to assemblages recently recorded for the nearby locations of Tilley Swamp (Stewart *et al.*, 1998a), Deep Swamp (Stewart, 1996) and Bunbury Conservation Reserve and Stoneleigh Park Heritage Agreement (Stewart *et al.*, 1998b).

Species of conservation significance

Heath Goanna (*Varanus rosenbergi*)

The presence of the Heath Goanna (*Varanus rosenbergi*) in the survey area is worthy of special mention (Figure 23). Due to concern regarding the decline of this species throughout much of its original South Australian distribution it is now considered 'rare' in this State (Robinson *et al.*, 2000). Two of the three individuals observed during the survey were patrolling the edge of a dry wetland suggesting that this habitat may be important to its persistence in the area.

Other species of interest

Only the Common Long-necked Tortoise (*Chelodina longicollis*), Eastern Tiger Snake (*Notechis scutatus*) and Lowland Copperhead (*Austrelaps superbus*) are considered wetland dependant species. Local populations of *Notechis scutatus* and *Austrelaps superbus* probably increase after flood events when

expanding frog populations provide a reliable food source. Populations of *Chelodina longicollis* would be transient, migrating from other more permanent wetland areas during flood events. The observation of a single *Notechis scutatus* at site GYP00701 (a dry *Melaleuca halmaturorum* ssp. *halmaturorum* Tall shrubland) indicates that a resident population of this species persists between flood events. *Austrelaps superbis* has a limited distribution in SA and the West Avenue Range is near the northern limit of its range. This species may therefore be more susceptible than *Notechis scutatus* to habitat changes arising from prolonged dry spells or engineering changes to drainage patterns.

None of the reptiles or frogs so far recorded in the survey area are of national conservation significance. However, the permanent loss of any wetland habitat in the South East of South Australia would reduce the available habitat for wetland dependant species that have a limited distribution in this State, such as the Lowland Copperhead (*Austrelaps superbis*). In addition, changes to native vegetation in the South East, including that which borders swamps and wetlands, may affect populations of the Heath Goanna (*Varanus rosenbergi*), a species which appears to be in decline on mainland South Australia.



Figure 19. The Meeowing Frog (*Neobatrachus pictus*) one of the ‘burrowing frogs’.
Photo. Hafiz Stewart.



Figure 20. The Bull Frog (*Lymnodynastes dumerili*) one of the ‘burrowing frogs’.
Photo. Hafiz Stewart.



**Figure 21. This beautifully marked Brown Tree Frog (*Litoria ewingi*) was collected opportunistically from damp soil around the base of a water tank.
Photo. Hafiz Stewart.**



**Figure 22. The Common Long-necked Tortoise (*Chelodina longicollis*) colonises the wetland areas of the West Avenue Range during flood events.
Photo. Hafiz Stewart.**



Figure 23. The Heath Goanna (*Varanus rosenbergi*) is considered ‘rare’ in South Australia. Photo. Hafiz Stewart.

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

Flora

The Biological Survey of the West Avenue Range was conducted during summer. At this time many plant species may have finished flowering and some annual species have died off. Consequently, it is unlikely that all plant species inhabiting the study area were recorded during the present survey. A follow up vegetation survey conducted in early spring may identify several more plant species in the study area.

When considering all plant species recorded from the study area (including records from the Biological Survey of the South East, this survey, and the opportune database) this part of the West Avenue Range supports a total of at least 309 plant species. This total includes 27 species of conservation significance and 49 weed species. Of the twelve vegetation communities identified in the study area, seven are considered to be of high conservation significance.

Six plant species of state conservation significance (*Agrostis billardiera* var. *filifolia*, *Brachycome basaltica* var. *gracilis*, *B. parvula* var. *parvula*, *Eryngium vesiculosum*, *Leucopogon clelandii* and *Montia australasica*) and three plant communities of high regional conservation significance (*Eucalyptus camaldulensis* Woodland, *Leptospermum lanigerum* Tall closed shrubland and *Selleria radicans* Herbland) were recorded from low-lying habitats. These habitats are subject to periods of inundation, and are therefore most likely to be affected by changes to the water regime, water quality or salinity.

