

Fire Management Plan

Bookmark Mallee

2009-2019



Incorporating Danggali Proposed Wilderness Protection Area; Danggali, Cooltong and Pooginook Conservation Parks; Chowilla Regional Reserve; Calperum and Taylorville Stations and Gluepot Reserve

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September 2009



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EXECUTIVE SUMMARY

The Riverland Biosphere Reserve (previously Bookmark) is one of the largest reserve systems in South Australia. Between its land management partners, it protects over 700 000 ha of habitat, including a Wilderness Protection Area (WPA). The areas within the Riverland Biosphere with which this plan is concerned are known as the Bookmark Mallee. It contains a diverse range of flora and fauna species, including some threatened species found exclusively within the region. The recognition that inappropriate fire regimes present a threat to biodiversity regardless of land tenure is important in such a fire-prone landscape. Consequently, the development of this plan has been funded by the Natural Heritage Trust (NHT) through the South Australian Murray-Darling Basin (SAMDB) Natural Resource Management (NRM) Board.

This Fire Management Plan for the Bookmark Mallee has been developed to provide direction for fire management activities, including bushfire suppression, in the region. The plan emphasises the protection of life and property as well as providing direction for land managers in the protection and enhancement of the natural and cultural heritage of Bookmark. Implementation of the recommendations and works listed in this plan is subject to available resources as well as regional and state-wide priorities. Some degree of flexibility will be required for fire suppression in those areas where there has only been partial implementation of works.

The Bookmark Mallee was identified as a priority for fire management planning within the Department for Environment and Heritage (DEH) Murraylands Region to address the following issues.

- General protection of life, property and environmental values in the planning area.
- Protection of important habitat for many species and communities including those with conservation ratings.
- The protection of fire management blocks and reserves, both public and private, within a landscape context, with the aim of reducing the likelihood of a whole reserve or a large portion of a reserve burning in a single fire event.

These issues were addressed by:

- applying a risk assessment process to identify life, property and environmental values at risk from bushfires
- applying DEH Fire Management Zoning Principles to manage fuel in Asset and Buffer Zones
- identifying significant ecological assets and applying Ecological Fire Management Guidelines to determine appropriate burning in Conservation Zones
- auditing tracks within the Bookmark Mallee using the Government Agencies Fire Liaison Committee's (GAFLC) '*South Australian Firebreaks, Fire Access Tracks and Sign Standards Guidelines*'

A number of recommendations as a result of applying the above processes have been identified.

- Prescribed burning to:
 - reduce fuel in Asset and Buffer zones as outlined in the plan. Other methods of fuel reduction will also be used, and in some cases are specifically mentioned
 - reduce fuel in strategic areas within Conservation zones to provide landscape and habitat protection for included lands and known threatened species populations
 - create mosaics of patches with a range of fire ages.
- Track upgrades in accordance with GAFLC guidelines (GAFLC, 2008).
- Identification of suppression considerations that may assist bushfire suppression operations to contribute to improved fire management.

This plan promotes the implementation of appropriate fire management regimes to protect and enhance the communities to which these species belong. It also outlines a process aimed at increasing our knowledge and understanding of species' and communities' response to fire through monitoring and directed research, enabling further enhancement of fire management techniques.

The local community and Country Fire Service volunteers have contributed extensive amounts of time, energy and resources to fire suppression on Bookmark and they are to be commended for this contribution. The co-operation of both the immediate stakeholders and the local community will be critical to the success of the plan. This plan presents a unique opportunity to manage the landscape with respect to fire as it brings together a variety of different land conservation managers over one of the largest continuous remnants of old-growth mallee in Australia.

TABLE OF CONTENTS

EXECUTIVE SUMMARY	I
TABLE OF CONTENTS	III
List of Tables.....	v
List of Figures.....	v
List of Attached Maps	v
1 RATIONALE AND KEY OBJECTIVES.....	1
1.1 Background.....	1
1.2 Key Objectives	3
2 THE PLANNING FRAMEWORK.....	5
2.1 Legislation	5
2.2 DEH Fire Management Policy	6
2.3 Zoning Policy	6
2.4 Regional Biodiversity Planning	7
2.5 Reserve Management Planning	7
2.6 Fire Management in Heritage Agreements	7
2.7 The Role of the Local Country Fire Service	8
3 BUSHFIRE ENVIRONMENT.....	10
3.1 Location	10
3.2 Climate, Wind and Weather.....	10
3.3 Fire Behaviour in Mallee Ecosystems	10
3.4 Fuel.....	11
4 FIRE HISTORY AND FIRE REGIMES.....	13
4.1 Fire Regimes in Mallee Communities.....	13
4.2 Prior to European Settlement.....	13
4.3 Twentieth Century Fires.....	13
4.4 Present and Future Fire Regimes	14
5 DAMAGE POTENTIAL TO BUILT ASSETS.....	16
5.1 Land Use.....	16
5.2 Built Assets and Property Protection	16
5.3 Tourism.....	16
5.4 Cultural Heritage.....	16
6 BIODIVERSITY	18
6.1 Fire and Mallee Ecosystems	18
6.2 Vegetation.....	18
6.3 Fauna.....	20
6.4 Other Threats to Biodiversity	27
7 BUSHFIRE SUPPRESSION	28
7.1 Legislation	28
7.2 Policies and Procedures	28
7.3 Fire Emergency Procedures and Response Planning	28
7.4 General Objectives for Fire Suppression	28
7.5 Strategies and Actions to Achieve Objectives.....	29
7.6 Fire Access and Firebreaks.....	31

7.7	Use of Control Lines during Fire Incidents.....	32
7.8	Heavy Machinery	32
7.9	Fire Management Infrastructure	33
8	FIRE MANAGEMENT ZONES.....	36
8.1	Zoning Background.....	36
8.2	Risk Assessment	36
8.3	Asset (A) Zone	36
8.4	Buffer (B) Zone.....	38
8.5	Conservation (C) Zone	39
9	ACTIONS AND WORKS	41
9.1	Fire Management Blocks.....	41
9.2	Prescriptions.....	41
10	CALPERUM AND TAYLORVILLE	42
10.1	Tenure, Size, Land Use	42
10.2	Natural Values.....	42
10.3	Vegetation.....	43
10.4	Built Assets	43
10.5	Fire History	43
10.6	Fire Risk.....	44
10.7	Management Objectives for Calperum and Taylorville	44
10.8	Recommended Actions and Works	44
10.9	Suppression.....	48
11	GLUEPOT	49
11.1	Tenure, Size, Land Use	49
11.2	Natural Values.....	49
11.3	Vegetation.....	49
11.4	Built Assets	50
11.5	Fire History	50
11.6	Fire Risk.....	50
11.7	Management Objectives for Gluepot	50
11.8	Recommended Actions and Works	51
11.9	Suppression.....	53
12	DEH RESERVES	54
12.1	Tenure, Size, Land Use	54
12.2	Natural Values.....	55
12.3	Vegetation.....	55
12.4	Built Assets	56
12.5	Fire History	57
12.6	Fire Risk.....	58
12.7	Management Objectives for DEH Reserves	59
12.8	Actions and Works	59
12.9	Suppression.....	63
13	IMPLEMENTATION SCHEDULE AND RECOMMENDATIONS.....	65
13.1	Summary of Recommendations	65
13.2	Recommended Works and Implementation Schedule	66

14	BIODIVERSITY WORKS – RESEARCH AND MONITORING	74
15	REFERENCES	76
16	ACKNOWLEDGEMENTS	78
17	APPENDICES	79
	Appendix 1: Wilderness Code of Management Sections 3.6 and 3.10.....	79
	Appendix 2: Key to South Australian (SA) Conservation Status Codes	80

List of Tables

Table 1: Major Vegetation Communities in the Bookmark Mallee	19
Table 2: Fire management requirements and status of threatened flora recorded in the Bookmark Mallee.....	22
Table 3: Fire management requirements and status of threatened avifauna recorded in the Bookmark Mallee.....	23
Table 4: Fire management requirements of threatened reptiles and mammals recorded in the Bookmark Mallee.....	26
Table 5: Fire Management Blocks Within Calperum and Taylorville	42
Table 6: Built Assets Within Calperum and Taylorville	43
Table 7: Proposed B-zone Implementation on Calperum and Taylorville	45
Table 8: Track Recommendations for Calperum and Taylorville	46
Table 9: Status of and Recommendations for Tanks on Calperum and Taylorville	47
Table 10: Fire Management Blocks Within Gluepot Reserve	49
Table 11: Tanks on Gluepot Reserve	52
Table 12: Fire Management Blocks Within DEH Reserves	54
Table 13: Built Assets on DEH reserves	57
Table 14: Tank Maintenance and Installation on DEH Reserves.....	62
Table 15: Recommended Works to be Undertaken in Bookmark Mallee Reserves.....	66
Table 16: Proposed B-zone Strip Burning Priorities and Justification.....	72

List of Figures

Figure 1: Overall Fuel Hazard	11
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List of Attached Maps

- Map 1 – Terrain, Tenure and Infrastructure
- Map 2 – Vegetation Communities and Significant Species
- Map 3 – Fire History (four data frames)
- Map 4 – Fire Management and Access

1 RATIONALE AND KEY OBJECTIVES

1.1 Background

The intention of this plan is to give strategic direction and a framework for fire management activities in the Bookmark Mallee. It defines objectives for ecological fire management and life and property protection, but more specifically, it provides recommendations and strategies and suggests works to allow those objectives to be met. The recommended pre-suppression works and activities will increase the level of preparedness for bushfires and improve the effectiveness of suppression during bushfire incidents.

The plan is unique due to the inclusion of land managed for conservation by four stakeholders over seven reserves. In doing this, it acknowledges that fire in the district is a landscape process, impacting on a variety of ecological communities regardless of land tenure. Of the plan's reserves, DEH owns **Danggali** Wilderness Protection Area and **Danggali Cooltong** and **Pooginook** Conservation Parks and **Chowilla** Regional Reserve, jointly managed by Robertson Chowilla P/L (lessees). Danggali Wilderness Protection Area and Conservation Park will henceforth be referred to simply as 'Danggali'. Birds Australia owns **Gluepot Reserve**, whilst the Australian Landscape Trust manages **Calperum** and **Taylorville** stations.

As the lead agency for biodiversity management in South Australia, the Department for Environment and Heritage (DEH), through the support of the SAMDB NRM Board and NHT, has developed this plan with the objective of improving ecological fire management outcomes for the area. Fire prevention planning for land outside DEH reserves is currently the responsibility of the District Bushfire Prevention Committee, in accordance with the requirements of the *Fire and Emergency Services Act, 2005*. This may change in the future, however, with the formation of regional committees. DEH Regional Conservation Delivery is represented on this committee, along with local government and local CFS brigades, in a collaborative approach to fire prevention planning and decision making. Adjoining lands are considered in the plan, but only in the context of works and activities required to minimise the risk to assets from fires originating in the plan area.

The driving factor in the plan's development and its landscape approach was the identification of fire as the key threatening process to the survival of the Endangered Black-eared Miner (*Manorina melanotis*). The species has been the focus of a National Recovery Program and Calperum, Taylorville and Gluepot have subsequently been listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act (EPBC) 1999* as Critical Habitat for the species. Areas of these reserves support 'old-growth' mallee communities greater than 40 years of age, which have been identified as key habitat not only for the Black-eared Miner, but also for a number of other mallee fauna species, such as the Malleefowl (*Leipoa ocellata*). This plan is designed to provide direction for the mitigation of the threat posed by fire through both pre-suppression and suppression activities.

Reducing Costs

Whilst the impacts of fire in the plan area are largely environmental given the low population density and lack of infrastructure in the area, the economic and social costs of suppressing large fires have been an issue. Often the effort expended in suppressing large bushfires has been disproportionate to the success of suppression operations. It is hoped that the pre-

suppression strategies prescribed in this document will serve to mitigate some of this cost and serve to reduce the time taken to suppress bushfires.

Identifying Assets and Assessing Risks

There are comparatively few built assets within or adjacent to the plan area. However, identifying the risk to these assets, along with quantifying risks to ecological assets is a priority for effective fire management in and around Bookmark. The identification of rare or significant populations or communities of flora are simpler given their sessile nature. Identifying corresponding fauna assets in a landscape of this size is rather more problematic given they are either rare, mobile, cryptic or a combination of all three. Along with known population or community locations and distributions, there is also the need to identify potential sites for habitation in the future if fire management is to be holistic in its approach. This is particularly the case in the extensive areas that were burnt in 2006. Actions prescribed will source ecological information provided on a range of threatened and significant species in the plan area to meet this objective.

Managing Fire Regimes

Historically, much of the focus of fire management across Australia has centred on event-based management. Ecologically, improved management of fire regimes is required across this landscape to ensure the conservation of the ecological communities it supports. The conditions in recorded history have been dominated by large fires at relatively low frequency. Due to land clearance and grazing in the surrounding properties limiting the extent of suitable habitat for many species, a continuation of the current fire regime is unlikely to be viable. Attempts to manipulate, in the first instance, the extent and location of bushfires within the plan area is pivotal in the sustainable management of not only significant or threatened species in the area, but all of the communities it supports.

The scale of manipulation is dependent on the objectives. Initial strategies will seek to provide protection through prescribed burning across the landscape at a variety of scales. Whereas the major concern with fire events within the plan area centres on landscape level events (i.e. >10 000 ha), bushfires of much smaller magnitudes can be equally destructive at a local or habitat scale.

Increasing Knowledge

Improving our fire management knowledge in the plan area, with respect to fire suppression techniques, fire behaviour and fire ecology is a key goal. Numerous research projects are undertaken in the Bookmark Mallee, including Latrobe and Deakin Universities' Mallee Fire and Biodiversity project, which incorporates sites in both Danggali and Gluepot. Calperum, Taylorville and Gluepot also undertake regular monitoring and research. The knowledge base created by this work needs to be built on, particularly with respect to the interactions of significant species or communities and fire regimes if the prescribed use of fire is to meet the ecological objectives set.

Improving Response

The Bookmark Mallee is an extremely difficult environment in which to combat fire. The size of the area, lack of access and water, steep sandy terrain and often-rapid rate of fire-spread all contribute to a volatile fire environment. DEH, in collaboration with CFS and private land holders, will continue to improve fire response capacity through supporting and encouraging

the exchange of ideas and the development of plant and equipment to better manage bushfires in the area.

Managing a Paradox

The relationship between “optimal habitat” for threatened species and fire risk within Bookmark is inherently paradoxical. The habitat of preference for many threatened mallee birds within the region is mallee greater than 40 years old with a *Triodia* (*Triodia* spp.) understorey. Whilst species such as the Black-eared Miner and the Malleefowl can subsist in areas of lesser age, these areas form the stronghold for their distribution (Baker-Gabb, 2001; Benshemesh, 2000; Clarke, 2005). Paradoxically, it is areas older than 40 years post-fire that have the greatest levels of standing fuels, surface litter and bark hazard and as such are at the highest risk from fire. As such, fire management is complicated for three main reasons:

- Broad-scale fuel reduction burning will render large areas of habitat unsuitable to key species for up to four decades, and the limited extent of existing habitat may not provide the necessary buffer to support a species such as the Black-eared Miner at critically low levels.
- Improving water availability and access for fire response will potentially impact on the Black-eared Miner by allowing invasion and genetic introgression of the closely related Yellow Throated Miner (*Manorina flavigula*), which prefers a disturbed environment and access to water. Yellow-throated Miners cannot inhabit the contiguous areas of old-growth mallee required by the Black-eared Miner. Additionally, creating artificial watering points has been shown to reduce biodiversity in the surrounding area (Harrington, 2002) through increased grazing around and a proliferation of water dependent fauna.

Hence, the challenge within Bookmark is to develop a strategy that maximises the protected area by reducing the ‘edge effect’ caused by such management-related disturbances as prescribed burning and track maintenance. In the same instance, the strategy should not seek to exclude fire from a system that clearly requires it (albeit at long intervals) to maintain its full diversity. Alongside these pre-suppression objectives are strategies that will improve and streamline response to bushfires in the area without unnecessarily compromising biodiversity values. The extent of the impacts of these proposed tradeoffs, both pre-suppression and suppression, will be monitored closely over time to aid in the evolution of this plan.

“Fire prevention” is neither desirable nor achievable in this landscape; fires have and will continue to occur in this landscape as a natural process, regardless of any human intervention. However, the risk that fire poses to both biodiversity and built assets can be managed proactively within an adaptive framework that seeks to implement actions and learn from results. This plan is designed to provide direction for the mitigation of this threat through both pre-suppression and suppression activities.

1.2 Key Objectives

Whilst different blocks within Bookmark are targeted for specific management actions, the management plan for the overall area is underpinned by a number of key objectives.

1. To protect life and property on all reserves listed within the Plan.

2. To restrict the extent of non-prescribed fire in order to protect and maintain as much 40 plus year-old mallee habitat as possible for the conservation of threatened species; particularly the Black-eared Miner and Malleefowl.
3. To contain bushfires within single fire management blocks wherever possible, and to prevent fire spreading beyond the reserve, on to adjacent Heritage Agreements, farmland, horticultural and residential blocks.
4. To minimise the impacts of both bushfire suppression and pre-suppression works on the Bookmark landscape through better incident management, planning and targeted rehabilitation.
5. To minimise the impacts of both bushfire suppression and pre-suppression works on the Wilderness value of northern Danggali through better incident management, planning and targeted rehabilitation.
6. To monitor the effects of fire (both planned and unplanned) on mallee ecosystems with respect to amplified grazing pressure in buffers and potential displacement of black-eared miner colonies.
7. To facilitate a better understanding of the role of fire (both planned and unplanned) and its impacts in mallee ecosystems, and the efficacy of prescription burning in mitigating the threat that bushfire presents through targeted research and monitoring programs.
8. To protect Cultural Heritage sites from fire.

2 THE PLANNING FRAMEWORK

2.1 Legislation

2.1.1 State Legislation

DEH has responsibilities for fire management activities within Reserves constituted under the [National Parks and Wildlife Act 1972](#) (NPW Act), and the [Wilderness Protection Act 1992](#).

A significant section of Danggali CP has recently been gazetted as a Wilderness Protection Area under the *Wilderness Protection Act 1992*. This plan must demonstrate compliance with requirements of the *South Australian Code of Management for Wilderness Protection Areas and Zones* (DEH, 2004) with respect to fire, emergency and essential management operations under Sections 3.6 and 3.10. Refer to Appendix 1 for a copy of these sections.

The *Fire and Emergency Services Act 2005* outlines the responsibilities of DEH and other combatant authorities in relation to fire management in National Parks and Wildlife Reserves. In prescribing any works or activities, involving clearance or the use of fire (also defined as 'clearance'), the plan must also meet requirements under the *Native Vegetation Act 1991*. In most cases, this will mean the completion and approval of a fire management plan. Where a prescribed burn is proposed in the absence of a fire management plan, or if the proposed burn is not covered by the current fire management plan, a prescribed burn plan (accompanied by an environmental assessment) must be completed and approved by the Native Vegetation Council (or within an agreed framework), before the prescribed burn is undertaken.

2.1.2 Commonwealth Legislation

Overarching these State Acts is the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The EPBC Act promotes the conservation of biodiversity by providing protection for:

- species and communities listed under the Act in Commonwealth areas, including listed threatened species and ecological communities, listed migratory species and listed marine species; and
- protected areas (World Heritage properties, Ramsar wetlands, Biosphere reserves, Commonwealth reserves and Conservation zones).

Bookmark is afforded protection under this Act for a number of reasons:

1. It is a listed UNESCO Biosphere.
2. It contains a Commonwealth Reserve.
3. It contains EPBC rated species and presently is the only area on mainland Australia designated as Critical Habitat for an Endangered species (the Black-eared Miner).

As such this plan requires Commonwealth approval before any recommended works that may impact upon this area may proceed. However, as this plan deals with the abatement of the key threatening process to this species, the Act also serves as a powerful lever to implement resource and improve the plan as time progresses.