In addition, a further four regionally rare plant species (*Centella cordifolia*, *Melaleuca gibbosa*, *Stipa exilis* and *S. trichophylla*) and nine regionally uncommon plant species (*Bulbine semibarbata*, *Comesperma polygaloides*, *Dichelachne crinita*, *Hydrocotyl plebeya*, *Lawrencina spicata*, *Pratia platycalyx*, *Senecio biserratus*, *Utricia incisa* and *Wilsonia humilis*) may also be adversely affected by changes to the water regime, water quality or salinity.

Many of the species of high conservation significance and one of the vegetation associations of conservation significance (*Leptospermum lanigerum* Tall closed shrubland) mentioned above occur at Henry Creek (Figure 2). As the proposed Bald Hill Drain is likely to carry

increased flows of more saline water into Henry Creek, this action is likely to adversely affect this plant community and the associated plant species of high conservation significance.

Bridal Creeper (*Myrsiphyllum asparagoides*) is particularly dominant in some *Eucalyptus fasciculosa* Low woodlands in the study area and represents some of the worst infestations in the South East.

Fauna

Two mammal species of conservation significance were recorded within the study area. The proposed drain should not adversely affect these species. However, the study area also supports seven introduced mammals including the Fallow Deer, which appears to be increasing in the area and may provide management problems in the future.

While 12 bird species of conservation significance were recorded in the study area, only the Malleefowl (*Leipoa ocellata*) is rated as nationally 'vulnerable' (Figure 14).

Some bird species such as the Southern Emu-wren (*Stipiturus malachurus*) may be indirectly affected by construction of the Bald Hill Drain through modification of their preferred *Melaleuca brevifolia* Low shrubland habitats which are associated with low lying areas. These areas are most likely to be adversely affected by changes to the water regime, water quality or salinity.

The study area supports 16 species of reptile and 4 species of frog. Several Heath Goannas (*Varanus rosenbergi*) which are considered to be rare in South Australia were observed patrolling the edge of the dry wetlands during the survey. These observations suggest that these low-lying habitats may be of importance to this species.

The West Avenue Range Biological Survey

RECOMMENDATIONS

The Biological Survey of the West Venue Range was a conducted over an eight-day period in December 1999. Thus, it is unlikely that the data gathered from this one short survey could answer all of the biological questions raised in relation to the West Avenue Range. Rather, this survey should be seen as a useful guide and an important first step. Further work is required in order to build a more complete picture of the biology of the West Avenue Range. However, some recommendations can be inferred from the existing data and these are discussed below.

Flora

The Biological Survey of the West Avenue Range focused on collecting and recording terrestrial vascular plants. No aquatic or non-vascular plants were collected. As these aquatic plants are likely to be of conservation significance, further survey work is required to determine the diversity and extent of aquatic plants found in the study area. Obviously, this work should be conducted during periods of inundation.

A further vegetation survey conducted in spring would also help to identify several other plant species in the study area – some of which (particularly the orchid species) may be of conservation significance.

This part of the West Avenue Range supports some of the worst infestations of Bridal Creeper (*Myrsiphyllum asparagoides*) in the South East. The habitat quality of the low woodlands affected could be greatly enhanced by a weed control program. However, if herbicides are used then the utmost care should be exercised to make certain they do not detrimentally affect the ecology of the West Avenue Range and its watercourse. It is advisable to seek expert advice in relation to the use of herbicides in wetland habitats before proceeding with this form of weed control.

Many of the plant species and communities of conservation significance are likely to be adversely affected by any significant change to the water regime or quality (turbidity, nutrient levels, and pollution) or a rise in salinity. Plant species and communities with a preference for low-lying areas are most at risk. The *Leptospermum lanigerum* Tall closed shrubland, *Melaleuca halmaturorum* ssp. *halmaturorum* Tall shrubland and *M. brevifolia* Low shrubland vegetation associations found at the northern and eastern parts of the study area are at the highest risk of degradation. This is because these are the areas closest to the location of the proposed Bald Hill Drain. In particular, the *Leptospermum lanigerum* Tall closed shrubland found at Henry Creek, which is a plant community of conservation significance, and the number of species of high

conservation significance associated with this plant community are likely to be negatively affected by the construction of the Bald Hill Drain. Figure 13 (contained inside a pocket attached to the inside back cover of this report) shows the distribution of these plant communities.