2.2 DEH Fire Management Policy

DEH has a fire management policy that states 'DEH will manage fire in the State's reserve system to protect life, property and environmental assets and enhance the conservation of natural and cultural heritage' (DEH, 2008a). This policy outlines a number of key principles:

- Fire is a natural component in Australian ecosystems.
- Reserves play a crucial role in protecting biodiversity, particularly within a fragmented landscape, and are acknowledged as valuable ecological assets.
- Land development has limited the extent, contiguity and biodiversity of these ecosystems whereby those remaining areas of natural vegetation now protected in reserves may become vulnerable to irreversible change if unprotected from recurrent fire.
- Land development has led to the development of residential, agricultural and horticultural assets with increased potential for risk to life and property from uncontrolled fire.
- The community has an expectation that their developed assets should be protected from the threat of unplanned fire.
- Intervention to suppress unplanned fire is sometimes necessary to limit damage to natural and developed assets.

Under this policy direction, appropriate consideration is given in fire management planning by DEH to achieve the dual aims of protecting the environment as well as protecting human life, property and assets. Property protection activities, where recognised as a priority, will be carried out in such a way as to reflect, wherever practicable, the importance of protecting the dynamics of natural ecosystems.

2.3 Zoning Policy

DEH has a Zoning Policy that outlines the zoning standard used for fire management planning on DEH managed lands (DEH, 2008b). The zoning policy has been applied to the planning areas as a whole. It is derived from:

- the level of perceived risk, using Policy and Procedure for Risk Assessment in DEH Fire Planning (DEH, 2008c)
- the Overall Fuel Hazard, which is assessed using the Overall Fuel Hazard Guide for South Australia (DEH, 2006a)
- the activities considered appropriate to mitigate the threat that fire poses to life, property and environmental assets.

Three distinct zones exist: Asset zone (A-zone), Buffer zone (B-zone) and Conservation zone (C-zone). These are applied according to fire management objectives. A- and B-zones are determined by fuel management objectives whereas C-zones are designated to assist in the conservation of biodiversity through the application of appropriate fire regimes. For more information on zoning, refer to Section 8 of this plan (Fire Management Zones) and the *Policy and Procedure for Fire Management Zoning in DEH Fire Planning* (DEH, 2008b).

2.4 Regional Biodiversity Planning

The South Australian Murray-Darling Basin Biodiversity Plan (Kahrimanis, *et al.*, 2001) is one of several regional biodiversity plans developed by DEH. The Plan guides the conservation, management and rehabilitation of habitats at a regional level. It recognises inappropriate fire regimes as a threat to biodiversity, and the planning objectives, works and activities presented in this Fire Management Plan have been developed to ensure consistency with the Biodiversity Plan.

The Bookmark Mallee Fire Management Plan is directed by strategies and actions detailed in the *Regional Recovery Plan for the Mallee Emu-wren Stipiturus mallee, Striated Grasswren Amytornis striatus, Western Whipbird Psophodes nigrogularis leucogaster and Red-Lored Whistler Pachycephala rufogularis in the South Australian Murray Darling Basin* (DEH, 2005). This plan recognises the significant threat that inadequate fire regimes pose to target species and outlines a number of management recommendations accordingly.

2.5 Reserve Management Planning

The overall management philosophies for the Riverland Biosphere are described in an Action Plan (Bookmark Biosphere Trust, 2001). With respect to fire, this document provides a broad direction for fire management practices without detailing strategies or being exhaustive in its assessment of the role of fire in the Biosphere. Within the plan area, Plans of Management (POM) for individual reserves have been developed for all the reserves except for Cooltong Conservation Park:

- Gluepot Reserve (Baker-Gabb, 2004)
- Danggali Conservation Park (DENR, 1995a)
- Pooginook Conservation Park (DENR, 1994)
- Chowilla Regional Reserve (DENR, 1995b).

The objectives and strategies in this fire management plan are consistent with strategies listed in these plans of management. The interests of CFS and the Bushfire Prevention Committee have been met through appropriate consultation with the Steering Committee. It is important to note however, that only a small percentage of the plan area is within hundreds; the remainder is pastoral. Consequently, consultation has also involved the Pastoral Board and the South Australian Farmer's Federation. The plan identifies fire management blocks, zones and specific objectives and prescriptions for those zones.

2.6 Fire Management in Heritage Agreements

Gluepot Reserve is the largest Heritage Agreement in SA. Prescribed fire may be used for the following purposes in Heritage Agreements contained within this plan:

- Fuel reduction around or adjacent to built assets.
- To provide landscape protection for populations and or communities of threatened or significant flora and fauna.
- To meet specific ecological objectives such as weed management, threatened species populations or habitat restoration.

To facilitate a consistent approach across the planning area and to ensure that the objective of any prescribed action is aligned with the objectives stated within the plan, any fire management actions prescribed and implemented on Heritage Agreements are undertaken by individual landholders within the following constraints:

- Any prescribed action undertaken on private land will comply with the guidelines stated within the plan and the relevant Acts listed.
- All prescribed burning planned for Heritage Agreement areas will be prepared in accordance with the DEH *Policy and Procedures for Prescribed Burning* (DEH, 2008d) and the GAFLC *South Australian Prescribed Burning Code of Practice* (GAFLC, 2004).
- All prescribed burning conducted within Heritage Agreement areas will be completed only in conjunction with an adequate monitoring program.
- The final decision to implement any prescribed action listed within the plan for a specific Heritage Agreement is the landowners.
- DEH, through the Murraylands Conservation Programs Unit will provide technical support and expertise in the preparation of prescribed burn plans, environmental assessment tables and pre- and post-fire monitoring. Funding for monitoring programs can be sought through the Native Vegetation Council grants scheme.
- DEH will not contribute toward the implementation (either through resources or financially) of any prescribed action on private land unless it is demonstrated that there is a benefit or shared risk to public land.

Recommendation

Heritage Agreements

1. To assist in the implementation of prescribed burning and other pre-suppression works within Heritage Agreements and other privately managed land it is recommended that funding be sought through the SAMDB and other funding sources. These funds should be managed through the Conservation Programs Unit (Murraylands Region).

2.7 The Role of the Local Country Fire Service

The Country Fire Service has overall responsibility for fire suppression activities. Fire response in Bookmark is undertaken jointly by the DEH Brigade and CFS Brigades that form the Chaffey and Mid-Murray CFS Groups. The statewide DEH Brigade is a recognised brigade of the CFS, but its response is limited to DEH reserves only. Local volunteers are heavily relied upon for fire suppression activities, particularly in the early stages of an incident. The co-operation, support and understanding between CFS, DEH and the local community have been critical to successful fire suppression in the past, and will be critical to the successful implementation of this plan.

The role of the CFS in prescribed burning at this point is informal and based on specific operation agreements between the CFS and land managers. It is hoped that this plan will serve to foster a partnership between land managers and the CFS toward the common goal

of reducing fire impacts within the area. Inter-agency involvement with prescribed burning is valuable for a number of reasons:

- Inter-agency operations promote a better understanding of the policies and approaches used to manage fire at a landscape level.
- Such activities provide excellent training opportunities for both DEH and CFS staff on a joint platform. Better knowledge of fire behaviour in mallee, mallee fire ecology, operational procedures and local resource capacity are benefits directly attributed to such exercises.

3 BUSHFIRE ENVIRONMENT

The basic components of any landscape contributing to the bushfire potential include terrain, slope and aspect, climate and weather, vegetation and land use. Bookmark is an area with a high seasonal potential for bushfires, supporting 700 000 hectares of continuous mallee of varying fire risk. The understorey communities, the grazing pressure that respective areas have been exposed to over the past century, and episodic germinations of Speargrass (*Austrostipa scabra*) all contribute to the fire potential of the Bookmark Mallee.

3.1 Location

The Riverland Biosphere (previously known as Bookmark Biosphere) is situated north of the River Murray stretching east from Waikerie to the South Australian border (refer to Map 1). The Plan area incorporates all designated mallee conservation land north of the Sturt Highway and Old Wentworth Road. The DEH Reserves in the plan area are: Danggali WPA, Danggali, Cooltong and Pooginook Conservation Parks and Chowilla Regional Reserve. Three additional pastoral leases managed for conservation make up the remainder: Calperum and Taylorville Stations (vested in the Commonwealth Director of National Parks, and managed by the Australian Landscape Trust) and Gluepot Reserve (owned by Birds Australia).

3.2 Climate, Wind and Weather

Bookmark has a semi-arid climate characterised by extremely hot, dry summers and cool winters. The average rainfall is 240 mm per annum but highly variable, ranging between 150 mm to 550 mm. Per annum rainfall distributions are skewed, with a mode well below an annual average that is raised by a few exceptionally high rainfall years. Thunderstorms extending from the north are common during the summer months; however, they are not always associated with significant rainfall.

Summer temperatures reach an average maximum of 31°C with an overnight minimum of 14°C. Daily maximum temperatures in excess of 40°C are common in the summer. Winters are generally dry and mild with an average maximum of 16°C and overnight temperatures dropping to an average minimum of 4.5°C, although temperatures can drop to as low as minus 4°C.

Wind speed and direction varies seasonally within Bookmark. In the presence of a high-pressure system ahead of a cold front, winds are frequently from the north before swinging to the southwest. Winds in these instances are often strong and gusting both before and after the frontal system arrives.

3.3 Fire Behaviour in Mallee Ecosystems

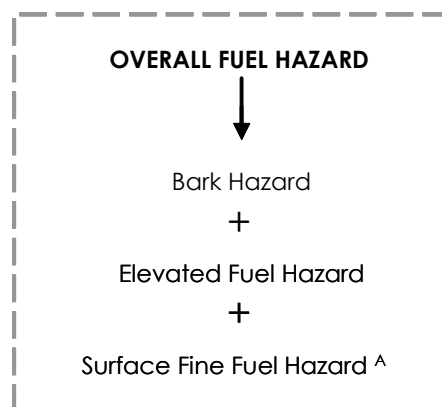
Fire behaviour in low-rainfall mallee ecosystems is not well documented, with significant knowledge gaps in the relationships between fuel arrangement, type and quantity, the weather conditions and the resultant fire behaviour. Much of the available information on mallee fire is sourced from New South Wales (Bradstock and Cohn, 2002; Willson, 1999) with little research conducted to date in South Australia. The arrangement and types of fuel present in mallee often result in considerable variation in the intensity, rate of spread and residence time of a fire (Bradstock and Cohn, 2002).

Essentially fire behaviour in mallee is a function of vegetation type and the ability of weather conditions, in particular wind, to propagate fire. Within Bookmark, there is a strong relationship between vegetation type, soil type and topography. Dunes support a canopy of mallee with a *Triodia* (*Triodia spp.*) understorey. These areas present the greatest fire risk in mallee systems due to the extreme flammability of *Triodia*. Conversely, plains, swales and claypans that support sparser fuels such as mallee with a chenopod understorey or Black Oak (*Casuarina pauper*) communities pose a lower fire risk. This risk is raised under ephemeral fuel conditions (discussed in detail in the following section). Black Oak systems have frequently been used as natural low fuel buffers for bushfire suppression and are of critical importance when planning suppression strategies.

The varying continuity of fuels in mallee systems, including *Triodia*, produces a heavy reliance on wind for fire to propagate (Bradstock and Cohn, 2002). In high winds, dunes with low percentage *Triodia* cover can carry a fire. It is also under these conditions that areas of heavier fuel loading in mallee can produce unpredictable fires. Crowning in moderate to high fire danger conditions in older mallee is commonplace given the open nature and height of the canopy, the understorey fuel and the extensive surface litter forming a continuous link with suspended bark on branches. An extension of this unpredictability in mallee fire behaviour is spotting potential. Spotting distances of two kilometres have been observed in large fires under extreme conditions (Rawson, 1982).

3.4 Fuel

Fuel hazard assessment methodology is based on the Overall Fuel Hazard Guide for South Australia (DEH, 2006a), which is ultimately an assessment of four fuel layers (components). These are surface fuel (litter), near surface fuel, elevated fuel and bark fuel (Figure 1). The Overall Fuel Hazard is used to determine the level of risk posed by bushfire to life, property and environmental assets in the risk assessment.



[^] Surface Fine Fuel Hazard adjusted to account for the presence of Near Surface Fuel

FIGURE 1: OVERALL FUEL HAZARD

Each fuel layer contributes to different aspects of fire behavior: flame depth and height, surface fire combustion and rate of spread, spotting and crown fire (DEH, 2006a). Each layer, as well as the Overall Fuel Hazard can be assessed as: *Low*, *Moderate*, *High*, *Very High* or *Extreme*.

Research conducted by McCarthy and Tolhurst (2004) into the effectiveness of fuel reduction burning in Victoria concluded that maintaining Overall Fuel Hazard levels at *High* or less aids in slowing the rate of spread of a subsequent bushfire. It was determined that to achieve long-term fuel reduction effects the focus should be on the reduction of bark and elevated fuels as these fuel layers are likely to contribute the most to the overall fuel hazard.

3.4.1 Conditions for Large Fire Events

For many areas of South Australia, there has been little collation, analysis and interpretation of fire events and their associated fuel and weather conditions. Bookmark and indeed mallee ecosystems in general are no exception. Apart from anecdotal information, the differences in fuel and weather conditions that cause fires of different sizes and intensities have not been fully investigated or documented with any reliability. However, it is broadly understood that strong wind combined with high temperatures and low humidity produce moderate to severe fire activity. Fires of greater than 10 000 hectares are generally only observed in mallee on decadal basis and are usually associated with a specific set of conditions (Bradstock and Cohn, 2002; Willson, 1999). Fires in the majority of other years are smaller and restricted by the patchy distribution of fuel types that mallee provides. There is a marked increase in the likelihood of large fires occurring in Bookmark when the following conditions are experienced:

- A proliferation of ephemeral grasses creating continuous fuel in areas with otherwise variable fuel loads. Mass germinations of Speargrass associated with appropriately timed rainfall events (Bradstock and Cohn, 2002; Willson, 1999) occur on a scale large enough to create these conditions. Evidence (albeit anecdotal in earlier cases) suggests a correlation between this burst of ephemeral vegetation and large fire events in both SA and adjacent mallee in NSW, however, the exact circumstances required to trigger such an event is not known. Planning for such sudden fuel accumulations is not simple, as there are no readily identified indicators for these events at present. In addition, the scale on which they occur and the rate of fuel accumulation (potentially from germination to one metre in height within eight weeks) makes the effective implementation of any strategy across a landscape as large as Bookmark very difficult.
- High incidence of lightning strikes as a result of increased thunderstorm activity between October and February (Morelli and Forward, 1996; Willson, 1999).
- Low humidity, decreased soil and fuel moisture commonly experienced with long, hot Riverland summers.
- Years of extended drought resulting in exceptionally low fuel moisture, and creating circumstances whereby fire can propagate much earlier in the season than is normal, as well as creating more extreme conditions throughout summer.
- High winds shifting direction during the course of a fire. In particular fires in Bookmark have the tendency to start during dry thunderstorms on hot northerly winds ahead of a south-westerly change. This wind pattern, in combination with predominantly east-west running sand dunes supporting a *Triodia* understorey will often produce a southwest-northeast shaped fire scar in larger incidents.

It is therefore imperative that the development and implementation of objectives, strategies and on-ground actions reflect the conditions and recognise the potential for fire and the resultant impacts on both conservation reserves and private land. The potential impacts are discussed in the following sections.

4 FIRE HISTORY AND FIRE REGIMES

4.1 Fire Regimes in Mallee Communities

Fire regimes in the drier Mallee communities of south-eastern Australia have not been subject to the same exhaustive study and analysis seen in other regions in closer proximity to populated areas. This combined with a limited mapped fire history since European settlement means the true nature of fire regimes in low-rainfall mallee is unclear. Despite this, the availability of more recent research, mapping, land use and meteorological data is allowing an ever-improving knowledge base on Mallee fire regimes.

4.2 Prior to European Settlement

Pre-European fire regimes are poorly understood in this area. Mass germinations of Speargrass appear to be the main contributor to large fire events both pre- and post-European settlement, and still result in large fires today.

Unfortunately, little is known of what fire regimes, if any, were applied by Aboriginal occupants in the region. The Paakantji people most recently inhabited the area north of the River Murray with preference given to the mallee during the winter months when resources along the River were scarce. Any observations regarding the role that traditional owners have played in altering fire regimes in mallee are largely speculative (Harris, 1989). Observations would suggest that some localised patches of vegetation may have been burnt either purposely or inadvertently by traditional owners; suffice to say that the practices employed were nowhere near the scale, intensity and frequency of groups in northern Australia. Fire has therefore not shaped the landscape to the same extent.

4.3 Twentieth Century Fires

4.3.1 Mapping Fire Occurrences

A Map displaying fire history has been compiled from DEH and CFS records of fire incidents (Map 3). The map displays:

- *Last Fire*, that is, the most recent fire event for any given location within the planning area up to the completion of the 2007/8 Fire Season; and
- *Fire Frequency*, that is, the number of times an area has burnt since records have been kept (1945) up to the completion of the 2007/8 Fire Season.

The quality of the fire scar mapping varies, depending on the methods of capture, which range from digitising enlarged aerial photographs to interpretation of hand drawn maps. Where fire scars were visible on historic aerial photography (largely at 1:40 000 scale) they have been digitised for mapping and future analysis in a Geographic Information System (GIS). It is important to note that only visible fire scars were mapped. As such, the mapped fires should be regarded as a *minimum* estimate of fire occurrences.

4.3.2 Ignition Sources – Lightning and Humans

Lightning is the largest ignition source for fires in the region. Dry thunderstorms are a common occurrence throughout summer. Ignitions are most common at the head of a cool change late in the afternoon or early evening as the wind is shifting from the north to the west. These

thunderstorms frequently produce multiple strikes and ignitions across the Bookmark landscape.

The occurrence of human-related fires is presently minimal in the Bookmark Mallee because of its relative isolation and access restrictions. However, anecdotal information suggests that pastoralists and landowners have historically lit fires within the *Triodia*-covered dunes (Forward and Robinson, 1996; Jock Robertson, pers. comm.; Mark Arnold, pers. comm.) to remove areas of unpalatable *Triodia* and replace them with more palatable ephemeral species. This practice was often associated with summer electrical storms, and occurred mainly in the southern areas of Bookmark, leaving the northern areas, such as Danggali, to natural ignition sources. One noteworthy event occurred within Bookmark in December of 1950 (Forward and Robinson, 1996; Mark Arnold, pers. comm.) when a fire was started in ephemeral Speargrass at a woodcutter's camp. It spread east, burning a large portion of the Bookmark Mallee over several weeks.

With deliberate burning now absent on Chowilla Regional Reserve, and restricted public access to many areas natural ignitions are likely to persist as the most common ignition source.

4.3.3 Fire Frequency and Impact

Fire frequency in Bookmark traditionally has been low given the fuel, climate and relative lack of human activity. Forward and Robinson (1996) calculated the likelihood of fire occurring in Danggali to be once every 2.5 years. This figure is unlikely to have been altered substantially by pastoral practices in the northern areas of Bookmark. In contrast, burning associated with pastoralism may have increased fire frequency to some extent in southern extent of the plan area (i.e. Taylorville and Calperum) (Mark Arnold, pers. comm.).

4.3.4 The Last Decades

Land management has changed in Bookmark over the last three decades as the extent of the area set aside for conservation has increased, starting with the acquisition of Danggali by DEH in 1976 and the acquisition of Calperum, Taylorville and Gluepot pastoral leases in the 1990's. De-stocking of these reserves in conjunction with increased feral animal (particularly goat) control, has initiated some recovery within vegetation communities. An increase in available fuel can be expected in association with this recovery over a number of decades, however to this point no direct links have been made between destocking and an increase in fire size or frequency. Whilst the build-up of these perennial fuels will continue, years of prolific Speargrass growth are still expected to be the major contributing factor to extensive fires in Bookmark.

4.4 Present and Future Fire Regimes

4.4.1 Impact of Land Use and Operational Capacity on Fire Regimes

Land use changes have increased the economic, political and community pressure on CFS and DEH to suppress bushfires when they occur. Concurrently, the operational capacity to suppress fires has increased through several mechanisms including improved access, well-equipped and trained firefighters, aerial suppression support and improved incident management. Backburning can also increase our capacity to suppress fires, but may result in

a different fire patchiness and extent than what may have occurred naturally in the past, and can actually increase the amount of area burned if used indiscriminately.

Pressure to suppress all fires combined with improved control techniques results in many fires being extinguished sooner than would happen naturally. This in turn means the natural fire regime is altered, as are the fuel and flammability patterns across the landscape. Given the vast size of Bookmark, the sparse settlement within the region and the comparatively low operational suppression capacity, the human influence on fire regime within Bookmark is not as pronounced as it has been in other areas of the state. In saying this, pastoralism is likely to have introduced a slightly different fire regime to the region through the activity of prescribed burning.

4.4.2 Future Fire Regimes

Future fire management must influence fire regimes responsibly with the best available knowledge, given the existing landscape, current fire patterns, ecology and surrounding land use. Given the complex interactions between seasonal conditions, ephemeral fuels and natural vegetation patchiness in Bookmark, the task of defining an “ideal fire regime” (as described by Willson, 1999) is difficult. Grazing pressure from both introduced and native herbivores has been reduced from much of the plan area through de-stocking and the closure of artificial water points. Consequently, the levels of certain fuel types can be expected to increase, potentially resulting in increased fire frequency with the return of a more natural fire regime. The size and contiguous nature of the area means that fire regimes, whilst modified through human intervention, could return to a state largely similar to that witnessed before pastoralism. Under current objectives, intense, fine-scale intervention is therefore not required.

5 DAMAGE POTENTIAL TO BUILT ASSETS

5.1 Land Use

Areas adjoining Bookmark have a variety of land uses (refer to Map 1). Land to the north and west of the area is entirely pastoral, with nine properties stretching from Glenlock in the southwest around the Biosphere's western boundary to Oak Vale on Danggali's northern fence. Population and infrastructure throughout these areas is minimal. The Biosphere's eastern exposure is a mixture of pastoral and nature reserves including Scotia Sanctuary (Australian Wildlife Conservancy, AWC), Tarawi Nature Reserve (Department for Environment and Climate Change) and Belmore Station. Major exposure risks are to the south (along the River Murray corridor) of the plan area where there are numerous parcels of cropping, pastoral, centre-pivot irrigation and horticultural lands, as well as some rural housing exposures. The eastern boundary of Cooltong and south-eastern boundary of Calperum present a relatively high risk to built assets, with the township of Renmark nearby.

5.2 Built Assets and Property Protection

All land management agencies have an obligation to minimise the risks to built assets posed by fire in reserves. There is an obligation to protect, amongst others, private and public built assets, farm and horticultural land. The difficulty is in striking a balance between property protection and conservation management objectives.

Whilst a very large percentage of the planning area is unpopulated, there are a number of built assets both within and adjacent to the plan area requiring protection from fire. These include homes, outbuildings, shearing and implement sheds, vineyards, orchards, DEH visitor facilities and information bays. Additionally, cultural heritage sites also require protection, but in such a way as to not detract from their value.

All landholders are obliged to comply with the *Fire and Emergency Services Act, 2005*, which outlines responsibilities for fire preparedness. DEH will implement works for fire management on DEH managed lands within the planning area in order to minimise risks, however adjoining landholders are also required to implement works on their own property to minimise the threat of fire.

5.3 Tourism

The Riverland Biosphere is internationally recognised as a tourist destination. Whilst the majority of tourism within the Riverland is centred on the River Murray corridor, there are still numerous visitors to the mallee areas of the Biosphere; specifically Gluepot, Danggali and parts of Chowilla Regional Reserve. Gluepot in particular is popular as a destination for bird watchers and campers. The potential impacts of fire on the ecology of the area mirror those of tourism, which is essentially ecologically driven.

5.4 Cultural Heritage

5.4.1 Aboriginal Heritage

Aboriginal history in Bookmark is rich, with sites in Chowilla dating back 12 000 years (Forward and Robinson, 1996). Much of the Bookmark Mallee was inhabited by the Danggali people in the north of the area and the Meru in the south (AIATSIS, 2005). During the winter months,

when resources around the River Corridor were scant, people frequently moved north into the more resource-rich mallee. There are two sites registered within the plan area on the Department for Aboriginal Affairs and Reconciliation (DAARE) Heritage Sites Database. These are Nanya's Wurlie in Danggali, a campsite inhabited for 30 years by an exiled group from 1864 (Tindale, 1974) and the Nappers Old Accommodation House Burial Ground in Cooltong CP. The protection afforded to known Aboriginal sites is listed in Section 12.

5.4.2 European Heritage

Bookmark has a long history of pastoralism spanning well over 150 years. Exploration commenced in 1830 when Charles Sturt travelled down the River Murray. From 1838, the river corridor was used as a major droving route from New South Wales to Adelaide. It was not until the 1860's that pastoralism was initiated in the region by Richard Holland. He and his three step-sons (the Robertson's) first leased the land known as Bookmark and grazed both sheep and cattle following the provision of permanent water supply running north of the river (Forward and Robinson, 1996). This land was further divided at a later point into Calperum and Chowilla. These areas are still pastoral leases today, with Chowilla managed as a Regional and Game Reserve by DEH and the Robertson family. Henry Martin managed Danggali as a pastoral lease for nearly 60 years until 1975 before it was purchased by DEH, destocked and managed as a Conservation Park.

Gluepot Reserve was a pastoral lease for 120 years from the time James White acquired it on 1 July 1877 until Birds Australia purchased the property in 1997. Over that period, it was managed by a number of lessees. Reg Warnes and his family managed the lease for the longest period, from 1934 to 1961.

Danggali CP was dedicated in 1976, and is an amalgam of four pastoral properties; Canopus, Morgan Vale, Hypurna and Postmark. Pooginook CP was dedicated in 1970.

6 BIODIVERSITY

6.1 Fire and Mallee Ecosystems

Whilst adaptations to fire are most evident in vegetation, there is considerable evidence to suggest that the many mallee invertebrates, reptiles, birds and mammals have also developed mechanisms to not only persist but thrive in the post-fire environment. These adaptations may be behavioural, physiological, anatomical or biological, and in some cases many species would cease to exist in the absence of fire. Conversely, given the dramatic changes to the landscape associated with European settlement, there is an equal threat posed by too frequent fire, even in remnant areas as large as the Bookmark Mallee. As such, management of fire and more importantly fire regimes is essential to ensure the long-term conservation of these communities.

6.2 Vegetation

Mallee vegetation communities are best described as fire tolerant (Willson, 1999). Whilst certain mallee species respond well to fire and in some instances are fire promoted, the intricacy of the role that fire plays in mallee systems is often oversimplified through categorising a species as “fire adapted” or “fire sensitive” (Bradstock and Cohn, 2002). Mallee environments can subsist for very long periods (~100 years) (Willson, 1999) without fire, during which time there may be significant alterations to extant vegetation community composition and structure. Studies in Tarawi have shown that plant species richness in mallee communities post-fire is greater in areas with a longer fire interval (~90 years) than areas with a shorter interval of around 15 to 20 years (Dayman and Keith, 2004; Noble, 1989). The ability of many mallee species to lie dormant in the seed bank for decades without fire or adequate post-fire rain demonstrates that an absence of disturbance is not deleterious to species richness or diversity in the medium term. There is no doubt that fire promotes a short term increase in species richness, largely based on a flourish of annual or ephemeral species, however; fire at too frequent an interval within mallee ecosystems is deleterious to all species. The role that fire plays in shaping vegetation community composition and succession in such a variable system is therefore difficult to quantify.

6.2.1 Vegetation Mapping

The vegetation of the Bookmark Mallee has been mapped in 1996 as part of the South Olary Plains Biological Survey by the Geographical Analysis and Research Unit, Department of Housing and Research Development (now DEH). It was mapped using aerial photography interpretation with site visits to representative areas. The data was digitised for use in a geographic information system (GIS).

As the vegetation map (Map 2) and Table 1 shows, there are ten major vegetation groups within the planning area. These are based on the dominant overstorey, or tree layer and the sub-dominant overstorey and dominant understorey species.

TABLE 1: MAJOR VEGETATION COMMUNITIES IN THE BOOKMARK MALLEE

Taken from South Australian Vegetation ID and mapped during the South Olary Plains Vegetation Survey, 1994

		Vegetation Community
Unit Code	SP0001	<i>Eucalyptus gracilis</i> mid mallee woodland over <i>Enchylaena tomentosa</i> var. (mixed) mid open shrubland and <i>Zygophyllum aurantiacum</i> ssp. (mixed) low sparse shrubland
	SP0002	<i>Eucalyptus socialis</i> ssp. mid mallee woodland over <i>Enchylaena tomentosa</i> var. (mixed) low sparse shrubland and low sparse hummock grassland (<i>Triodia</i> spp.)
	SP0003	<i>Eucalyptus dumosa</i> mid mallee woodland over <i>Eremophila glabra</i> ssp. (mixed) mid sparse shrubland and <i>Beyeria opaca</i> (mixed) low sparse shrubland and low open hummock grassland (<i>Triodia</i> spp.)
	SP0006	<i>Casuarina pauper</i> (mixed) low woodland over <i>Senna artemisioides</i> ssp. <i>coriacea</i> mid open shrubland and <i>Maireana sedifolia</i> low open shrubland and <i>Schismus barbatus</i> (mixed) low sparse shrubland
	SP0007	<i>Casuarina pauper</i> (mixed) low open woodland over <i>Senna artemisioides</i> ssp. (mixed) mid open shrubland and <i>Eriochiton sclerolaenoides</i> (mixed) low sparse shrubland
	SP0012	<i>Lycium australe</i> (mixed) mid open shrubland over <i>Sclerostegia tenuis</i> (mixed) low open shrubland and <i>Disphyma crassifolium</i> ssp. <i>clavellatum</i> (mixed) low open forbland
	SP0013	<i>Alectryon oleifolius</i> ssp. <i>canescens</i> low open woodland over and <i>Enneapogon avenaceus</i> low open tussock grassland
	NP0004	<i>Maireana sedifolia</i> low open shrubland over <i>Sclerolaena obliquicuspis</i> (mixed) low open shrubland
	NP0019	<i>Dodoniaea viscosa</i> ssp. <i>angustissima</i> (mixed) tall open shrubland over <i>Maireana pyramidata</i> (mixed) low sparse shrubland and <i>Atriplex limbata</i> (mixed) low sparse shrubland
	NP0028	<i>Acacia victoriae</i> ssp. mid sparse shrubland over <i>Maireana pyramidata</i> (mixed) low open shrubland and low open forbland

6.3 Fauna

Fauna, as with mallee flora, can exist in a wide variety of post-fire ages. However, our understanding of the role that fire plays in the ecology and distribution of mallee fauna is not clear. A common consensus on the role of fire in the ecology of mallee fauna is that fire occurring at an interval of less than 15 years over large areas is detrimental to all mallee fauna (Clarke, 2005; Willson, 1999). At this point, an upper threshold for fire intervals has not been defined for mallee fauna with any consistency. Willson (1999) provided tentative thresholds for fauna in Tarawi Nature Reserve; however these figures were qualified as 'at least' values, citing a need for greater research into vital attributes of mallee fauna.

6.3.1 Avifauna

When compared with other mallee fauna there is a better understanding of the fire ecology of avifauna through work on specific threatened species (e.g. Baker-Gabb, 2004; Clarke, 2005). Many bird species use a range of post-fire ages and their densities may be high in recently disturbed areas, however, species diversity is highest in 'old-growth' mallee (Clarke, 2005; Willson, 1999). Mallee habitat of 40 or more years of age has been shown to be key habitat for a range of threatened species, while communities last burnt 20 years ago act as important refuge for all threatened mallee birds within Bookmark (Clarke, 2005). In comparison, communities less than 15 years post-fire were not central to the needs of any threatened species. Extensive, high intensity bushfires that leave few patches and destroy hollows are undesirable for all species of mallee bird (Clarke, 2005; Willson, 1999). Therefore, the need to develop a management program that maximises the protection of areas that currently fall within this age range from large events, in addition to areas that are potential future habitat is of vital importance.

6.3.2 Mammals & Reptiles

Mallee reptiles and mammals' responses to fire appear less specific than those of birds. Both reptiles and mammals are found in a range of different post-fire ages (Bradstock and Cohn, 2002; Willson, 1999). *Triodia* cover is considered important as microhabitat for a number of different reptile species (Willson, 1999), and it is considered beneficial for areas to be burned at intervals and/or frequencies of greater than 15 years. Large, high intensity events that promote minimal patchiness are not desirable. Areas with a relatively mature, continuous cover of *Triodia* (i.e. communities 20-60 years of age) have been identified as central to the needs of species such as the Mallee Ningui (*Ningui yvonneae*). Bats specifically require hollows for roosting and nesting, hence stands of ancient, hollow mallee in swale areas devoid of fire for very long periods (>100 years) are important. Conversely, dune areas with old, senescing *Triodia* are regarded as suboptimal habitat for a range of mallee mammals (Bradstock and Cohn, 2002).

6.3.3 Species of Conservation Significance

The Environmental Database of South Australia contains records from several data sources including the Threatened Plant Population Database, the Biological Survey of South Australia and opportunistic sightings of significant flora and fauna.

In this plan 'of conservation significance' is used to describe important or *rated* populations or species of animals, plants or birds. Species may be:

- rated as Threatened, with a rating of Endangered, Vulnerable or Rare, under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
- rated as Threatened, with a rating of Endangered, Vulnerable or Rare, under the South Australian *National Parks and Wildlife Act 1972, Revised Schedules 7, 8 and 9*
- rated as Extinct, Threatened or Near Threatened under *The Action Plan for Australian Birds (APAB)* (Garnett and Crowley, 2000), which recognised the International Union for Conservation of Nature (IUCN) *1994 Red List of Threatened Animals* (Groombridge B (Ed.), 1993) categories and guidelines
- of significant value within an ecosystem based on its ecological importance, either as food resource, habitat or dominant/keystone species/community regardless of its conservation status.

Given the high incidence of threatened species within Bookmark, the use of species distributions records has been pivotal in the development of the plan. It should be noted that many of these species distributions are poorly defined because the database only contains point locations from site visits or observations. Importantly, distributions for key threatened species such as the Black-eared Miner and Malleefowl are better mapped due to more intensive surveying. The South Olary Plains survey records for the region are now several years old and will require verification before any management actions are based on them. Extensive surveys throughout Gluepot and Calperum over the past five years have resulted in better knowledge of species distributions in these areas.

There is a commitment to increasing capacity to incorporate species' requirements into improved ecological fire management. However, how each or all of a site's unique attributes in terms of its location relative to other patches, vegetation, soil, lithology, aspect, terrain, fire regimes or post-fire age contribute to the survival of a particular species is a complex question. It is beyond the scope of this plan to extrapolate site records for species across a landscape or to determine what the critical habitat requirements are for all species.

Table 2, Table 3 and Table 4 present a list of flora and fauna found within the Bookmark Mallee that are either rated as threatened or of significance to fire management. Included in the tables are the species' status under both the SA NPW Act and the Commonwealth EPBC Act, information on the fire ecology of the species (if any) and the source of that information. The information presented in these tables summarises threatened species' response to fire, thus demonstrating justifications for the management prescriptions listed within the plan. Information gathered through monitoring programs and research projects will build on this baseline over time to make more informed fire management decisions for threatened species.

TABLE 2: FIRE MANAGEMENT REQUIREMENTS AND STATUS OF THREATENED FLORA RECORDED IN THE BOOKMARK MALLEE

Common Name	Taxonomic Name	Status*		Fire Regime Guidelines	Data Source
		EPBC Act	NPW Act		
Large Adder's Tongue	<i>Ophioglossum polyphyllum</i>		R	None known.	
Lax Bluebush	<i>Maireana suaedifolia</i>		R	None known.	
Mallee Bitter Pea	<i>Daviesia benthamii humilis</i>		R	Obligate reseeder.	(Choate, 1997)
Nealie	<i>Acacia loderi</i>		R	None known.	
Pale Flax Lily	<i>Dianella porracea</i>		V	None known.	
Pale Fruit Cherry	<i>Exocarpos strictus</i>		R	Possible resprouter. Unconfirmed for species.	(Choate, 1997)
Rohrlach's Bluebush	<i>Maireana rohrlachii</i>		R	None known.	
Showy Lawrencia	<i>Lawrencia berthae</i>		R	Possible obligate reseeder. Other members in the Genus have been recorded regenerating in this way.	(Choate, 1997)
Wilga	<i>Geijera parviflora</i>		R	None known.	
Yellow flower Sour-bush	<i>Choretrum glomeratum</i> var. <i>chrysanthum</i>		R	None known.	

* Refer to Appendix 2 for a description of codes used

TABLE 3: FIRE MANAGEMENT REQUIREMENTS AND STATUS OF THREATENED AVIFAUNA RECORDED IN THE BOOKMARK MALLEE

Common Name	Taxonomic Name	Status*			Fire Regime Guidelines	Data Source
		EPBC Act	NPW Act	Action Plan for Australian Birds		
Black-eared Miner	<i>Manorina melanotis</i>	EN	E		Strong preference to mallee/ <i>Triodia</i> > 40 years of age for nesting and foraging.	(Baker-Gabb, 2001; Clarke, 2005)
Chestnut Quail-thrush	<i>Cinclosoma castanotus castanotus</i>		R		Most commonly found in mallee/ <i>Triodia</i> > 24 years of age, particularly areas 45 + years of age.	(Clarke, 2005)
Crested Bellbird	<i>Oreoica gutturalis gutturalis</i>			Lower Risk (Near Threatened)	Strong association with post-fire mallee/ <i>Triodia</i> habitat > 20 years of age (areas 45 + of greatest importance).	(Clarke, 2005)
Gilbert's Whistler	<i>Pachycephala inornata</i>		R		No information	
Hooded Robin (South-east subspecies)	<i>Melandryas cucullata cucullata</i>		R	Lower Risk (Near Threatened)	Requires understorey to predate on insects and small reptiles. Prevalence in 40 year old mallee suggests a preference for longer fire intervals.	(Garnett and Crowley, 2000)
Jacky Winter (South-east subspecies)	<i>Microeca fascinans fascinans</i>	RA	R		No information	
Major Mitchell's Cockatoo	<i>Lophochroa leadbeateri</i>		R		Requires very old growth mallee with hollow logs to roost and nest in.	
Malleefowl	<i>Leipoa ocellata</i>	VU	V		Strong preference to mallee 30 + years with a significant litter layer for mound building. Will forage in more recently burnt sites.	(Benshemesh, 2000; Clarke, 2005)

* Refer to Appendix 2 for a description of codes used

Common Name	Taxonomic Name	Status*			Fire Regime Guidelines	Data Source
		EPBC Act	NPW Act	Action Plan for Australian Birds		
Masked Owl	<i>Tyto novaehollandiae novaehollandiae</i>		E	Lower Risk (Near Threatened)	Requires very old growth mallee with hollow logs to roost and nest in.	(Garnett and Crowley, 2000)
Painted Honeyeater	<i>Grantiella picta</i>		R	Lower Risk (Near Threatened)	A primary reliance on the seed of the parasitic Mistletoe (<i>Amyema</i>) as food largely confines the suitable habitat of this bird to unburnt areas where the plant has hosts sufficiently established.	(Garnett and Crowley, 2000)
Peregrine Falcon	<i>Falco peregrinus</i>		R		No specific fire requirements, requires larger, old trees for breeding.	
Red-lored Whistler	<i>Pachycephala rufolugaris</i>	VU	R		Strong association with post-fire mallee/ <i>Triodia</i> habitat > 20 years of age (areas 45 + of greatest importance).	(Clarke, 2005)
Regent Parrot (Eastern subspecies)	<i>Polytelis anthopeplus monarchoides</i>		V		Non-specific, forages in mallee whilst not breeding in the River Corridor.	
Scarlet Robin (Eastern subspecies)	<i>Petroica multicolor boodang</i>	RA	R		No information	
Scarlet-chested Parrot	<i>Neophema splendida</i>		R		A nomadic visitor to Bookmark based on seasonal conditions. Requires very old growth mallee with hollow logs to nest in, as such a regime of reduced fire frequency is preferred. But forages in the herbage found in recently burnt areas.	(Garnett and Crowley, 2000)
Southern Scrub-robin	<i>Drymodes brunneopygia</i>			Lower Risk (Least Concern)	Strong association with post-fire mallee/ <i>Triodia</i> habitat > 20 years of age (areas 45 + of greatest importance).	(Clarke, 2005)