If the construction of the proposed Bald Hill Drain does take place then it is recommended that the design of the drain accommodate for the sensitivity of these plant communities (and associated plant species) to changes in the water regime or quality (turbidity, nutrient levels, pollution) or a rise in salinity. It is also recommended that alternative routes to Henry Creek be investigated to receive water flows from the Bald Hill Drain as this unique vegetation type contains many plant species of conservation significance and may be the most affected by the drainage scheme.

Vegetation health monitoring post drainage development has been undertaken at Deep Swamp, Tilley Swamp and the Hanson and Tiver Heritage Agreements (Stewart, 2001, Telfer, *et al*, 2000, Milne and Squire, 2001a,b). Several of these reports show significant negative impacts on the health of surrounding vegetation within 850 metres of the constructed drains. It is essential that the same monitoring program be instituted in the study area to determine the full impacts of the proposed drain. This monitoring should be conducted prior to drain construction to allow comparisons of vegetation health before and after drain construction. A simultaneous water-sampling program is also recommended. This would enable information on vegetation species and communities to be compared to changes in water regime, quality or salinity levels.

Fauna

Many bird species of conservation significance such as the Malleefowl (*Leipoa ocellata*), Brown Quail (*Coturnix ypsilophora*), Painted Button-quail (*Turnix varia*), Southern Emu-wren (*Stipiturus malachurus*) and Slender-billed Thornbill (*Acanthiza iredalei hedleyi*) may be adversely affected if the Bald Hill Drain is positioned too close to the *Melaleuca* spp. heaths that these species inhabit and utilise. Milne and Squire (2001b) suggest that drains should be constructed at least 1000 metres away from any *Melaleuca brevifolia* or *M. halmaturorum* plant communities to minimise the impacts of drain construction on local flora and fauna.

Only one reptile of conservation significance (the Heath Goanna *Varanus rosenbergi*) is known from the study area. However, this species appears to be in decline throughout South Australia. The wetland habitats of the

South East may be important to this species, as they are to other reptiles, and so the design of any new drainage works should avoid degrading these habitats.

While no mammals of conservation significance should be negatively affected by the drain, the local population of Fallow Deer appears to be increasing. High numbers of Fallow Deer may adversely affect the ecology of the study area. A monitoring program is recommended to better assess the distribution and abundance of the population and its impact on the ecology of the area.

Other

An investigation of the aquatic invertebrates of the West Avenue Range and Henry Creek may provide useful information in relation to the ecology of the study area and wetlands in the South East in general. Many of the wetlands in the South East contain endemic species. These wetlands may be important for the conservation of these aquatic invertebrates. These species may also be useful as indicator species when assessing the overall ecological health of the area.

Summary

The current data demonstrates that the West Avenue Range supports a variety of species and communities of conservation significance. It is recommended however, that further biological research is needed in order to gain a more complete understanding of the ecology of this area.

Any major change in the water regime or quality (turbidity, nutrient levels, pollution) or a rise in salinity may be detrimental to the long-term viability of many of the plant and animal species of conservation significance found in this part of the West Avenue Range. Consequently, it is recommended that new drainage works should only proceed if they are designed and constructed in a way that minimises any potentially adverse impacts on the flora and fauna of the West Avenue Range. Expert advice should also be sought to ensure drain design achieves this objective, including the amelioration of any spoil banks, and determining the number, location and design of any fauna crossings.

Alternative routes to Henry Creek should be investigated to receive the extra water flow from any new drainage works. Furthermore it is recommended that if new drainage works are constructed then vegetation and water monitoring programs should be instigated prior to drain construction and maintained for several years after, to assist in determining the direction of short, medium and long-term ecological change.

RESOURCE MATERIAL AND BIBLIOGRAPHY

MAPS

1:250 000 Topographic

Naracoorte SJ 54-2 1988

1:50 000 Topographic

Duffield 6824-I 1985
Tilley Swamp 6825-II 1983
Gyp Gyp 6924-IV 1983

Floristic vegetation map

The West Avenue Range floristic vegetation map was based on previous regional mapping, data collected from survey sites, fieldwork and the interpretation of 1:40 000 scale colour aerial photography, reproduced at 1:20 000 scale. Tim Hudspith from Biodiversity Survey and Monitoring (DEH) conducted and coordinated the mapping with assistance from Tim Croft. Tim Hudspith, using ESRI ARC/INFO GIS software produced the final map, which is reproduced at 1:40 000 scale for this report (Figure 13). This map is contained in a pocket attached to the inside back cover of this report.