Common Name	Taxonomic Name	Status*			Fire Regime Guidelines	Data Source
		EPBC Act	NPW Act	Action Plan for Australian Birds		
Striated Grass-wren	<i>Amytornis striatus striatus</i>		R		A <i>Triodia</i> specialist. Strong association with post-fire mallee/ <i>Triodia</i> habitat > 20 years of age (areas 45 + of greatest importance).	(Clarke, 2005)
Striped Honeyeater	<i>Plectorhyncha lanceolata</i>		R		No information.	
White-browed Treecreeper	<i>Climacteris affinis superciliosa</i>		R	Lower Risk (Near Threatened)	A <i>Triodia</i> resident that predated on insects in litter and bark. Little known of fire ecology, a reliance on litter suggests a preference to older habitat.	(Garnett and Crowley, 2000)

TABLE 4: FIRE MANAGEMENT REQUIREMENTS OF THREATENED REPTILES AND MAMMALS RECORDED IN THE BOOKMARK MALLEE

	Common Name	Taxonomic Name	Status*		Fire Regime Guidelines / Ecological Notes	Data Source
			EPBC Act	NPW Act		
Reptiles	Bandy Bandy	<i>Vermicella annulata</i>		R	Little known about fire response. A nocturnal burrower that prefers <i>Triodia</i> dune habitat, believed to almost exclusively prey on Blind Snakes.	(Cogger, 1994)
	Bardick	<i>Echiopsis curta</i>	VU	R	Poorly understood, prefers logs and ground debris on sandy soils. No specific information on preferred post-fire habitat. Areas > 30 years of age with accumulated litter may be preferred.	(Cogger, 1994)
	Olive Snake-lizard	<i>Delma inornata</i>		R	Minimal information on specific fire requirements. Prefers <i>Triodia</i> as habitat to forage and shelter in along with leaf litter. As such early post fire habitat (<10 years) would appear unsuitable.	(Cogger, 1994)
Mammals	Eastern Grey Kangaroo	<i>Macropus giganteus</i>		R	No information	
	Greater Long-eared Bat	<i>Nyctophilus timoriensis</i>		V	Requires ancient mallee with hollow logs to roost and nest in.	(Dominelli, 2000)
	Little Pied Bat	<i>Chalinolobus picatus</i>		E	Requires ancient mallee with hollow logs to roost and nest in.	(Dominelli, 2000)

* Refer to Appendix 2 for a description of codes used

6.4 Other Threats to Biodiversity

6.4.1 Pest Plants

It is well known that fires can provide the opportunity for some weed species to establish and proliferate, with many weed species out-competing native species in post-fire regeneration. While this is not likely to be a problem in the larger blocks, where the perimeter to area ratio, or 'edge effect', is low and the areas are relatively weed-free, it may cause a problem in areas adjacent to farmland or in existing modified vegetation. A monitoring program will ensure that vulnerable areas are evaluated pre and post-fire to determine what post-fire weed control is required. Weed invasion is relatively localised in Bookmark, and not seen as being a large issue post-fire, however, monitoring will incorporate the recording of any new species within an area (native or otherwise). Control measures can be tailored based on the extent and nature of the invasive species recorded.

6.4.2 Pest Animals

As with weeds, feral animals can benefit from post-fire conditions. Goats, rabbits and pigs can benefit from readily available post-fire regrowth and the increased access a fire provides. Native species, such as kangaroos, may also thrive and concentrate in the regenerating areas for the same reason. The level of post-fire pressure these species apply depends on a number of factors, including pre-fire numbers and the size, shape and location of fire. Monitoring the effects of post-fire grazing in Buffer (B-zones) will provide an important component of the monitoring program for this plan (refer to Section 14). Evidence from Tarawi Nature Reserve in NSW (Willson, 1999) suggests that post-fire grazing is amplified in buffer zones, with native and feral species congregating in larger numbers in these areas. Whilst these areas will be subject to modification on a cyclical basis, their quality should not be reduced to the point where they do not resemble the surrounding system. In monitoring this response, land managers can firstly gauge the impact of the treatment and then modify management accordingly if the impacts are seen to be too severe.

7 BUSHFIRE SUPPRESSION

7.1 Legislation

Section 97 of the *Fire and Emergency Services Act, 2005* explains the importance of this Fire Management Plan and the role of the CFS during a fire incident on DEH land. The legislation states that under fire or threat of a fire a member of the CFS, as the lead combatant agency for bushfire suppression in SA, must consult with the person in charge (if that person is in the presence of, or may be immediately contacted by, the member of the CFS of that reserve) and if the prescribed action would affect a government reserve, they must take into account any relevant provisions of a management plan for the reserve that have been brought to the attention of the member.

7.2 Policies and Procedures

The following Policies and Procedures are to be used in conjunction with this Fire Management Plan:

- DEH Fire Management Policy (DEH, 2008a)
- DEH Fire Policy and Procedure Manual (covering various aspects of fire management) (DEH, 2008e)
- CFS Chief Officer's Standing Orders (COSOs) (CFS, 2007a)
- CFS Standard Operating Procedures (SOPs) (CFS, 2007a)
- CFS Operations Management Guidelines (OMGs) (CFS, 2007b).

Strategies implemented during an incident will be determined by the Incident Management Team (IMT), taking this plan into consideration.

7.3 Fire Emergency Procedures and Response Planning

DEH has developed a Response Plan for the Bookmark District, which details fire response for all its reserves. Such details include a brief description of the reserves' priority fire management considerations, hazards and firebreaks. It also includes overarching details such as DEH fire management principals, despatch levels, resources and communication plan. The Response Plan is reviewed and updated annually as necessary to ensure all information contained within the document is current.

7.4 General Objectives for Fire Suppression

- To provide for the protection of human life during fire suppression activities.
- To provide for the protection of built assets and neighbouring properties from bushfires.
- To ensure that sound conservation and land management principles are applied to fire suppression and fire management activities.
- To provide for the strategic containment of bushfires.

7.5 Strategies and Actions to Achieve Objectives

- Control lines will be established for use during bushfire incidents. These are fire access tracks that have been upgraded to GAFLC guidelines and will be subject to ongoing maintenance.
- New access tracks on all reserves will only be constructed for suppression purposes, where provided for in planning, or where approved by the Incident Controller in liaison with DEH staff.
- When bushfires occur, unless otherwise stated, only recognised control lines will be utilised for vehicle-based suppression activities.
- Previous fire scars (bushfires or prescribed burns), changes in vegetation type and topography (bushfires or prescribed burns) and the resultant variations in fuel patterns will be used to assist suppression activities.
- The use of heavy machinery to construct control lines within blocks for fire suppression will be used in accordance with DEH Policy and Procedures following authorisation from the Incident Controller in liaison with a DEH representative or (in the case of private land) the landowner involved.
- The use of retardant should be restricted to the protection of human life, built reserve and private assets, or to contain hotspots where ground crew access is hindered by terrain and vegetation and it is possible that a fire will build before these areas can be blacked out. Approval must be given by the Incident Controller in liaison with a DEH representative or (in the case of private land) the landowner involved.

7.5.1 Justifications for Suppression Strategies

All land management agencies have an obligation to maximise safety for fire suppression activities. For this plan, standards for control lines are in line with GAFLC guidelines (GAFLC, 2008). Where the combination of vegetation, fuel loads and terrain is likely to reduce the effectiveness of these control lines, they may be widened or perimeter burns undertaken in the immediate vicinity of control lines to minimise the likelihood of bushfires them.

By utilising control lines, and through the strategic use of previous fire scars and fuel patterns, the need to undertake other high impact suppression measures such as mineral earth breaks during a running fire will be reduced.

7.5.2 Aerial Observation

The extremely large size of the planning area and lack of adequate lookouts necessitates the deployment of aircraft to accurately locate a fire. The weather conditions that are conducive to fires will often result in multiple widespread strikes and ignitions. Locating these ignition points from the ground is both time-consuming and potentially dangerous given the distances involved and the lack of vantage points.

Recommendations

Aerial Observation

2. It is strongly recommended that Incident Management Teams request aerial observation as early as possible in the incident. An aerial platform should be deployed when smoke is first sighted or in the event of an electrical storm passing through the area during the months September through to March.

7.5.3 Aerial Suppression

Aerial suppression is a costly exercise and requires considerable ground support. It is ineffective in halting a running fire unless used in conjunction with ground crews and established control lines. Bombers are not present in the Riverland and as such, they need to be requested from out of the region. Primary aerial response zones will be given priority.

Aerial suppression is recommended throughout the planning area after careful consideration of the following:

- If adequate ground based support is available to compliment bomber work.
- The proximity of the airstrip to the fire, expected turnarounds times for filling and dropping and the capacity of the strip to handle multiple trips under load. The maximum ideal drop radius is 20 km however this may be extended to greater distances, at the expense of maximum effectiveness as the time between dropping loads is increased. Presently large portions of the planning area are further than 20 km from a CFS approved airstrip, reducing the effectiveness of air operations. Established strips are shown in Map 4.

7.5.4 Backburning Operations

Used correctly, backburning can be a highly effective bushfire suppression tool. However, some tradeoffs require consideration before works are implemented. These tradeoffs are particularly evident in a landscape such as Bookmark that is managed purely for conservation, as a backburn is essentially a self-defeating exercise given that has the potential to destroy what you are attempting to protect. An Incident Management Team (IMT) should consider three critical aspects:

A > When should backburning be conducted?

Backburning should **only** be conducted when authorised by the IMT under favourable weather conditions. Weather conditions should maximise the probability of managing the backburn, but they should also ensure that the appropriate fire behaviour is produced to provide an effective break against the approaching bushfire. As such, backburning in the early hours of the morning under sub-optimal fire conditions may not produce an adequate result.

B > Where should backburning be conducted?

Backburning is most effective when it augments existing low fuel areas. Such areas include Black Oak or Chenopod plains, swale areas, existing prescribed burn buffers or bushfire scars. Operations should be conducted from existing designated control lines that may be further

widened by the use of heavy machinery. The width of these burns should be determined by the IMT based on the weather conditions and the observed and predicted fire behaviour. Existing buffers may be reburnt if they are over 10 years in age or if, in the view of the IMT, a fire will carry through them under the current conditions. In the event of a Speargrass year, these areas should be reburnt to remove fuel.

C > How should backburning be conducted?

A backburn is essentially a prescribed burn, excepting that it is implemented under emergency conditions with a fraction of the preplanning that occurs with similar landscape protection or fuel reduction burns. For this reason there must be consultation with DEH when planning to backburn areas.

7.6 Fire Access and Firebreaks

Government Agencies Fire Liaison Committee (GAFLC, 2008) has produced *South Australian Firebreaks, Fire Access Tracks and Sign Standards Guidelines*. This document specifically details parameters for fire management access tracks and control lines, including adjacent fuel management, siting and maintenance, mapping, signage and safety.

All existing tracks within planning area are deemed essential for fire management operations and are to be maintained at the minimum standard detailed in the GAFLC guidelines unless otherwise stated within this plan.

The planning area is dissected by a range of access tracks (refer to Map 4), all varying in quality, width and level of maintenance. For the purposes of this plan, tracks are categorised in accordance with GAFLC guidelines (see below). Firebreaks are often associated with access tracks. Designated fire access tracks and firebreaks on DEH reserves are presently treated on a four-year cyclic basis. Tracks are placed into one of four categories:

- **Vehicle or Service Tracks:** Includes vehicular access tracks of no fixed width for reserve management staff, apiarists or private access to heritage agreement areas.
- **Minor Fire Tracks:** Trafficable in one direction, maintained at a width of four metres both at ground and canopy level.
- **Standard Fire Tracks:** As above, trafficable in a two-way direction through the provision of passing bays at intervals of 400 metres.
- **Major Fire Tracks:** Maintained at a minimum width of seven metres at both ground and canopy level to provide safe two-way access.

Refer to Map 4 for information on existing fire access tracks.

7.6.1 Firebreak / Fire Access Signage

Presently, adequate signage displaying information on the type of access, the name of the track or break, physical location, dead ends or steep terrain as defined in the GAFLC guidelines (2008) does not exist in the planning area. Consequently, signs should be erected across the planning area. Money for signs should be sought through the Bushfire Mitigation Fund through joint applications via DEH, the CFS and the relevant District Bushfire Prevention Committee.

7.6.2 Tracks

For those areas of the plan that are not managed by DEH, it is recommended that the GAFLC guidelines (2008) are adopted by all landowners in the planning area to maintain consistency in the standard of fire access tracks and control lines. A consistent minimum standard, regardless of tenure or terrain, will provide Incident Management Teams with greater confidence when planning strategies to suppress fires. Fire crew can access areas and execute these strategies with the confidence that access tracks are at a suitable standard.

7.6.3 Fencing

All unnecessary or fencing adjacent to access tracks and fire trails within the plan area should be removed to reduce access restrictions during incident response, provided that:

- resources permit; and
- no other obligations exist necessitating the maintenance of the fencing.

Recommendations	
Fire Access	3. Erect track signs across the planning area as per the GAFLC guidelines
	4. Encourage adjacent landowners to upgrade/maintain their tracks as per the GAFLC guidelines.
	5. Remove unnecessary fencing adjacent to access tracks and fire trails within the plan area if feasible.

7.7 Use of Control Lines during Fire Incidents

The use of control lines should be determined by the Incident Management Team, based on fire severity and weather conditions giving due consideration to safety and strategic advantage.

If control lines do not meet the recognised standard, they may be fuel reduced to achieve a low cover of vegetation up to 10m wide during a fire incident. The decision to do so lies with the IMT following consideration of the following conditions:

- All mechanically treated edges, either existing or new, are rehabilitated during prescribed burns and bushfires (wherever it is practically safe and feasible to do so) to encourage vegetation recovery.
- New control lines implemented to control fire edges should avoid dune crests and where possible run in as close as possible to a straight line to minimise the chance of rekindles escaping and maximise the chance of crews suppressing fire flanks. In areas where this line is away from the fire edge, fuel should be burnt wherever possible.

7.8 Heavy Machinery

Bushfire management and suppression within the planning area can be made more efficient by use of heavy machinery. Historically, the most commonly used method of implementing

control lines or securing fire edges in the region has been a bulldozer towing a cross-ribbed roller. This method has been favoured over mineral earth or ploughed breaks because they can access difficult terrain and provide an area of modified fuel with minimal long-term impact on vegetation community composition (Pelton and Conran, 2002; Pelton unpub. data). A low loader with a bucket or scrub rake can also have proven to be useful at mineral earth breaks. The decision to deploy heavy machinery for direct attack should be made by the IMT at the earliest possible point in time given:

- the time it takes to deploy heavy machinery is anywhere between two and 12 hours depending on the location of the machine, the state of the access roads, the mode of transport and the location of the fire;
- the quicker the response time, the earlier in the incident work can commence, thereby increasing the probability that control lines will be successful and decreasing the overall area cleared in the establishment of these lines, and;
- the fire weather and associated fire behaviour conditions under which machinery will be operating.

All actions involving heavy machinery are to be authorised by the IMT following liaison with DEH and the relevant landowner. Heavy machinery is only to be used when the IMT has determined that:

- there is a significant threat to life and/or property;
- the sensitivity of vegetation and habitat define a critical need to stop the fire entering an adjacent area (i.e. known threatened species habitat);
- there is unlikely to be irreversible or an unacceptable level of impact on cultural heritage sites (Aboriginal or European), significant ecological communities, species or habitats, and;
- the topography is suitable and/or safe for heavy machinery and the line will be trafficable by 14s/QRVs (small fire appliances) to support implementation and mop-up.

No heavy machinery is to operate without a support appliance with firefighting capability or adequate communication capabilities.

Within Danggali WPA, all heavy machinery use should take in to account the wilderness value of the reserve.

7.9 Fire Management Infrastructure

Existing water sources and facilities have been mapped on the individual block maps. Access to water sources for firefighting purposes should be negotiated directly with neighbours, through the CFS Group or the District Bushfire Prevention Committee. A Response Plan, dealing with DEH response to bushfire, will be updated as required, to reflect alterations and additions to utilities and facilities. In the absence of an existing joint response plan, response planning for other land in the plan area is the responsibility of the individual Land Manager.

7.9.1 Water Supplies

Despite a strong preference for dry firefighting techniques, water supplies for firefighting are critical in Bookmark. Firefighter safety and effective black-out and mopping up operations in both bushfires and prescribed burning require a water supply. The lack of adequate water supplies is particularly problematic in Bookmark during longer campaign fires. The requirement for water to be trucked in is often unavoidable given the absence of permanent water (either through bores or pipelines). However, the strategic placement of water tanks (refer to Map 1) where there is presently no water supply will help in easing this burden. Strategically located tanks provide points for water to be moved to for either bushfires or prescribed burns. They also provide firefighters with ample water early in an incident when chances of containment are greatest.

Recommendations	
Tanks	6. All designated firewater tanks within the plan area should preferably be at a minimum of 50% capacity at the start of each fire season.
	7. The level and status of all Firewater tanks and dams in Bookmark should be reported to the relevant CFS Group Officer and the DEH Fire Management Officer on a monthly basis during the Fire Danger Season.
	8. Roofs should be built wherever possible over tanks to catch as much in-situ rainfall as possible.
	9. Tanks should be lined to reduce the rate of water loss where this will significantly enhance the water-holding capability of the tank.
	10. All operational tanks are protected by Asset Protection zones (A-zones), with a 40 metre cleared area around each site to allow for safe access and egress for appliances and plant.
	11. All designated firewater tanks are fitted with SAFB or CFS compatible fittings. Sites containing more than one tank should be reticulated where possible to ensure a number of suitable points for appliances to refill.

Dam Locations and Reliability

In the absence of constant water, supply dams are the only potential source of available water for fire fighting purposes in Bookmark. It has been demonstrated that dams within semi-arid mallee ecosystems produce localised reductions in species diversity (Harrington, 2002). Therefore a direct conflict exists between fire management and biodiversity management requirements. To return the landscape to a state similar to that of pre-pastoralism, dams have been closed at both Calperum and Gluepot. Danggali is the only reserve that relies solely on dam water for firefighting. It contains 41 open dams, 18 of these are listed as being required for firefighting, domestic use or for wildlife observation.

Recommendations

Dams

12. The 18 listed dams on Danggali should be maintained at their current standard, with fencing erected to reduce grazing pressure, for fire management purposes. The remaining dams should only be closed if it is demonstrated that an alternate source of water is in reasonable proximity.
13. Dams should only be retained where they make a significant and essential contribution to water storage for firefighting, pending the installation of planned tank storages.
14. If water supplies are present in nearby dams then this supply should be used before tank supplies.

8 FIRE MANAGEMENT ZONES

8.1 Zoning Background

Fire management zones as detailed in the *Fire Policy and Procedure for Fire Management Zoning* (DEH, 2006b) have been introduced into DEH fire management planning to:

- ensure that appropriate management actions are implemented to meet the requirements for asset protection and ecological management in DEH reserves
- clarify the areas where different fire management activities will be undertaken on DEH managed land and reserves
- ensure a standard approach to the application of fire management zones on DEH managed lands and reserves in South Australia
- assist in the development of Fire Management Plans and programs for reserves.

Fire management zones are categorised according to the primary objective for fire management; Asset Zone (A-zone), Buffer Zone (B-zone) or Conservation Zone (C-zone). These zones were determined giving consideration to the level of risk and the protection and management of built assets, natural and cultural values (DEH, 2006b). The zones are displayed on Map 4 (Fire Management and Access).

8.2 Risk Assessment

A risk assessment was conducted in line with the *Policy and Procedures for Risk Assessment in DEH Fire Planning* (DEH, 2006c), as a requirement of the compilation of this Fire Management Plan. The risk assessment is a tool used to gauge the risks arising from bushfire to life, property and environmental values within the planning area. It considers visitor use, assets (built, heritage and environmental) and neighbouring properties for all parcels of remnant native vegetation. The Overall Risk rating was then used to determine Fire Management Zones.

The following sections briefly describe each of the zoning categories, and describe the objectives and strategies for each category.

8.3 Asset (A) Zone

A-zones contain built or significant cultural assets archaeological or heritage listed sites, homes, outbuildings, visitor centres, tanks and interpretive signs. These could possibly be areas where human-caused ignitions may occur but, to date, the statistics suggest this is unlikely. However, they are areas that need to provide safe zones for visitors during significant fire incidents. Current fire protection standards around assets within the planning area are acceptable given the risk fire poses, if these standards are adhered to annually then no further work will be required to improve asset safety. The overall fuel hazard in A-zones should not exceed *Moderate*.

Note: All built assets within the planning area are by default A-zones; fuel levels in these areas may be modified by any means deemed appropriate by reserve management in accordance with DEH policy or by private landholders in liaison with the Bushfire Prevention Committee or Conservation Programs staff.

8.3.1 Management Objectives for A-zones

- To protect visitors, firefighters and firefighting equipment from bushfires.
- To protect cultural heritage sites from the impacts of bushfire and bushfire suppression.
- To minimise bushfire damage to infrastructure.
- To lower the risk of human-caused ignitions.

8.3.2 Detailed Strategies in A-zones

A > Low Fuel Buffers

Provide an area of low fuel to a radius of at least 40 metres to act as a buffer during a bushfire and to provide suppression advantage should a fire start in the zone. Options for achieving this include mulching, slashing, rolling, manual removal of standing fuels, or small prescribed fires on the perimeter of the zone. Prioritising the order and means in which these zones are to be maintained is the responsibility of the Regional Fire Management Officer and the District Ranger, Riverland, based on the relative risk to the site in question, the resources available and the priority of protecting the site when compared to other landscape or habitat protection works prescribed in other zones.

Justification: As many of the areas are also assembly points during emergencies it is critical they offer protection from bushfire.

B > Managing and Educating Visitors

The management of ignition risks associated with visitor use and at reserve facilities and the education of visitors with respect to the aims of this plan is essential.

Visitors to the planning area during the fire danger season (approximately November to April) will continue to be provided with information detailing pre-suppression measures (including prescribed burning) and emergency procedures in the event of a bushfire.

Justification: Human-caused ignitions are attributed to a very small percentage of fires in the Bookmark Mallee. There is considerable benefit gained from presenting overarching philosophies and objectives of the plan to the public. Strategies such as fire access signage, explaining the presence of C-zone burning, B-zones, A-zones and monitoring sites will provide a strong message that land managers in the area are proactive regarding fire management as opposed to reactive.

Recommendation

Managing Visitors

15. Interpretive signage, describing evacuation procedures and the aims and strategies of the Bookmark Mallee Fire Management Plan, should be installed on DEH reserves and at relevant Visitor Centres and the DEH Regional and District Offices.

8.4 Buffer (B) Zone

These are areas where the protection of buildings, farms, horticultural or ecological assets is of critical importance. B-zones are strategically located to protect built assets or are located against major fire access routes with the aim of providing greater protection and suppression opportunities to firefighters by assisting in halting or breaking up a bushfire. Areas designated as B-zones will be retreated cyclically to manage fuel levels. The overall fuel hazard in B-zones should not exceed *High*.

8.4.1 Management Objectives in Buffer Zones

- To minimise the risk of property and ecological asset losses due to bushfire.
- To minimise the likelihood of fires entering blocks from adjacent areas.
- To define a level of prescribed fire that is both effective in halting the spread of bushfires and ecologically sustainable for the communities impacted on.
- To promote patchiness in fires, prescribed or otherwise.
- To provide greater protection and an increased suppression advantage for firefighters and greater protection for the public on major public roads traversing the planning area.

8.4.2 Detailed Strategies in Buffer Zones

A > Establish strategic areas of low fuel using prescribed fire.

Prescribed burning within these zones consists of linear strips. Strips 200 to 500 metres wide shall be implemented at strategic points across the landscape adjacent to fire access tracks.

In areas with conservation land situated either side of the fire access track; the alternate side will be burned to the same width once the fuel level reaches *High*. This will effectively produce a buffer of reduced fuel designed to aid in halting the spread of smaller, less intense fires, and slowing the progression of larger, more intense events. It will also assist suppression efforts by providing protection to firefighters along access tracks.

In areas where B-zones are situated adjacent to private land, the zone will be retreated again once the fuel hazard reaches *High*. In these areas, DEH will negotiate with the relevant landholder and District Bushfire Prevention Officer to ensure that adequate complimentary or reciprocal fire management work is carried out on the boundary of the adjacent property in question.

Alterations to the width or continuity of a designated B-zone are permitted under the following circumstances:

- Where there are operational restrictions and risks associated with implementing a prescribed burn in steep and/or sandy terrain.
- Where variations in fuel hazard levels across the pre-designated area of the zone exist.
- Where an identified, viable and significant population of a listed species of flora or fauna is located within the zone area.

Note: any decision to alter the extent or continuity of a prescribed burn in this instance needs to be negotiated between the Regional Fire Management Officer, the Riverland District Ranger and Conservation Programs Unit staff.

All B-zones should be implemented against a major fire access track. If a second, parallel scrub break is employed to secure the fire during the treatment of the zone, this break will be burnt, rehabilitated and closed once prescribed burning operations are completed to promote regeneration of vegetation.

B-zones are not to be re-treated at intervals any less than 20 years for any one site except in the following circumstances:

- When implementing backburning operations in the event of a bushfire. Designated buffer zones should be retreated first in the event of a bushfire, thereby limiting the impacts to an area already altered by management
- During Speargrass (*Austrostipa scabra*) seasons. The hazard created by Speargrass in swale areas is best managed by reducing fuel on the adjacent dunes. Any pre-suppression or back-burning should target existing B-zones. In doing so, impacts are largely restricted to these areas, thereby making operations more manageable and increasing the chance of success in the event of a large fire.

Justification: Areas of modified or reduced fuel strategically located across the planning area will provide a safer operating environment for firefighters, greater protection for assets within and adjacent to the planning area, increase the patchiness of bushfires and restrict their extent, thereby minimising the impacts upon ecological communities.

8.5 Conservation (C) Zone

C-zones are defined as those areas where the primary objective of fire management is the conservation of ecological communities and species, or biodiversity. Given the minimal built assets in the Bookmark Mallee, the vast majority of the planning area is a designated C- zone.

Note: This does not imply that other zones do not include areas of conservation significance or that conservation objectives will be disregarded in other zones; these objectives also apply to A- and B-zones within the planning area.

8.5.1 Management Objectives for C-zones

- To manage fires and fire regimes to meet the ecological fire requirements of species and communities that may be at risk from inappropriate fire regimes.
- To minimise the risk of any large block (> 10 000 ha), or multiple blocks burning in a single high intensity bushfire event.
- To provide refuge areas for fauna species during a large bushfire, either within large blocks or in adjacent blocks.
- To promote patchiness in fires, prescribed or otherwise.
- To minimise the negative impacts of fire management and suppression activities on conservation values and provide a suppression advantage for bushfire operations wherever possible.

8.5.2 Detailed Strategies in C-zones

Five key fire management strategies exist in C-zones:

A > Prescribed fire

It is recommended that the area burned by prescribed fires is restricted to less than 10% of any large block within a five-year period. A large block is defined as a block greater than 10 000 ha. This will limit the impact of fire upon optimal habitat. Ideally, bushfires should also be managed to restrict the burnt area to within a single block or less than 10 000 ha.

B > Landscape protection burning

Landscape protection burns provide an area of low fuel to act as a buffer during a bushfire by removing understorey fuels with prescribed fires, whilst leaving the majority of the canopy intact. Late autumn and winter provide the optimal conditions for such burns by minimising the risk of fire escape and its impacts upon breeding fauna. The primary objective is landscape protection on a temporary basis, implemented in a way similar to that of B-zones.

C > Bushfire exclusion from regenerating areas

Consecutive bushfires in any conservation zone in Bookmark should be a *minimum of 40 years apart*, or a period that can be demonstrated to be sustainable for vegetation community recovery. This will be achieved by implementing management strategies to assist in excluding bushfire, or promoting patchiness in the event of one occurring. Information suggests that many mallee fauna species of concern will not inhabit areas with any regularity until at least 40 years post-fire and there is currently no evidence to suggest that its long-term exclusion is detrimental to any species of flora or fauna.

D > Further research and monitoring of mallee fire regimes and management strategies.

This is vital in improving fire management strategies and ensuring that they are based upon current knowledge and remain adaptive. Research needs to be aimed at addressing specific questions relevant to reserve management and improved ecological fire management. Refer to Section 14 for recommendations related to research and monitoring.

E > Create fire patchiness

Patchiness assists recolonisation, increases post-fire diversity and creates a patch mosaic of fire age classes. Bushfires burning very large areas over many habitat types leave few unburned patches of vegetation, thus increasing the possibility of local flora and fauna extinctions. Fire management strategies should promote patchiness as much as possible through the:

- preservation of unburnt patches inside the fire perimeter during fire suppression, and;
- judicious use of backburning as a suppression strategy, using natural fuel breaks and existing fire scars.

Backburning very long lines well in front of the fire edge can result in a wide fire front with poor mosaics and patchiness. Thoughtful planning of any backburning operation should ensure that the area to be backburnt is kept to a minimum, and that existing fire scars and fuel patterns are fully utilised.

9 ACTIONS AND WORKS

9.1 Fire Management Blocks

Fire management objectives apply to Bookmark on three scales. These are (in order of size):

- the entire Bookmark Mallee area
- reserves within the Bookmark Mallee
- fire management blocks.

Whilst many fire management objectives apply to the broader areas of reserves and zones, the use of fire management blocks enables the application of objectives and strategies at a finer scale when required. Bookmark is divided into 35 such blocks, each separated primarily by physical boundaries such as roads and fence lines.

Each block has its own individual attributes, including vegetation species and communities, threatened fauna and infrastructure. Most blocks in the Bookmark Mallee contain both important vegetation communities and rated fauna species, along with infrastructure of various types. This detail is shown on Map 4.

9.2 Prescriptions

This Plan presents prescriptive measures at the reserve scale in order to provide succinct recommendations to the individual landholders. Other details, including size, vegetation types, natural assets, built assets and proposed works, incorporating zoning and infrastructure improvements, are also included. Map 4 gives a perspective of the zoning prescriptions in relation to each other and to the greater region.

10 CALPERUM AND TAYLORVILLE

10.1 Tenure, Size, Land Use

Managed by Australian Landscape Trust, Calperum and Taylorville make up 325 875 ha. The properties contain 14 fire management blocks. Table 5 shows fire management block details, including the built assets, land use and natural values. Refer to Map 4 for block locations.

TABLE 5: FIRE MANAGEMENT BLOCKS WITHIN CALPERUM AND TAYLORVILLE

	Block Name	Size (ha)	Important Vegetation Community	Rated Fauna Species	Built Assets	Homes & Accommodation	Rated Flora Species	Grazing/Pastoral
Calperum	80x80	21 227	✓	✓	✓	✓		
	Bald Hill	31 767	✓	✓	✓			
	Burnt Camp	24 603	✓	✓	✓			
	Frogamerry	25 855	✓	✓				
	Hideaway	27 830	✓	✓	✓			
	Oak Bore	18 555	✓	✓	✓	✓		
	Overflow	25 136	✓	✓	✓			
	Ral Ral	13 395	✓	✓	✓			
	South Yubalia	28 382	✓	✓	✓			
	Timor	19 342	✓	✓	✓	✓		
Taylorville	Neckrope	15 680	✓	✓				
	Phillips	33 340	✓	✓				
	Scaddon	22 453	✓	✓	✓	✓		
	Wilks	18 310	✓	✓				

10.2 Natural Values

All of the bird species in Table 3 have been recorded in Calperum and Taylorville. Black-eared Miner colonies and habitat have been identified in all fire management blocks. This in itself appears to indicate suitable habitat for many of the other bird species. The Lax Bluebush (*Maireana suaedifolia*) is Rare in SA, and has been recorded in Timor and Frogamerry Blocks. Similarly, the Mallee Bitter Pea (*Daviesia benthamii* subsp. *humilis*) is also rare in SA and has been recorded in South Yubalia and Phillips Blocks.

The existing biological dataset for Bookmark represents sampling from one point in time in most cases, rather than any extended monitoring. Many of the blocks within this Plan contain only one or two survey sites, and consequently, the lack of recorded presence for any species does not indicate their absence from that site. Any inference one draws about flora and fauna species presence in blocks using this data should not be considered definitive.

10.3 Vegetation

Bookmark Mallee consists broadly of *Eucalyptus* Mallee forest and Mallee woodland (SA Vegetation ID); however the Mallee species and understoreys comprising this classification vary greatly over the reserve. The dominant Mallee species are Beaked Red Mallee (*Eucalyptus socialis*), White Mallee (*E. dumosa*), Yorrell (*E. gracilis*), Red Mallee (*E. oleosa*) and Blue Mallee (*E. cyanophylla*), with an understorey comprising of shrubs (predominantly chenopods), tussock grasses (e.g. *Enneapogon* sp.) and hummock grasses (*Triodia* sp.). Refer to Map 2 for more detail on the distribution of these vegetation types. Small patches of *Enneapogon* tussock grasslands are scattered throughout the reserve, with some small central patches of Boxthorn (*Lycium* sp.) shrubland and Hopbush (*Dodoneaea* sp.) shrubland in the northeast.

10.4 Built Assets

Built assets mainly comprise operational tanks, bores, sheds and outstations. The locations of these can be seen in Map 1. Refer to Table 6 for further details.

TABLE 6: BUILT ASSETS WITHIN CALPERUM AND TAYLORVILLE

		Built Assets
Calperum	80x80	Yabbie Tank, 80x80 Tank, North Oak Bore, Twin Dams, accommodation block
	Bald Hill	Tilmy Outstation Ruin & Crutching Shed
	Burnt Camp	30 000 Tank, Burnt Camp Pumphouse, South Oak Bore Tank, Oak Bore Tank
	Frogamerry	Flash Jack Dam Tank
	Hideaway	Hideaway Hut, End Tank, Middle Tank
	Oak Bore	Oak Bore Shearing Shed & Research Station
	Overflow	End Tank, Middle Tanks, Stony Pinch Tank
	Ral Ral	Rotten Lake Tank
	South Yubalia	Harry's Trap Tank, Yubalia Hut & ruins, visitor signs, Canegrass Tank
	Timor	Long Dam Pumphouse & Tank, Old Timor Outstation & Ruin, Crutching Shed & Tank, Emu Tank
Taylorville	Neckrope	None
	Phillips	None
	Scaddon	Casuarina Research Station & Casuarina Tank
	Wilks	None

10.5 Fire History

The extensive fires of November to December 2006 throughout Taylorville and south-western Calperum dominate this area's fire history. A patchy and more diverse fire history also exists in the southeastern portion of Calperum, with mapped small fires from the 1970's to the 1990's. Other small fire scars are scattered throughout the reserve (Refer to Map 3).

It is known that large fire events occurred over much of the region during 1917 and the 1950's, however maps were not produced and the exact extent of the fire is unknown.

10.6 Fire Risk

Fire risk is *High* in all of Calperum's fire management blocks except for Ral Ral and Bald Hill blocks in the east, which were assessed as *Moderate*. The large fires of 2006 have ensured that most of Taylorville will not pose a fire risk in the near future, although the unburned vegetation in the northern part of Phillips Block still holds a *High* fire risk rating.

The greatest ignition risk comes from dry lightning during the summer months. Restricted public access at Calperum ensures that the risk of human-caused ignitions is minimal. As most of the adjacent property to the north and west is grazed and/or recently burned, the risk of fire moving in from adjacent property is also low. There is a slight risk of smoke taint occurring in grapes grown in areas adjacent to the Bookmark Mallee in the growing season of October to May, particularly in the Cooltong district adjacent to Overflow Block.

During years of prolific Speargrass germination, the fire risk is elevated over all affected areas, whether they are recently burned or not.

10.7 Management Objectives for Calperum and Taylorville

- To protect life and property on both reserves.
- To restrict the extent of non-prescribed fire in order to protect and maintain as much 40 plus year-old mallee habitat as possible for the conservation of threatened species; particularly the Black-eared Miner and Malleefowl.
- To contain bushfires within single fire management blocks wherever possible, and to prevent fire spreading beyond the reserve, on to adjacent Heritage Agreements, farmland, horticultural and residential blocks, the Renmark aerodrome and the northern outskirts of Renmark.
- To minimise the impacts of both bushfire suppression and pre-suppression works on the Bookmark landscape through better incident management, planning and targeted post-fire rehabilitation.
- To monitor the effects of fire (both planned and unplanned) on the Reserves' ecosystems with respect to amplified grazing pressure in buffers and potential displacement of Black-eared Miner colonies.
- To facilitate a better understanding of the role of fire (both planned and unplanned) and its impacts in the Reserves' ecosystems, and the efficacy of prescription burning in mitigating the threat that bushfire presents through targeted research and monitoring programs.

10.8 Recommended Actions and Works

10.8.1 B-zone Burning

Eight B-zones are to be implemented within Calperum and Taylorville and on their boundaries. These are listed in order of priority in Table 7. The priority ratings are intended to provide some guidance in the order of implementation, however they do not dictate that all actions will be implemented in the next five years or in that order. Nor should they be seen as

a performance measurement guideline. Works are dependent on a number of variables including funding, future bushfires, climate and suitable conditions for prescribed burning. Priorities are likely to change with the influence of these variables, and will be subject to periodic review.

It should be ensured that no more than 2% of any block should become a B-zone.

TABLE 7: PROPOSED B-ZONE IMPLEMENTATION ON CALPERUM AND TAYLORVILLE

	Property	Block Names	Priority	B-zone Maximum Sizes		
				Distance (km)	Area (ha)	
Boundary or Track	Birdseye-Hideaway Boundary	Gluepot/ Calperum	Hideaway	1	11.6	232
	Shotline Track	Calperum	Hideaway South Yubalia	2	28	560
	Phillips – Middle Gluepot Boundary	Gluepot/ Taylorville	Phillips Middle Gluepot	3	18	360
	Phillips Track	Taylorville	Phillips	4	18.3	366
	Overflow / Cooltong – Renmark Boundary	Calperum/ Cooltong (DEH)	Overflow	5	9.5	190
	Overflow / Cooltong – Monash Boundary	Calperum/ Cooltong (DEH)	Overflow	6	10.9	218
	Pipeline Track	Calperum	Ral Ral Timor Burnt Camp Oak Bore 80x80	7	17.8	355
	80 x 80 Canopus Road	Calperum	80x80	8	13.5	270

10.8.2 Track Maintenance

Track maintenance programs on Calperum and Taylorville should be focussed on the Reserves' major access tracks. These are the **Pipeline Track**, **Shotline Track**, **Oil Road** and **Centre Track**. Maintenance should be conducted on these tracks to a standard that can support heavy vehicles such as 34's and tankers. It is also a priority to maintain an access road north and south from Casuarina Dam, including the existing Middle Taylorville/ Scaddon fence line to the southern boundary of Gluepot Reserve and the northern boundary of Neckrope and Wilks blocks. This will allow the delivery of fire water and improved access to the core Black-eared Miner habitat in western Calperum and eastern Gluepot. A summary of tracks recommended for maintenance is provided in Table 8.