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APPENDICES

Appendix I

PLANT SPECIES RECORDED FROM THE WEST AVENUE RANGE

Species are arranged in alphabetical order of Family and then Species (with common name). Introduced species are marked with an asterisk (*). The following list includes all plant species recorded from survey sites during the biological survey of the West Avenue Range (survey number 118). These survey site numbers have been shortened for example 'DUF00101' is listed as '1'. Records obtained opportunistically during the survey are listed under 'Opp'.

The following list also includes all plant species recorded from survey sites located within or nearby the West Avenue Range during the biological survey of the South East (survey number 29). These survey site numbers are listed in full for example 'DID0101'.

A cross indicates the presence of a plant species.

South Australian conservation ratings are listed under 'SA'.

SOUTH AUSTRALIAN CONSERVATION STATUS (SA)

The codes are based on Schedules of the National Parks and Wildlife Act 1972 (SA) as amended in 2000. Please note that these codes only provide a guide to status under this Act, and there may be discrepancies and omissions that result from differences in taxonomy and nomenclature. Where certainty is required, the schedules should be consulted directly to determine official designations under the NPWS Act.

E **Endangered** (Schedule 7, Part 2)

Note that there is no category specifically for species that are presumed to be extinct. Instead these are included in the Endangered category.

V **Vulnerable** (Schedule 8, Part 2)

R **Rare** (Schedule 9, Part 2)

REGIONAL CONSERVATION STATUS

(Note: these codes are not listed in Appendix I but are discussed in the vegetation section of results chapter).

The regions are as defined by the State Herbarium (Plant Biodiversity Centre). These are illustrated in the back covers of 'Flora of South Australia' (Ed. Jessop and Toelken, 1986) and 'A List of the Vascular Plants of South Australia (Edition IV)' (Ed. Jessop, 1993). Note: Care should be exercised when applying regional conservation status designations to records near region boundaries. In such cases, it is advisable to also make reference to the status codes that apply in adjoining regions.

(Listed in order of decreasing conservation significance:)

X **Extinct/Presumed extinct:** not located despite thorough searching of all known and likely habitats; known to have been eliminated by the loss of localised population(s); or not recorded for more than 50 years from an area where substantial habitat modification has occurred.

E **Endangered:** rare and in danger of becoming extinct in the wild.

T **Threatened:** likely to be either Endangered or Vulnerable but insufficient data available for more precise assessment.

V **Vulnerable:** rare and at risk from potential threats or long term threats that could cause the species to become endangered in the future.

- K** **Uncertain:** likely to be either Threatened or Rare but insufficient data available for a more precise assessment.
- R** **Rare:** has a low overall frequency of occurrence (may be locally common with a very restricted distribution or may be scattered sparsely over a wider area). Not currently exposed to significant or widespread threats, but warrants monitoring and protective measures to prevent reduction of population sizes.
- U** **Uncommon:** less common species of interest but not rare enough to warrant special protective measures.
- Q** Not yet assessed but flagged as being of possible significance.