TABLE 8: TRACK RECOMMENDATIONS FOR CALPERUM AND TAYLORVILLE

		Track Name	Track Maintenance	Landscape Protection Burning
Fire Management Blocks	Numerous Blocks	Pipeline Track Shotline Track Centre Track Oil Road	✓	✓
	Overflow	Middle-End Tank Track	✓	✓
	Ral Ral	Fiscom Dam-Old Timor Dam Track	✓	✓
	Bald Hill	Amalia Track	✓	✓
		Monoman Tank Track	✓	✓
	Timor	Emu-Frogamerry Tank Track	✓	✓
	Frogamerry	Timor Boundary Track		✓
	80x80	80x80 Tank Track		✓
		Canopus Track	✓	✓
	Oak Bore	Murphy's Branchline Tank Track	✓	✓
		Nanyah Dam Track	✓	✓
	Burnt Camp	Hideaway Tank Track	✓	
	Scaddon	Scaddon-Frogamerry Track	✓	
	Neckrope/Wilks	Northern Neckrope/Wilks Track	✓	

Additional maintenance should be conducted on access roads to firefighting infrastructure, such as access tracks to Casuarina Dam. Landscape protection burning adjacent to tracks should occur to prevent the spread of large fires. Recommended tracks for these activities are shown in Table 8.

Track maintenance should also include the widening of track junctions to an internal radius of 8.5 m to create vehicle turning points. Overtaking bays should be created on perimeter tracks in swale areas (width of 7.5 m and length 17 m) as close as possible to intervals of 500 m as described in the GAFLC guidelines (GAFLC, 2008).

10.8.3 Tanks

A large number of operational tanks already exist on Calperum, however western Taylorville is in need of strategically placed waterpoints for firefighting. Due to the decommissioning of The Pipeline, not all tanks can be guaranteed as reliable fire water sources. Table 9 prioritises tank maintenance and installation. These priorities are intended only as a guide, and should be reviewed periodically depending on changing conditions.

TABLE 9: STATUS OF AND RECOMMENDATIONS FOR TANKS ON CALPERUM AND TAYLORVILLE

	Block Name	Tank Name	Priority	Upgrade	Collecting Roof	Install	Reliable waterpoint
Calperum	Burnt Camp	Burnt Camp Pumphouse A	2		✓		
		Burnt Camp Pumphouse B	2				
	Frogamerry	Flash Jack	3		✓		
	Hideaway	End Tank Hideaway	1		✓		
	Oak Bore	Murphy's Branchline	2				
		Oak Bore tank network	1				Yes
	Overflow	End Tank Overflow	2				Yes
		Middle Tank Overflow					Yes
		Stony Pinch					Yes
		Overflow	3				Yes
	Ral Ral	Rotten Lake	3				Yes
	South Yubalia	Harry's Trap	1		✓		
	Timor	Long Dam A	3			Covered	
Long Dam B					Covered		
Emu Tank		2			✓		
Taylorville	Phillips/Neckrope	Schmidt Dam	2			✓	
	Scaddon	Casuarina Dam	1		Enclosed		Yes

It is recommended that Middle Tank Overflow, Oak Bore, Rotten Lake and Stony Pinch tanks be regularly maintained. The remaining tanks, some of which have water-collecting roofs, will not be guaranteed as fire water sources; however reports on their status should be forwarded to the Mid-Murray CFS Group Officer approximately monthly during the fire season.

Taylorville requires approximately 10 000 gallons of fire water storage at Casuarina Dam in Scaddon and two at Schmidt Dam in Phillips Block. These dams are strategically placed for fire access. The new tanks should be filled from the adjacent dams when they are holding water. Reports on dam levels should be forwarded to the Mid-Murray CFS Group Officer at regular intervals during the fire season.

10.8.4 Signs

It is recommended that interpretive signs describing evacuation procedures, refuges and the aims and strategies of the Bookmark Fire Management Plan be installed in key visitor areas within Calperum and Taylorville.

Track signs in line with GAFLC sign standards (GAFLC, 2008) should be installed on priority tracks and intersections within Calperum and Taylorville to provide information on the tracks' names, standard and locations for fire suppression purposes. This should be done in conjunction with other land managers in the area to ensure consistency over the Bookmark Mallee.

10.9 Suppression

Quick response with small units (14's) to any incident is essential to restrict the size of fires in Calperum and Taylorville. The use of dry fire fighting techniques, including heavy machinery, is recommended given the paucity of water and the logistical difficulties associated with maintaining supply. Guidelines for heavy machinery use, aerial suppression and back-burning are discussed in Section 7.

It is recommended that a joint Response Plan be developed between ALT, Gluepot and CFS to give direction and co-ordination to all response activities within the Bookmark Mallee.

11 GLUEPOT

11.1 Tenure, Size, Land Use

Managed by Birds Australia, Gluepot Reserve covers an area of 54 508 ha. The property consists of three fire management blocks; Old Gluepot in the west, Middle Gluepot in the centre and Birdseye Block at the eastern end. Table 10 shows fire management block details, including the built assets, land use and natural values.

TABLE 10: FIRE MANAGEMENT BLOCKS WITHIN GLUEPOT RESERVE

	Block Name	Size (ha)	Important Vegetation Community	Rated Fauna Species	Built Assets	Homes & Accommodation	Rated Flora Species	Grazing/Pastoral
Gluepot Reserve	Birdseye	20 693	✓	✓				
	Middle Gluepot	23 007	✓	✓	✓	✓		
	Old Gluepot	10 808	✓	✓				

11.2 Natural Values

There are 18 nationally listed threatened bird species on Gluepot Reserve (Table 3 from Baker-Gabb, 2004), all of which are found within all three blocks. The reserve supports a large number of Black-eared Miner colonies and a population of Malleefowl. Other rated mallee bird species commonly found breeding on Gluepot Reserve include the Red-lored Whistler (*Pachycephala rufogularis*) the Striated Grasswren (*Amytornis striatus striatus*) and Major Mitchell's Cockatoo (*Lophochroa leadbeateri*). The Regent Parrot (*Polytelis anthopeplus monarchoides*) and the Scarlet-chested Parrot (*Neophema splendida*) also frequent Gluepot Reserve's waterpoints.

11.3 Vegetation

The dominant broad vegetation type at Gluepot Reserve is *Eucalyptus* Mallee Forest and Mallee Woodland; however the species composition varies considerably within this classification across the reserve. Old and Middle Gluepot Blocks are dominated by Yorrell (*Eucalyptus gracilis*), Red Mallee (*E. oleosa*), Beaked Red Mallee (*E. socialis*) and White Mallee (*E. dumosa*) over various shrubs, including *Senna* species, *Zygophyllum* species and Ruby Saltbush (*Enchylaena tomentosa tomentosa*). Birdseye Block is dominated by Beaked Red Mallee and Red Mallee, Sugarwood (*Myoporum platycarpum*) and White Mallee over hummock grasslands (*Triodia* sp.) and sparse shrubland. One small patch of *Enneapogon* tussock grassland exists in Old Gluepot Block and Birdseye Block has small patches of Boxthorn (*Lycium* sp.) shrubland in its southeast. Refer to Map 2 for further detail.

Additional floristic mapping of the reserve has been conducted and it should be noted that it was at a finer scale than what has been presented here (Hyde, 2001). This detailed dataset will prove a useful resource if used to reduce the impact of fire management works on the reserve by incorporating areas of low fuel with works implementation.

11.4 Built Assets

The majority of built assets on the reserve are in Middle Gluepot Block. These include the visitors' centre, homestead, visitors' quarters, implement and equipment shed, campground toilet blocks and bird hides.

11.5 Fire History

The known fire history is restricted to three patch ages. There was a small fire in the north of Middle Gluepot Block in 1980, whilst approximately half of Birdseye Block was patchily burned in the November to December 2006 fires. The remaining area can be classed as habitat older than forty years. The large fires of 1917 and the 1950's throughout the area have not been mapped, and their extent within Gluepot Reserve is not known. Refer to Map 3.

11.6 Fire Risk

Middle Gluepot and Old Gluepot Blocks are open to public access, and are therefore at risk of human-caused ignitions. Birdseye Block is only at risk of ignition from lightning strike due to its restricted access.

There is little risk of fire moving in to Gluepot Reserve from the west, northwest or southwest via Old Gluepot Block due to the presence of Black Oak (*Casuarina pauper*) woodland and grazing in adjacent land. There is, however, a good chance of fire moving eastward between Gluepot Reserve's blocks. The east-west running Mallee/*Triodia* dunes that cover much of the reserve provide relatively continuous fuel, which is occasionally broken by patches of Black Oak and dune swales. These swales could provide continuous fuel in seasons of prolific Speargrass growth. The fire danger risk in all three of Gluepot Reserve's blocks is rated as *High*.

11.7 Management Objectives for Gluepot

- To restrict the extent of non-prescribed fire within the reserve in order to protect and maintain as much 40 year plus mallee habitat as possible for the conservation of Black-eared Miner, Malleefowl and other threatened species.
- To restrict the southerly and easterly movement of fire into other Gluepot Reserve blocks and in to Taylorville or Calperum.
- To minimise the impact that fire management actions have upon the communities present in either wildfires or prescribed burns, and to rehabilitate these impacted areas as quickly as possible post incident.
- To monitor the effects of prescribed burning on the ecological assets within the Reserve with respect to amplified grazing pressure in buffers, potential displacement of threatened species (particularly Black-eared Miner colonies) and weed invasion through fire scars.
- To protect Middle Gluepot Block's assets and infrastructure from fire.

11.8 Recommended Actions and Works

11.8.1 B-Zone Burning

The northern half of Birdseye Block and the surrounding habitat requires fire protection due to a large part of the southern half being burned in November 2006. It is also desirable to prevent fires moving in to or out of Middle Gluepot Block. This protection is to be provided with the implementation of B-zones on the some of the blocks' boundaries and existing tracks:

- A 200 m wide B-zone will extend along Birdseye Block's northern boundary and down the east Birdseye Block boundary. This B-zone is of the highest priority as it will hinder fires entering/exiting the Birdseye Block.
- A 200 m B-zone should be implemented along the Oil Road. Initially this will meet the edge of the 2006 fire scar, but may need to be extended in future years.
- A 200 m wide B-zone is to be implemented along the Middle Gluepot Block/Birdseye Block boundary. Initially this will only be north of the Oil Road due to the presence of the 2006 fire scar, but may need to be extended southward in future years when fuel loads recover.
- A B-zone of 100 m wide should be implemented south of the Oil Road/Hideaway Block (Calperum) boundary.
- B-zones are to be implemented on the southern boundary of Middle Gluepot Block, bordering with Phillips Block (Taylorville).
- A B-zone should be implemented on the Old Gluepot Block/Middle Gluepot Block boundary.

Whilst the highest priority B-zone proposals are currently within Gluepot Reserve, re-treatment will be required after ten years. Close consultation is recommended between Gluepot and ALT with the aim of re-treating on the adjacent reserves in ten or more years' time. In light of this, sharing of resources and personnel between organisations and across boundaries is also recommended in order to create more efficient and safe operations.

It should be ensured that no more than 2% of any block should become a B-zone.

11.8.2 Track Maintenance

All tracks within the reserve should be maintained at a width of four metres at both ground and canopy level to provide access for appliances when responding to an incident.

Track junctions should be widened to an internal radius of 8.5 metres to create vehicle turning points. Overtaking bays should be implemented on perimeter tracks in swale areas (width of 7.5 metres and length of 17 metres) at appropriate and practical intervals.

11.8.3 Landscape Protection Burns

Landscape Protection Burns may be implemented within Gluepot Reserve, particularly within Birdseye Block to slow fire spread and increase fire patchiness. No recommendations are made here with regard to the timing and placement of landscape protection burns except that they should be planned and approved by the Native Vegetation Council on an individual basis if deemed appropriate. The B-zones proposed above are seen as providing

priority protection on a landscape scale, however further landscape protection burns may be deemed strategic and implemented in the future following approval by the relevant stakeholders.

11.8.4 Tanks

Gluepot maintains six water tank systems for firefighting. The Old Gluepot Block has Old Gluepot Tank (a total of four 5 000 gallon poly tanks with a large rain catching roof) and Emu Tanks (a 20 000 gallon cement with a large rain catching roof). Middle Gluepot Block has Froggy Tank (a 20 000 cement with rain catching roof and a tank liner) and Whistler Tank (a 20 000 gallon cement tank capped but filled from Quins Dam by a permanent pump system). Birdseye Block has two 5 000 gallon poly tanks at the old Oil Road Dam sit (these do not have a rain catching roof) and Grasswren Tank (a 20 000 gallon cement with a rain catching roof). In addition, there are a large number of tanks at Gluepot Homestead in Middle Gluepot Block, holding a total of 76 000 gallons. These tanks are detailed in Table 11. All tanks are equipped with CFS fittings.

TABLE 11: TANKS ON GLUEPOT RESERVE

	Block Name	Tank Name	Total Capacity (Gallons)	Number of Tanks	Collecting Roof	Reliable Waterpoint
Gluepot Reserve	Old Gluepot	Old Gluepot	20 000	4	✓	Yes
		Emu Tanks	20 000	1	✓	Yes
	Middle Gluepot	Froggy Tank	20 000	1	✓	Yes
		Whistler Tank	20 000	1	✓	Yes
		Gluepot Homestead	76 000	Numerous	✓	Yes
	Birdseye	Oil Road Dam	10 000	2		Yes
		Grasswren Tank	20 000	1	✓	Yes

One additional tank should be installed at the Oil Road/Hideaway Block boundary intersection. None of these tanks should be allowed to drop below 50% of their capacity at any stage of a fire season or prior to a planned burn.

11.8.5 Signs

It is recommended that interpretive signs describing evacuation procedures, refuges and the aims and strategies of the Bookmark Fire Management Plan be installed in key visitor areas within Gluepot Reserve.

Track signs in line with GAFLC sign standards (GAFLC, 2008) should be installed on all tracks and intersections within Gluepot Reserve to provide information on the tracks' names, standard and locations for fire suppression purposes. This should be done in conjunction with other land managers in the area to ensure consistency over the Bookmark Mallee.

11.9 Suppression

Quick response with small units (14s/QRVs) to any incident is essential to restrict the size of fires in Gluepot. The use of dry firefighting techniques, including the use of heavy machinery is recommended given the paucity of water and the logistical difficulties associated with maintaining supply. Guidelines for heavy machinery use, aerial suppression and backburning are discussed in Section 7.

12 DEH RESERVES

12.1 Tenure, Size, Land Use

DEH managed land consists of five reserves – Danggali Wilderness Protection Area and Conservation Park, Chowilla Regional Reserve (jointly managed with Robertson Chowilla Pty Ltd), Cooltong Conservation Park and Pooginook Conservation Park. Pooginook and Cooltong Conservation Parks are relatively small reserves and constitute only a single fire management block, both of which abut the southern borders of Taylorville and Calperum. Chowilla RR and Danggali are relatively large at 252 065 ha and 75 267 ha respectively. Refer to Map 4 for spatial detail.

Chowilla RR is the only reserve in Bookmark Mallee that is subject to grazing. Table 12 shows fire management block details, including the built assets, land use and natural values.

TABLE 12: FIRE MANAGEMENT BLOCKS WITHIN DEH RESERVES

	Block Name	Size (ha)	Important Vegetation Community	Rated Fauna Species	Built Assets	Homes & Accommodation	Rated Flora Species	Grazing/ Pastureland	Proposed WPA
Danggali	Birthday	27 447	✓	✓	✓				✓
	Boundary	19 838	✓	✓					✓
	Canopus	30 562	✓	✓	✓	✓			✓
	Hypurna	4 606	✓		✓				Part
	Morgan Vale	28 427	✓	✓	✓				Part
	Olympic	16 779	✓	✓	✓	✓			Part
	Postmark	24 612	✓	✓			✓		✓
	Tipperary	46 654	✓	✓	✓				✓
	Toby's	24 514	✓	✓					Part
	Renmark	6 581	✓	✓					Part
	Nanya	6 998	✓	✓	✓				Part
	Gallagher	15 047	✓	✓					Part
Chowilla RR	Bore Hole	27 286	✓	✓	✓			✓	
	Coombool	16 442	✓	✓	✓			✓	
	Paradise	21 205	✓	✓	✓			✓	
	T Block	10 334	✓	✓	✓			✓	
Other	Pooginook	2 859	✓	✓			✓		
	Cooltong	3 716	✓	✓					

12.2 Natural Values

12.2.1 Danggali

Species records on Danggali vary from block to block, but this is probably attributable to a lack of data and survey effort for the most part. Old mallee communities suitable as habitat for many of the threatened species listed in Table 3 and Table 4 exist in most blocks. Canopus Block has been demonstrated to hold 11 rare or endangered species, including two reptiles, the Bardick (*Echiopsis curta*) and the Olive Snake-lizard (*Delma inornata*). Black-eared Miners have been observed in Renmark and Boundary Blocks. The Little Pied Bat and Greater Long-eared Bat have been recorded in most blocks, and all other blocks except Hypurna hold suitable habitat for the two species. Similarly, suitable Malleefowl habitat exists in most blocks.

12.2.2 Chowilla RR

Black-eared Miners have been recorded in Bore Hole and T-Block, whilst Major Mitchell's Cockatoo has been recorded in Coombool, Paradise and Bore Hole Blocks. Chestnut Quail Thrush have been recorded in Paradise, and T-Block incorporates suitable habitat for Malleefowl, Chestnut Quail Thrush, Major Mitchell's Cockatoo and the Redthroat.

12.2.3 Cooltong CP

Cooltong was initially designated as a Conservation Park due to the area's significant population of Malleefowl. There are two recorded sightings of Black-eared Miner colonies within the reserve, although these are now dated. It is likely that the birds frequent the northern section of the reserve adjacent to Stony Pinch (Calperum Station) where the species is found regularly. The relatively pristine mallee associations in the northern section of the park are also valuable habitat for other mallee species such as Yvonne's Ningau (Ningau yvonneae), Striated Grasswren, Red-lored Whistler and the Regent Parrot.

12.2.4 Pooginook CP

Pooginook CP is home to a number of threatened species. Historically, Black-eared Miner colonies have been recorded on the reserve's eastern boundary. Similarly, the block supports a population of Malleefowl in both dunes and interdunal swales. Other rated mallee bird species found in Pooginook CP include the Red-lored Whistler, Striated Grasswren, Major Mitchell's Cockatoo and the Regent Parrot. Southern Hairy-nosed Wombats (*Lasiorhinus latifrons*) are also found at several sites in the southern section of the reserve. This population, introduced to the reserve, is an important satellite population for the species' distribution within the SA Murray-mallee.

12.3 Vegetation

Refer to Map 2 to for spatial detail and to Table 1 for vegetation type descriptions.

12.3.1 Danggali

Danggali's dominant vegetation structure is *Eucalyptus* Mallee Forest and Mallee Woodland, however the south-eastern corner of the reserve is dominated by an extensive band of *Casuarina* Forest and Woodland. The species structure of the mallee is consists mainly of Beaked Red Mallee, Red Mallee, Sugarwood and White Mallee mid mallee woodland with a *Triodia* understorey in the Reserve's north. The mallee in the south mainly comprises Yorrell,

Red Mallee, Beaked Red Mallee and White Mallee mid mallee woodland, as recorded in the South Olary Plains Vegetation Mapping.

12.3.2 Chowilla RR

Vegetation within Chowilla RR is highly varied and patchy. The majority of the *Eucalyptus* Mallee Forest and Mallee Woodland comprises Yorrell, Red Mallee, Beaked Red Mallee and White Mallee mid mallee woodland. Extensive stands of *Casuarina* woodland cover the north-eastern corner of the reserve, and there are also patches of Hopbush (*Dodonaea sp.*) shrubland, Bluebush (*Maireana sp.*) shrubland and *Enneapogon* tussock grassland.

12.3.3 Cooltong CP

Cooltong CP contains three determinant species associations of *Eucalyptus* mallee forest and mallee woodland. These are Beaked Red Mallee mallee woodland in the north, Yorrell mallee woodland in the south, and a small patch of White Mallee mallee woodland. The southern end contains small patches of Common Bottle-washers (*Enneapogon avenaceus*) grassland.