Family	Species	Common name	SA	Svy. No.	1	2	3	4	5	6	7	8	9	DUF 0101	DUF 0401	DUF 0402	DUF 0601	GYP 0101	TILI 001	TILI 002	DID 1001	DID 1002	Opp.
AIZOACEAE	<i>Tetragonia implexicoma</i>	Bower Spinach		118									+										+
ASCLEPIADACEAE	* <i>Aselepias rotundifolia</i>	Broad-leaf Cotton-bush		118									+										
BORAGINACEAE	<i>Cynoglossum australe</i>	Australian Hound's-tongue		29										+	+				+				
	<i>Cynoglossum suaveolens</i>	Sweet Hound's-tongue	Q	118									+										+
	* <i>Echium plantagineum</i>	Salvation Jane		118								+											+
CAMPANULACEAE	<i>Lobelia alata</i>	Angled Lobelia		118																			+
	<i>Pratia platycalyx</i>	Salt Pratia	U	118																			+
	<i>Waltherbergia luteola</i>	Yellow-wash Bluebell		118																			+
CARYOPHYLLACEAE	* <i>Cerastium glomeratum</i>	Common Mouse-ear Chickweed		29										+									
	* <i>Spergularia media</i>	Coast Sand-spurrey		118																			+
CASUARINACEAE	<i>Allocasuarina mackliniana</i> ssp. <i>xerophila</i>	Macklin's Oak-bush		118																			
	<i>Allocasuarina muelleriana</i> ssp. <i>muelleriana</i>	Common Oak-bush		29																+			+
	<i>Allocasuarina verticillata</i>	Drooping Sheoak		29															+				+
CENTROLEPIDACEAE	<i>Centrolepis polygyna</i>	Wiry Centrolepis		118							+												
CHENOPODIACEAE	* <i>Atriplex prostrata</i>	Creeping Saltbush		118																			+
	* <i>Chenopodium glaucum</i>	Glaucous Goosefoot		118																			+
	<i>Rhagodia candolleana</i> ssp. <i>candolleana</i>	Sea-berry Saltbush		118																			+
	<i>Sarcocornia quinqueflora</i>	Beaded Samphire		118					+														+
COMPOSITAE	<i>Angianthus preissianus</i>	Salt Angianthus		118					+	+													+
	<i>Argentipallium obtusifolium</i>	Blunt Everlasting		29												+							+
	<i>Brachycome basalitica</i> var. <i>gracilis</i>	Swamp Daisy	R	118																			+
	<i>Brachycome ciliaris</i> var. <i>ciliaris</i>	Variable Daisy		118																			+
	<i>Brachycome parvula</i> var. <i>parvula</i>	Coast Daisy	R	118					+														+
	* <i>Carduus tenuiflorus</i>	Slender Thistle		118								+											+

The West Avenue Range Biological Survey

Appendix II

MAMMAL SPECIES RECORDED FROM THE WEST AVENUE RANGE

Species are arranged in alphabetical order of Family and then Species (with common name). Introduced species are marked with an asterisk (*). The following list includes all mammal species recorded from survey sites during the biological survey of the West Avenue Range (survey number 118). These survey site numbers have been shortened for example 'DUF00101' is listed as '1'. Records obtained opportunistically during the survey are listed under 'Opp'.

A cross indicates the presence of a mammal species.

South Australian conservation ratings are listed under 'SA'.

Mammal taxonomy follows Kemper, Reardon and Queale (in Robinson *et al.*, 2000).

The State conservation ratings are shown in bold following the scientific name. These have been taken from Kemper and Queale (1990).

The definition for the status codes are as follows:

E Endangered: taxa in danger of extinction and whose survival is unlikely if the causal factors continue operating.

V Vulnerable: taxa believed likely to move into the endangered category in the near future if the causal factors continue operating.

R Rare: taxa with small populations in South Australia that are not presently endangered or vulnerable, but are at risk.

Family	Species	Common name	SA	1	2	3	4	5	6	7	8	9	Opp
BOVIDAE	<i>*Ovis aries</i>	Sheep										+	
BURRAMYIDAE	<i>Cercartetus lepidus</i>	Little Pygmy-possum			+								
CANIDAE	<i>*Vulpes vulpes</i>	Fox							+		+		+
CERVIDAE	<i>*Cervus dama</i>	Fallow Deer		+	+		+		+	+	+		+
FELIDAE	<i>*Felis catus</i>	Cat			+								+
LEPORIDAE	<i>*Lepus capensis</i>	Brown Hare											+
	<i>*Oryctolagus cuniculus</i>	Rabbit		+	+	+			+		+	+	+
MACROPODIDAE	<i>Macropus fuliginosus</i>	Western Grey Kangaroo		+							+		+
	<i>Macropus rufogriseus</i>	Red-necked Wallaby	R										+
	<i>Macropus</i> sp.	Kangaroo		+	+	+	+	+	+	+			
MOLOSSIDAE	<i>Tadarida australis</i>	White-striped Freetail-bat											+
MURIDAE	<i>*Mus musculus</i>	House Mouse		+			+	+			+		
PHALANGERIDAE	<i>Trichosurus vulpecula</i>	Common Brushtail Possum									+		+
TACHYGLOSSIDAE	<i>Tachyglossus aculeatus</i>	Short-beaked Echidna									+	+	+
VESPERTILIONIDAE	<i>Nyctophilus geoffroyi</i>	Lesser Long-eared Bat											+
VESPERTILIONIDAE	<i>Chalinolobus gouldii</i>	Gould's Wattled Bat											+
	<i>Chalinolobus morio</i>	Chocolate Wattled Bat											+
	<i>Vespadelus regulus</i>	Southern Forest Bat											+
	<i>Vespadelus vulturinus</i>	Little Forest Bat											+
VOMBATIDAE	<i>Vombatus ursinus</i>	Common Wombat	R	+			+				+	+	+

The West Avenue Range Biological Survey

Appendix III

BIRD SPECIES RECORDED FROM THE WEST AVENUE RANGE

Species are arranged in alphabetical order of Family and then Species (with common name). Introduced species are marked with an asterisk (*). The following list includes all bird species observed from survey sites during the biological survey of the West Avenue Range (survey number 118). These survey site numbers have been shortened for example 'DUF00101' is listed as '1'. Records obtained opportunistically during the survey are listed under 'Opp'.

A cross indicates the presence of a bird species.

Australian conservation ratings are listed under 'AU'.

South Australian conservation ratings are listed under 'SA'. State conservation ratings follow the NPWS Act (1972), Kemper and Queale (1990) and Carpenter and Reid (1994).

The status codes definitions are as follows (after Horton in Robinson *et al.*, (2000)):

E Endangered: taxa in danger of extinction and whose survival is unlikely if the causal factors continue operating.

V Vulnerable: taxa believed likely to move into the endangered category in the near future if the causal factors continue operating.

R Rare: taxa with small populations in South Australia that are not presently endangered or vulnerable, but are at risk.

In addition Watts (1990) also used the category **Uncommon** for species not considered at risk. The definition for this category follows:

U Uncommon: taxa occurring in relatively low numbers in South Australia, but not rare.

Species considered common, and therefore not at immediate risk, are not labelled.

Family	Species	Common name	SA	AU	1	2	3	4	5	6	7	8	9	Opp
ACANTHIZIDAE	<i>Acanthiza apicalis</i>	Inland Thornbill												+
	<i>Acanthiza chrysorrhoa</i>	Yellow-rumped Thornbill										+		+
	<i>Acanthiza iredalei</i>	Slender-billed Thornbill	V											+
	<i>Acanthiza lineata</i>	Striated thornbill			+		+	+				+		+
	<i>Acanthiza nana</i>	Yellow Thornbill			+							+	+	
	<i>Acanthiza pusilla</i>	Brown Thornbill			+	+	+	+	+		+	+	+	+
	<i>Acanthiza reguloides</i>	Buff-rumped Thornbill			+							+		
	<i>Aphelocephala leucopsis</i>	Southern Whiteface												+
	<i>Calamanthus cautus</i>	Shy Heathwren				+	+							+
	<i>Calamanthus fuliginosus</i>	Striated Fieldwren												+
	<i>Sericornis frontalis</i>	White-browed Scrubwren			+		+		+			+	+	+
	<i>Smicromis brevirostris</i>	Weebill						+						
ACCIPITRIDAE	<i>Accipiter cirrhocephalus</i>	Collared Sparrowhawk						+						+
	<i>Aquila audax</i>	Wedge-tailed Eagle						+						+
AEGOTHELIDAE	<i>Aegotheles cristatus</i>	Australian Owllet-nightjar									+			
ALAUDIDAE	* <i>Alauda arvensis</i>	Eurasian Skylark							+					+
ALCEDINIDAE	<i>Todiramphus sancta</i>	Sacred Kingfisher												+
ANATIDAE	<i>Anas superciliosa</i>	Pacific Black Duck												+
ARDEIDAE	<i>Egretta novaehollandiae</i>	White-faced Heron												+
ARTAMIDAE	<i>Artamus cyanopterus</i>	Dusky Woodswallow												+
	<i>Artamus personatus</i>	Masked Woodswallow			+									+
	<i>Artamus superciliosus</i>	White-browed Woodswallow			+		+		+		+	+	+	+
	<i>Cracticus torquatus</i>	Grey Butcherbird									+			+
	<i>Gymnorhina tibicen</i>	Australian Magpie			+	+	+		+	+				+
	<i>Strepera versicolor</i>	Grey Currawong			+	+	+	+			+	+	+	+
CACATUIDAE	<i>Cacatua galerita</i>	Sulphur-crested Cockatoo									+			
	<i>Cacatua roseicapilla</i>	Galah			+		+	+		+	+			+
	<i>Calyptorhynchus funereus</i>	Yellow-tailed Black-Cockatoo	V											+
	<i>Nymphicus hollandicus</i>	Cockatiel												+
CAMPEPHAGIDAE	<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike			+			+						+
CASUARIIDAE	<i>Dromaius novaehollandiae</i>	Emu				+	+				+	+	+	+
CHARADRIIDAE	<i>Charadrius ruficapillus</i>	Red-capped Plover								+				
	<i>Elsyornis melanops</i>	Black-fronted Dotteral								+				
	<i>Vanellus miles</i>	Masked Lapwing												+
	<i>Vanellus tricolor</i>	Banded Lapwing												+
COLUMBIDAE	<i>Geopelia placida</i>	Peaceful Dove						+						+
	<i>Ocyphaps lophotes</i>	Crested Pigeon												+
	<i>Phaps chalcoptera</i>	Common Bronzewing			+	+		+						+
	<i>Phaps elegans</i>	Brush Bronzewing						+	+		+	+		
CORVIDAE	<i>Corvus coronoides</i>	Australian Raven				+		+	+					
	<i>Corvus mellori</i>	Little Raven												+
	<i>Corvus tasmanicus</i>	Forest Raven			+					+	+	+		+
DICRURIDAE	<i>Grallina cyanoleuca</i>	Magpie-lark						+						+