12.3.4 Pooginook CP

Pooginook's entire area is vegetated with *Eucalyptus* mallee forest and mallee woodland. The majority is Yorrell mallee woodland, with patches of Beaked Red Mallee woodland and White Mallee woodland.

12.4 Built Assets

The built assets on Danggali are associated with its history of pastoralism. Infrastructure on Chowilla RR is still actively used for the same purpose. Table 13 summarises the built assets.

It should be noted that Pooginook CP has a high voltage transmission line at its northern boundary. ETSA utilities should be informed in the event of a bushfire and consulted prior to any prescribed burning activities.

TABLE 13: BUILT ASSETS ON DEH RESERVES

	Block	Built Assets
Danggali	Renmark	
	Hypurna	Hypurna Homestead and outbuildings
	Nanya's	Nanya's Wurlie & campsite
	Olympic	
	Boundary	
	Gallagher	Oak Bore Shearing Shed & Research Station, Murphy's Branchline Track
	Morgan Vale	Morgan Vale Homestead ruins
	Canopus	Canopus Homestead, outbuildings & airstrip
	Toby's	
	Birthday	Birthday Hut
	Tipperary	Tipperary Hut
	Postmark	
Chowilla RR	Coombool	Paradise Outstation
	Paradise	Paradise Outstation, Woolshed
	Bore Hole	Springbank holding paddocks, Peppertree Outstation Motel, #3 Pumpshed, wool shed
	T-Block	
Other	Cooltong	
	Pooginook	High voltage transmission line

12.5 Fire History

12.5.1 Danggali

Danggali's recorded fire history is most diverse in the northern section of the reserve, where east-west running sand dunes support highly flammable *Triodia* communities. The most recent fire was in November 2006, creating a scar of 1 223 ha in Tipperary Block. Whilst there has also been a series of small fires in the 1990's and 2000's, the largest recorded fires in the reserve were in 1985. These burned large portions of Morgan Vale, Tipperary, Postmark, Canopus and Toby's Blocks, and were fuelled by mass Speargrass germination after successive years of high rainfall. Fuel levels and community structure in Danggali provide evidence that the reserve was affected by the large fires of 1917 and the 1950's.

12.5.2 Chowilla RR

No fires have been mapped on Chowilla RR except for a small fire in Coombool Block from 1990. Anecdotal evidence suggests that the large fires of the 1950's affected the reserve. These were fuelled by mass Speargrass germination. Chowilla's lack of historic fire can be

attributed to the reduction of fuel levels by grazing, which is still present, and the naturally variable and patchy vegetation assemblages.

12.5.3 Cooltong CP

There are three recorded fires in Cooltong CP; two bushfires and one prescribed burn that was implemented in July 2004 to buffer the top of the reserve. The older of these two scars resulted from a series of large fires that covered the Bookmark area in 1972 as the result of increased fuels associated with a Speargrass event. The most recent bushfire, situated on the eastern boundary of the reserve, occurred as the result of a lightning strike in December of 1996 and burnt 80 ha.

12.5.4 Pooginook CP

The northern end of Pooginook CP burned in the Bookmark fires of November 2006. Prior to these, there is one recorded fire in 1972 associated with a series of large fires in Taylorville and surrounding properties. Anecdotal evidence of large fires in the early 1950's appears to be supported by community structure and fuel levels in certain areas, although this is difficult to quantify. Fire risk in the park increases substantially with mass germination of Speargrass (as witnessed in 1972) associated with successive years of above average rainfall.

12.6 Fire Risk

12.6.1 Danggali

Areas with east-west running sand dunes supporting mature *Triodia* communities pose the highest fire risk on Danggali. This association is present in all blocks except for Renmark, Hypurna and Nanya Blocks, all of which are relatively small and situated in the south of the reserve. These blocks are protected from the north by a band of Black Oak that runs through the south of Canopus and Toby's Blocks. On the whole, fire risk can be considered as high due to the broad extent of mature sand dune vegetation and the lack of recent fire scars. All blocks are at risk from fire moving in from the west, including from Lord's Well on Danggali's western boundary.

Lightning strikes from dry electrical storms present the largest ignition risk, as human-caused ignitions are of minimal concern due to restricted public access.

12.6.2 Chowilla RR

Pastoralism and patchy vegetation communities reduce Chowilla's fire risk considerably. T-Block has the highest fire risk, however all four blocks are rated as Moderate. Grazing by sheep, as well as feral animals and kangaroos, occurs across the property, but less intensively in the west. Stocking rates in the western blocks have historically been 25% of the rates in the eastern blocks, maintaining higher fuel levels than those observed in the east (Robertson, pers. comm.). Where high fuel levels have accumulated, they are usually discontinuous due to the presence of low-fuel vegetation such as Bluebush plains and stands of Black Oak.

Lightning strikes from dry electrical storms present the largest ignition risk, as human-caused ignitions are of minimal concern due to restricted public access to the more flammable areas.

12.6.3 Cooltong CP

A series of *Triodia* dominated east-west running dunes through the northern half of Cooltong Block have considerable fire potential. Intermittent swales are at relatively small risk in comparison as fuel type and fuel loadings are lower. The southern half of the reserve is at minimal risk of bushfire as it is predominantly mallee plain and swale intermitted with large clearings created by pastoral grazing. There is a slight risk of smoke taint occurring in grapes grown in areas adjacent to Cooltong CP in the growing season of October to May.

12.6.4 Pooginook CP

Lightning strikes during dry electrical storms present the largest risk to this area. Pooginook CP was assessed as being at high risk from bushfire due to heavy fuel loadings and high flammability of its east-west running Mallee-*Triodia* dunes. Human-caused ignitions are of minimal concern on the block, although the high voltage overhead transmission line standing on the block's northern exposure does increase the potential risk and impact of fire.

12.7 Management Objectives for DEH Reserves

- To protect life and property on all Reserves.
- To restrict the extent of non-prescribed fire in order to protect and maintain as much 40 plus year-old mallee habitat as possible for the conservation of threatened species; particularly the Black-eared Miner and Malleefowl.
- To contain bushfires within single fire management blocks wherever possible, and to prevent fire spreading beyond the reserves, on to adjacent Heritage Agreements, farmland, horticultural and residential blocks, or into New South Wales.
- To minimise the impacts of both bushfire suppression and pre-suppression works on the landscape through better incident management, planning and targeted post-fire rehabilitation.
- To protect and maintain the wilderness value of Danggali WPA using low-impact management and suppression techniques.
- To monitor the effects of fire (both planned and unplanned) on ecosystems with respect to amplified grazing pressure in buffers and potential displacement of Black-eared Miner colonies.
- To facilitate a better understanding of the role of fire (both planned and unplanned) and its impacts in the Reserves' ecosystems, and the efficacy of prescription burning in mitigating the threat that bushfire presents through targeted research and monitoring programs.
- To protect Cultural Heritage sites from fire, namely Nanya's Wurlie and campsite and Nappers Old Accommodation House Burial Ground on Danggali.

12.8 Actions and Works

12.8.1 B-zone Burning

Danggali

Within Danggali, B-zones should be implemented:

- along the Danggali-NSW border where Postmark, Toby's and Birthday Blocks' eastern boundaries abut Lilydale Station, Scotia Sanctuary and Tarawi Nature Reserve. The extent of these buffers will be dictated by the presence and maturity of *Triodia* in the land adjacent to the border following DEH assessment by the Regional Fire Management Officer (RFMO) in consultation with the District Ranger, Riverland, and Conservation Programs staff. These buffers should integrate the Black Oak stands present on Postmark's eastern exposure
- along the northern boundary of Postmark Block (extending 3 km west of the north-eastern corner) and along the Postmark-Oakvale Track. Efforts should be made to link these with the two recent fire scars in the block. Fires should not be prescribed at an interval of less than 20 years in these areas.

Chowilla RR

The western boundary track from the junction of T-Block, Danggali and 80x80 Block to the South Bore Hole Corner should be assessed for B-zone burning by the Regional Fire Management Officer in consultation with the District Ranger, Riverland and Robertson Chowilla P/L. If fuel loads on Bore Hole reach *High* levels, a B-zone may be deemed necessary.

Cooltong CP

Within Cooltong CP, B-zones should be implemented:

- along the full length of the northern boundary (approximately 200 metres in width)
- one kilometre south of the northeastern corner of the reserve (100 metres in width)
- on the western boundary of the reserve from the northwestern corner, south to the centre track (200 metres in width). Discussions should be held with the owner of Monash Station as to the possibility of implementing this B-zone on western side of the fence on the two decadal cycle advocated.

12.8.2 Landscape Protection Burns

No landscape protection burns are proposed for Cooltong and Pooginook Conservation Parks, however this approach can be considered on Danggali and Chowilla RR given the spatial, financial and logistical constraints of implementing bounded burns on their large fire management blocks.

Danggali

Semi-bounded or unbounded landscape protection burns may be implemented on blocks with sand dunes to strategically break up the landscape. Northern Blocks such as Postmark, Tipperary, Morgan Vale, Gallagher, Canopus, Boundary and Olympic Blocks are appropriate for such operations. Suitable sites should be determined by the Regional Fire Management Officer in consultation with the District Ranger and Conservation Programs Unit staff.

Whilst fuel levels are traditionally low around Canopus Homestead, in the event of a Speargrass year fuel should be reduced for a distance of 200 metres around the buildings. This may either be achieved via mechanical means (slashing/mulching) or via burning where feasible. Fuel reduction should focus on understorey fuels, with care taken to minimise impacts on trees around the Homestead, Shearers Quarters and outbuildings.

Chowilla RR

Prescribed burning is recommended to manage fuel levels, regenerate senescent communities or manage Hopbush (*Dodonaea sp.*) proliferation. The nature and extent of these burns is to be developed by the Regional Fire Management Officer in consultation with the District Ranger, Riverland and Robertson Chowilla Pty. Ltd.

12.8.3 Track Maintenance

Danggali

Track maintenance programs should focus on maintaining the fire management blocks' perimeter breaks to a width of 20 metres and at a standard that can support 34's and tankers. The breaks should be retreated at an interval of not less than 10 years to allow some vegetation recovery and prevent erosion. It is recommended that:

- all existing tracks should be maintained as Major Tracks (e.g. to width of 7 metres)
- all internal track junctions should be widened to an internal radius of 8.5 metres to create vehicle turning points
- overtaking bays with a width of 7.5 metres and length of 17 metres should be implemented on perimeter tracks in swale areas as close as possible to intervals of 500 metres
- airstrip maintenance programs should be ongoing annually to maintain the Canopus airstrip at an acceptable standard for both spotter plane and bomber use.

Chowilla RR

The western boundary track abutting Calperum requires improvement to meet GAFLC guidelines. Access for both tenures is poor in this area jeopardising the efficacy of suppression operations in the event of a fire. As such, the track should be upgraded to a width of four metres from the junction of T-Block, Danggali and 80x80 Block (Calperum), south to the South Bore Hole Corner.

All internal track junctions should be widened to an internal radius of 8.5 metres to create vehicle turning points.

Note: Prescribed burning and other pre-suppression activities on Chowilla RR should not impact upon programs for other higher priority areas within the District. A potential method for avoiding this is to allow Robertson Chowilla P/L to implement these programs under the supervision of DEH staff.

Cooltong CP

Track junctions should be widened to an internal radius of 8.5 metres to create vehicle turning points. Overtaking bays should be implemented on dune tops to avoid collision between fire appliances.

Pooginook CP

Track junctions should be widened to an internal radius of 8.5 metres to create vehicle turning points. Overtaking bays should be implemented on perimeter tracks in swale areas (width of 7.5 metres and length of 17 metres) as close as possible to intervals of 500 metres.

12.8.4 Tanks and Infrastructure

Danggali requires the installation of tanks at strategic points. The installation of two 22 000 litre tanks at the Canopus airstrip will enhance the fire bombing options for Danggali. Recommended tanks at Tipperary and Morgan Vale (Refer to Table 14) will provide a water supply to the north of the reserve. These are to be filled when water is available in the adjacent dams and their level is to be monitored during the fire season. In the event of a fire, water is to be used from the dams first if they are holding suitable quantities of water.

TABLE 14: TANK MAINTENANCE AND INSTALLATION ON DEH RESERVES

	Block Name	Priority	Upgrade	Installation Recommendations		
				No.	Size (litres)	Location
Danggali	Birthday	1		2	22 000	Mulga Dam
	Boundary					
	Canopus	1		2	22 000	Canopus Airstrip
	Hypurna	2		1	22 000	Homestead
	Morgan Vale	1		1	22 000	Morgan Vale
		2		1	22 000	Little Oaks Dam
	Olympic					
	Postmark					
	Tipperary	1		1	22 000	Rainbow Dam
		2		1	22 000	Red Tank Dam
	Toby's	1		Install cover		
	Renmark					
	Nanya					
	Gallagher					
Chowilla RR	Bore Hole					
	Coombool					
	Paradise					
	T Block					
Other	Pooginook					
	Cooltong					

It is also recommended that a fire spotting tower be installed on the 'Dogleg' sand dune in Boundary Block to assist in incident control.

12.9 Suppression

12.9.1 Danggali

Accurate situation reports (SITREPS) and a decision to deploy heavy machinery or aerial suppression should be made at the earliest possible juncture in an incident. This strategy is of particular pertinence on Birthday, Tipperary and Postmark blocks, where response time will be a minimum of 90 minutes due to their remote locations. The deployment of small units (14's) to accompany machinery is essential to restrict the size of fires within all blocks. Guidelines for heavy machinery use, aerial suppression and back-burning are discussed in Chapter 7. Particular focus should be given to using the extensive natural fuel advantage areas within Renmark, Olympic, Boundary, Gallagher's, Morgan Vale, Canopus and Toby's Blocks. This should include the use of heavy machinery to link existing natural low fuel areas, such as Black Oak stands, thereby maximising efficiency and minimising impacts.

During suppression operations within Danggali, incident controllers should remain cognizant of its Wilderness Protection Area status. The main implication of this is that fires should be restricted to as small a size as possible, whilst taking extreme care to minimise damage to vegetation by heavy plant, machinery or backburning. DEH should be consulted in the event that any such action is deemed necessary.

12.9.2 Chowilla RR

Quick response with small units (14's/QRV's) to any incident is essential to restrict the size of fires within Chowilla RR. The use of dry firefighting techniques, including heavy machinery, is recommended given the paucity of water and the logistical difficulties associated with maintaining supply. Guidelines for heavy machinery use, aerial suppression and back-burning are discussed in Section 7.

12.9.3 Cooltong CP

Quick response with small units (14's/QRV's) to any incident is essential to restrict the size of fires within Cooltong CP. Suppression efforts should seek to act on threats to properties to the east of Cooltong CP before focusing on protecting as much of the northern section of the reserve as possible. All suppression activities should seek to use areas of reduced fuels through either natural vegetation breaks or existing buffers. Heavy machinery use and backburning may still be employed at the discretion of the Incident Controller, but may only be permitted after consultation with DEH. Guidelines for heavy machinery use, aerial suppression and back-burning are discussed in Section 7.

12.9.4 Pooginook CP

Quick response with small units (14's/QRV's) to any incident is essential to restrict the size of fires within Pooginook CP. The use of dry firefighting techniques, including the use of heavy machinery, is recommended given the paucity of water and the logistical difficulties associated with maintaining supply. Pooginook Block is one of the southern-most blocks in the plan area, so response times will be relatively short, thereby increasing the chance of suppressing the fire during first attack. Guidelines for heavy machinery use, aerial suppression and back-burning are discussed in Section 7.

12.9.5 Signs on all Bookmark DEH Reserves

It is recommended that interpretive signs describing evacuation procedures, refuges and the aims and strategies of the Bookmark Fire Management Plan be installed in key visitor areas within all DEH Bookmark reserves.

Track signs in line with GAFLC sign standards (GAFLC, 2008) should be installed on all tracks and intersections within DEH Bookmark reserves to provide information on the tracks' names, standard and locations for fire suppression purposes. This should be done in conjunction with other land managers in the area to ensure consistency over the Bookmark Mallee.

13 IMPLEMENTATION SCHEDULE AND RECOMMENDATIONS

13.1 Summary of Recommendations

Heritage Agreements

1. To assist in the implementation of prescribed burning and other pre-suppression works within Heritage Agreements and other privately managed land it is recommended that funding be sought through the SAMDB and other funding sources. These funds should be managed through the Conservation Programs Unit (Murraylands Region).

Aerial Observation

2. It is strongly recommended that Incident Management Teams request aerial observation as early as possible in the incident. An aerial platform should be deployed when smoke is first sighted or in the event of an electrical storm passing through the area during the months September through to March.

Fire Access

3. Erect track signs across the planning area as per the GAFLC guidelines
4. Encourage adjacent landowners to upgrade/maintain their tracks as per the GAFLC guidelines.
5. Remove unnecessary fencing adjacent to access tracks and fire trails within the plan area if feasible.

Tanks

6. All designated firewater tanks within the plan area should preferably be at a minimum of 50% capacity at the start of each fire season.
7. The level and status of all Firewater tanks and dams in Bookmark should be reported to the relevant CFS Group Officer and the DEH Fire Management Officer on a monthly basis during the Fire Danger Season.
8. Roofs should be built wherever possible over tanks to catch as much in-situ rainfall as possible.
9. Tanks should be lined to reduce the rate of water loss where this will significantly enhance the water-holding capability of the tank.
10. All operational tanks are protected by Asset Protection zones (A-zones), with a 40 metre cleared area around each site to allow for safe access and egress for appliances and plant.
11. All designated firewater tanks are fitted with SAFB or CFS compatible fittings. Sites containing more than one tank should be reticulated where possible to ensure a number of suitable points for appliances to refill.

Dams

12. The 18 listed dams on Danggali should be maintained at their current standard, with fencing erected to reduce grazing pressure, for fire management purposes. The remaining dams should only be closed if it is demonstrated that an alternate source of water is in reasonable proximity.

13. Dams should only be retained where they make a significant and essential contribution to water storage for firefighting, pending the installation of planned tank storages.
14. If water supplies are present in nearby dams then this supply should be used before tank supplies.

Managing Visitors

15. Interpretive signage, describing evacuation procedures and the aims and strategies of the Bookmark Mallee Fire Management Plan, should be installed on DEH reserves and at relevant Visitor Centres and the DEH Regional and District Offices.

13.2 Recommended Works and Implementation Schedule

Table 15 provides a summary of proposed works for each reserve, from Sections 10-12 of this fire management plan. Some works have been ranked in a suggested order of priority (note this is in a landscape context). The priority order of implementation is an indication only of the works that may be undertaken within the life of the plan. Works are dependent on a number of variables including funding, future bushfires, climate and suitable conditions for prescribed burning. This table should not be viewed as a performance measurement guide; however it does provide suggestions, while providing the flexibility to reschedule as variables change and impact on the ability of individual land managers to implement works.

A five-year implementation schedule is being developed in tandem with this plan, to include any actions and works that have been identified. From this schedule, an annual works program will be developed and implemented by the DEH, ALT and Birds Australia with the assistance of the CFS where possible. Individual burn plans will be developed prior to any prescribed burning. Post-fire reports will be produced and used as a basis for performance reporting against objectives.