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Appendix IV

AMPHIBIAN AND REPTILE SPECIES RECORDED FROM THE WEST AVENUE RANGE

Species are arranged in alphabetical order of Class, Family and then Species (with common name). Introduced species are marked with an asterisk (*). The following list includes all amphibian and reptile species recorded from survey sites during the biological survey of the West Avenue Range (survey number 118). These survey site numbers have been shortened for example 'DUF00101' is listed as '1'. Records obtained opportunistically during the survey are listed under 'Opp'.

A cross indicates the presence of an amphibian or reptile species.

South Australian conservation ratings are listed under 'SA'.

Taxonomy follows Hutchinson and Edwards (in Robinson *et al.* (2000).

Class	Family	Species	Common name	SA	1	2	3	4	5	6	7	8	9	Opp
AMPHIBIA														
	HYLIDAE	<i>Litoria ewingi</i>	Brown Tree Frog											+
	LEPTODACTYLIDAE	<i>Crinia signifera</i>	Common Froglet											+
	LEPTODACTYLIDAE	<i>Limnodynastes dumerili</i>	Bull Frog		+	+	+					+		
	LEPTODACTYLIDAE	<i>Neobatrachus pictus</i>	Painted Frog				+							
REPTILIA														
	AGAMIDAE	<i>Pogona barbata</i>	Eastern Bearded Dragon											+
	CHELIDAE	<i>Chelodina longicollis</i>	Common Long-necked Tortoise					+		+	+		+	+
	ELAPIDAE	<i>Notechis scutatus</i>	Eastern Tiger Snake								+			
	GEKKONIDAE	<i>Aprasia striolata</i>	Lined Worm-lizard		+	+						+		+
		<i>Pygopus lepidopodus</i>	Common Scaly-foot		+									
	SCINCIDAE	<i>Bassiana duperreyi</i>	Eastern Three-lined Skink		+	+	+	+	+					+
		<i>Ctenotus uber</i>												+
		<i>Ctenotus robustus</i>	Eastern Striped Skink		+							+		+
		<i>Hemiergis peronii</i>	Four-toed Earless Skink		+	+	+	+	+		+	+		+
		<i>Lampropholis delicata</i>	Delicate Skink								+	+		
		<i>Lampropholis guichenoti</i>	Garden Skink					+						
		<i>Lerista bougainvillii</i>	Bougainville's Skink		+	+		+				+		+
		<i>Morethia obscura</i>	Mallee Snake-eye		+	+		+				+		+
		<i>Tiliqua rugosa</i>	Sleepy Lizard				+		+		+			+
		<i>Tiliqua scincoides</i>	Eastern Bluetongue											+
	VARANIDAE	<i>Varanus rosenbergi</i>	Heath Goanna	R										+