TABLE 15: RECOMMENDED WORKS TO BE UNDERTAKEN IN BOOKMARK MALLEE RESERVES

Recommendations	
Calperum and Taylorville	<p>B-zones</p> <p>Eight B-zones are to be implemented within Calperum and Taylorville and on their boundaries. These are, in order of priority:</p> <ol style="list-style-type: none"> 1. Birdseye/Hideaway boundary 2. Shotline Track 3. Pipeline Track 4. Phillips – Middle Gluepot Boundary 5. Overflow / Cooltong – Renmark Boundary 6. Overflow / Cooltong – Monash Boundary 7. 80 x 80 Canopus Road 8. Phillips Track <p>Priorities should remain flexible, depending on future fires. It should also be recognised that only certain sections of tracks may be high priority for B-zones, depending on fire risk.</p>

Recommendations		
	Tracks	Track maintenance programs on Calperum and Taylorville should be focussed on the Reserves' major access tracks. These are the Pipeline Track, Shotline Track, Oil Road and Centre Track. Maintenance should be conducted to a standard that can support heavy vehicles such as 34s and tankers.
	Tracks	Track maintenance should include the widening of track junctions to an internal radius of 8.5 m to create vehicle turning points. Overtaking bays should be created on perimeter tracks in swale areas (width of 7.5 m and length 17 m) as close as possible to intervals of 500 m as described in the GAFLC guidelines (GAFLC, 2008).
Calperum and Taylorville	Tracks	Other tracks recommended for maintenance are: <ul style="list-style-type: none"> • Middle – End Tank Track (Overflow Block) • Fiscom Dam – Old Timor Dam Track (Ral Ral Block) • Amalia Track and Monoman Tank Track (Bald Hill Block) • Emu Tank – Frogamerry Tank Track (Timor Block) • Timor Boundary (Frogamerry Block) • 80 x 80 Tank Track and Canopus Track (80 x 80 Block) • Murphy's Branchline Tank Track and Nanyah Dam Track (Oak Bore Block) • Hideaway Tank Track (Burnt Camp Block) • Scaddon – Frogamerry Track (Scaddon Block) • Northern Neckrope/ Wilks Track (Neckrope/Wilks Blocks)
	Tanks	It is recommended that Middle Tank Overflow, Oak Bore, Rotten Lake and Stony Pinch tanks be regularly maintained. The remaining tanks, of which some have water-collecting roofs, will not be guaranteed as fire water sources.
	Tanks	Taylorville requires approximately 10 000 gallons of fire water storage at Casuarina Dam in Scaddon and at Schmidt Dam in Phillips Block. These dams are strategically placed for fire access. The new tanks should be filled from the adjacent dams when they are holding water.
	LPBs	Bounded landscape protection burns may be implemented adjacent to access tracks in areas where tracks have native vegetation on either side, or in areas that have known threatened or significant species populations. Refer to Section 8.5 (C-zones) for detail on the process to be followed.
	Signs	It is recommended that interpretive signs describing evacuation procedures, refuges and the aims and strategies of the Bookmark Fire Management Plan be installed in key visitor areas within Calperum and Taylorville.
	Signs	Track signs in line with GAFLC sign standards should be installed on priority tracks and intersections within Calperum and Taylorville to provide information on the tracks' names, standard and locations for fire suppression purposes. This should be done in conjunction with other land managers in the area to ensure consistency over the Bookmark Mallee.

Recommendations

Gluepot	B-zones	<ul style="list-style-type: none"> • A 200m wide B-zone will extend along the Birdseye Northern Boundary and down the East Birdseye Boundary. This B-zone is of the highest priority as it will hinder fires spreading in to or out of the Birdseye block. • A 200m B-zone should be implemented along the Oil Road. Initially this will meet the edge of the 2006 fire scar, but may need to be extended in future years. • A 200m wide B-zone is to be implemented along the Middle Gluepot/ Birdseye boundary. Initially this will only be north of the Oil Road due to the presence of the 2006 fire scar, but may need to be extended southward in future years when fuel loads recover; • A B-zone of 100m wide should be implemented south of the Oil Road/ Hideaway boundary; • B-Zones are to be implemented on the southern boundary of Middle Gluepot, bordering with Phillips Block on Taylorville, and; • A B-zone should be implemented on the Old Gluepot/ Middle Gluepot boundary.
	Tracks	All tracks within the reserve should be maintained at a width of four metres at both ground and canopy level to provide access for appliances when responding to an incident.
		Track junctions should be widened to an internal radius of 8.5 metres to create vehicle turning points. Overtaking bays should be implemented on perimeter tracks in swale areas (width of 7.5 metres and length of 17 metres) at appropriate and practical intervals.
	LPBs	Landscape Protection Burns may be implemented within Gluepot, particularly within Birdseye Block to slow fire spread and to increase fire patchiness. No recommendations are made here with regard to the timing and placement of landscape protection burns except that they should be planned and approved by the Native Vegetation Council on an individual basis if deemed appropriate. The B-zones proposed in section 2.8.2 are seen as providing priority protection on a landscape scale, however further landscape protection burns may be deemed strategic and implemented in the future following approval by the relevant stakeholders.
	Tanks	One additional tank should be installed at the Oil Road / Hideaway boundary intersection.
		None of Gluepot's operational tanks should be allowed to drop below 50% of their capacity at any stage of a fire season or prior to a planned burn.
	Signs	It is recommended that interpretive signs describing evacuation procedures, refuges and the aims and strategies of the Bookmark Fire Management Plan be installed in key visitor areas within Gluepot.
		Signs in line with GAFLC sign standards should be installed on all tracks and intersections within Gluepot to provide information on the tracks' names, standard and locations for fire suppression purposes. This should be done in conjunction with other land managers in the area to ensure consistency over the Bookmark Mallee.

Recommendations

Danggali	B-zones	Along the Danggali – New South Wales border where Postmark, Toby’s and Birthday Blocks’ eastern boundaries abut Lilydale Station, Scotia Sanctuary and Tarawi Nature Reserve. The extent of these buffers will be dictated by the presence and maturity of <i>Triodia</i> in the land adjacent to the border following DEH assessment by the Fire Management Officer (FMO) in consultation with the District Ranger, Riverland. These buffers should integrate the Black Oak stands present on the Postmark’s eastern exposure.
		Along Postmark’s northern boundary (extending 3 km west of the north-eastern corner) and along the Postmark-Oakvale Track. Efforts should be made to link these with the two recent fire scars in the block. Fires should not be prescribed at an interval of less than 20 years in these areas.
	LPBs	Semi-bounded or unbounded landscape protection burns may be implemented on blocks with sand dunes to strategically break up the landscape. Northern blocks such as Postmark, Tipperary, Morgan Vale, Gallagher, Canopus, Boundary and Olympic are appropriate for such operations. Suitable sites should be determined by the RFMO in consultation with the District Ranger.
		Whilst fuel levels are traditionally low around Canopus homestead, in the event of a Speargrass year fuel should be reduced for a distance of 200 metres around the buildings. This may either be achieved via mechanical means (slashing, mulching) or via burning where feasible. Fuel reduction should focus on understorey fuels, with care taken to minimise impacts on trees around the Homestead, Shearers Quarters and outbuildings.
	Tracks	The Burra Road and Tipperary Track should be maintained at a standard that can support 3-4’s and tankers, and ensure quick access to fires in the north of the block.
		The perimeter break should be maintained at a width of 20m and retreated at an interval of not less than 10 years.
		All internal track junctions should be widened to an internal radius of 8.5m to create vehicle turning points.
		Overtaking bays with a width of 7.5m and length of 17m should be implemented on perimeter tracks in swale areas as close as possible to intervals of 500m.
	Airstrip	Airstrip maintenance programs should be ongoing annually to maintain the Canopus airstrip at an acceptable standard for both spotter plane and bomber use.
	Fire Spotting	A fire spotting tower is to be installed on the ‘Dogleg’ sand dune in Boundary Block to assist in incident control.

Recommendations		
Danggali	Tanks	<p>Tanks recommended for installation are:</p> <ul style="list-style-type: none"> • 2 x 22 000 L tanks to be installed at Mulga Dam • 2 x 22 000 L tanks to be installed at Canopus airstrip • 1 x 22 000 L tank to be installed at Hypurna Homestead • 1 x 22 000 L tank to be installed at Morgan Vale Dam • 1 x 22 000 L tank to be installed at Little Oaks Dam • 1 x 22 000 L tank to be installed at Rainbow Dam • 1 x 22 000 L tank to be installed at Red Tank Dam
Chowilla	LPBs	<p>Prescribed burning is recommended to manage fuel levels, regenerate senescent communities or manage Hopbush (<i>Dodonaea spp.</i>) proliferation. The nature and extent of these burns is to be developed by the Regional Fire Management Officer in consultation with the District Ranger, Riverland and Robertson Chowilla Pty. Ltd.</p>
	Tracks	<p>The western boundary track abutting Calperum requires improvement to meet GAFLC guidelines. Access for both tenures is poor in this area jeopardising the efficacy of suppression operations in the event of a fire in that area. As such, the track should be recreated to a width of four metres from the junction of T-Block, Danggali and 80 x 80 (Calperum) south to the South Bore Hole Corner.</p> <p><i>Note: Prescribed burning and other pre-suppression activities on Chowilla should not impact upon programs for other higher priority areas with in the District. A potential method for avoiding this is to allow Robertson Chowilla to implement these programs under the supervision of DEH staff.</i></p>
		<p>All internal track junctions should be widened to an internal radius of 8.5m to create vehicle turning points.</p>
		<p>The western boundary track from the junction of T Block, Danggali and 80x80 to the South Bore Hole Corner should be assessed for B-zone burning by the Regional Fire Management Officer in consultation with the District Ranger, Riverland and Robertson Chowilla P/L. If fuel loads on Bore Hole reach high levels, a B-zone may be deemed necessary.</p>
Cooltong	Tracks	<p>Track junctions should be widened to an internal radius of 8.5 metres to create vehicle turning points. Overtaking bays should be implemented on perimeter tracks in swale areas (width of 7.5 metres and length of 17 metres) as close as possible to intervals of 500 metres.</p>
	B-zones	<p>Approximately 200-metre wide fuel-reduced B-zones should be implemented along the full length of the northern boundary.</p>
		<p>A B-zone of 100 metres in width shall be maintained for one kilometre south from the northeastern corner of the reserve.</p>
		<p>A 200-metre wide B-zone shall also be implemented and maintained on the western boundary of the park from the northwestern corner south to the centre track. Discussions should be held with the owner of Monash Station as to the possibility of implementing this buffer on western side of the fence on the two decadal cycle advocated.</p>

Recommendations

Pooginook

Tracks

Track junctions should be widened to an internal radius of 8.5 metres to create vehicle turning points. Overtaking bays should be implemented on perimeter tracks in swale areas (width of 7.5 metres and length of 17 metres) as close as possible to intervals of 500 metres.

TABLE 16: PROPOSED B-ZONE STRIP BURNING PRIORITIES AND JUSTIFICATION

Tracks or boundaries	Property	Blocks	Priority	Width (m)	B-zone Maximum Sizes		Justification
					Distance (km)	Area (ha)	
Birdseye-Hideaway-South Yubalia Boundary	Gluepot/ Calperum	Birdseye Hideaway	1	200	18.0	364	This strip bisects the BEM core habitat area outlined by Clarke (2005) and will aid in the protection of 40+ y.o. mallee the eastern half of the area. Provides a control line with greater protection for fire crews.
Birdseye-Hideaway Boundary	Gluepot/ Calperum	Birdseye Hideaway	2	100	3.1	31	Adds extra protection to the Birdseye – Hideaway-South Yubalia Boundary B-zone
Middle Gluepot – Birdseye Boundary	Gluepot	Middle Gluepot Birdseye	3	200	6.3	125	Will prevent the easterly spread of fire from Middle Gluepot in to the core Black-eared Miner habitat in Birdseye Block.
Shotline Track	Calperum	Hideaway South Yubalia	4	200	28.0	560	Aids in protecting eastern section of BEM core habitat and other species inhabiting high quality 40-year-old mallee communities. Provides a control line with greater protection for fire crews. Bisects Hideaway and South Yubalia FMBs from south to north.
Phillips – Middle Gluepot Boundary	Gluepot/ Taylorville	Phillips Middle Gluepot	5	200	17.7	354	Provides an east-west buffer against fire moving north into Middle Gluepot and Birdseye or vice versa. Greater control line safety for fire units.
Hideaway Old Road	Calperum	Hideaway Burnt Camp	6	200	16.8	335	Provides an east-west buffer against fire moving into the northern section of Hideaway or vice versa and destroying large areas of BEM core habitat. Greater control line safety for fire units.
Phillips Track	Taylorville	Phillips	7	200	18.3	336	Greater protection against fires moving into the eastern unburned tracts of 40 year old mallee habitat in the northeast of Phillips. Greater control line safety for fire units. Bisects Phillips from north to south.
Overflow / Cooltong – Renmark Boundary	Calperum/ Cooltong (DEH)	Overflow	8	200	9.5	190	A buffer against fire moving east into farming and horticultural areas west of Renmark. DEH section already implemented.

IMPLEMENTATION SCHEDULE AND RECOMMENDATIONS

Tracks or boundaries	Property	Blocks	Priority	Width (m)	B-zone Maximum Sizes		Justification
					Distance (km)	Area (ha)	
Overflow / Cooltong – Monash Boundary	Calperum/ Cooltong (DEH)	Overflow	9	200	10.9	218	An east-west running buffer aiding in preventing fire from moving north or south into or out of Cooltong or Overflow block. Greater control line safety for fire units. DEH section implemented
Pipeline Track	Calperum	Ral Ral Timor Burnt Camp Oak Bore 80x80	10	200	17.8	355	A buffer against fire moving into the eastern section of Calperum. Greater control line safety for fire units.
80 x 80 Canopus Road	Calperum	80x80	11	200	13.5	270	A buffer against fire moving into the northern and eastern section of the block. A buffer against fire moving into the eastern section of Calperum. Greater control line safety for fire units.
Cooltong – Monash Boundary	DEH	Cooltong	12	200	7.2	144	Increased protection against fire moving into Cooltong CP from Monash Station to the west. Greater control line safety for fire units.
Eastern Danggali Boundary (Postmark, Birthday & Toby's)	DEH: Danggali	Hypurna Toby's Birthday Postmark	13	200	51.1	1021	To be implemented in stages based on fuel levels & associated risk. A buffer against fire moving east into Scotia Sanctuary and Tarawi Nature Reserve (significant areas of old growth mallee proposed sites for BEM translocations). Greater control line safety for fire units.
Postmark Track	DEH: Danggali	Postmark	14	200	8.0	160	A north-south buffer against fire moving into the eastern section of Postmark and adjacent Scotia Sanctuary. Greater control line safety for fire units in area dominated by <i>Triodia</i> dunes.

14 BIODIVERSITY WORKS – RESEARCH AND MONITORING

Monitoring and assessing the impacts of both prescribed burning and fire in general is a critical component of this management plan. Information on the response of mallee ecosystems to fire, and in particular prescribed fire, has been largely restricted to studies in NSW. Much of this information can be extrapolated (albeit cautiously) to South Australian mallee given the similarity in the systems. With respect to baseline data Bookmark is well resourced given the existing monitoring programs on Gluepot, Calperum and Chowilla. Many of these sites are in areas that will be burnt, through either prescribed burning or bushfire, and as such will be useful for measuring changes brought about by fire. Despite this, existing programs will require augmentation to answer the range of questions posed. A potential monitoring program for Gluepot Reserve will serve to address a number of these questions. Some direction can be taken from approaches developed on Tarawi Nature Reserve (Willson, 1999) with respect to measuring associated impacts of grazing pressure and community recovery in prescribed burns. However, there has been little research to guide management actions with respect to population displacement of Black-eared Miner colonies through fire, nor has there been programs targeted at defining the efficacy of management actions in meeting the desired objective.

The desired outcome of the program is the protection and enhancement of biodiversity within the Bookmark Mallee, through the provision of an adaptive management framework that guides future fire management within the area.

The key questions of the monitoring program will address:

A > *What are the impacts of prescribed burning on threatened species with particular emphasis on localised displacement of populations?*

Pre and post-fire monitoring of colonies or sub-populations of target species such as Black-eared Miner and Malleefowl is critical to measuring the sustainability of prescribed burning practices in Bookmark.

B > *What are the impacts of major bushfires on threatened species?*

Post-fire monitoring of colonies or sub-populations of target species such as Black-eared Miner and Malleefowl is critical to measuring the impact of bushfire in Bookmark. Such assessments should be compared to data from ongoing pre-fire assessments and monitoring from across the landscape, however the emphasis here is on monitoring habitat recovery in relation to fire intensity, patchiness and post-fire conditions. Such studies will inform and improve fire management in the future.

C > *What impacts, if any, does amplified grazing pressure have on vegetation communities in the buffer zones implemented?*

Data collected from Tarawi Nature Reserve suggests that burnt strips have the potential to act as corridors for grazing for kangaroos, goats and rabbits (Willson, 1999). While these areas are fuel modified and as such grazing is not in conflict with this objective, it may have negative impacts on species composition in these areas. It is therefore necessary to quantify these impacts in order to prescribe management actions dealing with this. Grazing enclosures in post-fire sites that exclude just rabbits, goats and rabbits and goats, kangaroos

and rabbits will provide information on the relative impacts that each species is having on post-fire areas.

D > What is the efficacy of the prescribed works implemented in mitigating the effects of a bushfire?

This question will only be tested in circumstances where bushfires occur in treated areas; however it is important to record the effectiveness of the program in meeting objectives. Information required should include the weather conditions experienced when bushfires burn into buffer zones, the vegetation type / fuel levels in the area burnt and the cause / nature of any breaches across fuel modified areas.

E > To create a database for plant species response mechanisms to fire for the Bookmark area.

Flora response to fire in Bookmark is not well understood with respect to response mechanisms and community succession. A measure of pre- and post-fire species richness and diversity, as well as response mechanisms of individual species is essential baseline information. Within this, the impacts of burning out-of-season (i.e. in the cooler months) on response require assessment to provide informed adaptive management. Specific detail on threatened flora response should be sought through targeted research projects.

Not all fire management zones within Bookmark contain survey plots, and not all of the questions listed above are relevant to all land managers or indeed can be addressed given the resources available. Survey plots will therefore be placed strategically in zones that are representative of vegetation associations and habitat and more importantly best target the question asked. Implementation budgets will include provision for an annual monitoring component, with the outcomes of the monitoring program to be fed into the review process.

Monitoring in zones will be ongoing, with measurements made both pre-fire and immediately post-fire and at intervals following such that the responses of biodiversity to fire can be identified. Opportunistic plots may be established in recently burnt zones if they are deemed to contribute further to the information being collected through the program.

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16 ACKNOWLEDGEMENTS

This plan has been produced by the Department for Environment and Heritage with the support of the Australian Government through the Natural Heritage Trust (NHT, 2005). The authors were Ben Kaethner and Grant Pelton. Special thanks go to the Steering Committee members that contributed their time and expertise to the development of the plan. The authors would in particular like to thank Benita Dillon, Jody Gates, Brett Stephens, Sonia Dominelli and Phil Strachan for their assistance in driving the project at a Regional level. Mike Wouters, Karan Smith, James Robertson, Mark Cairns, Mike Arnold (Mid-Murray CFS Group Officer) and Raoul Otto De Grancy (Chaffey Group CFS Officer) are all to be thanked for their input at meetings, field trips and in providing comment on the plan as it was developed. The author is extremely grateful for the efforts of Charlotte Morgan and Benno Curth in undertaking the time consuming task of producing maps for the project. Thankyou also to Mate Osborne, Henry Pederson, Dennis Matthews, Duncan Mackenzie, Grant Whiteman, Ray Dayman and Jock Robertson for their local knowledge, input and cooperation. Special thanks also go to Ken Stokes, Mike Williams, Shane Wiseman and David Baker-Gabb & the Black-eared Miner Recovery Team for their comments and input into the project as it progressed.

17 APPENDICES

Appendix 1: Wilderness Code of Management Sections 3.6 and 3.10

Section 3.6 Fire

- (i) Fire management will be based on continuing research into the fire history of the area, the relationships between fire and the natural communities occurring within the area, and on the maintenance of wilderness quality.
- (ii) Deliberately lit fires will be used only in emergency situations, and in essential management operations as listed in 3.10 and subject to (i) above.
- (iii) Other human caused fires should, where practicable, be extinguished consistent with maintenance of wilderness quality.
- (iv) Naturally caused fires will be extinguished when, in view of the direction, intensity and extent of the fire and the fire suppression techniques available, they pose a threat to human life and property, and to habitats requiring protection.
- (v) Where fire suppression action is required, the methods utilised will be, wherever possible, those which will have the least long-term impact on wilderness quality.
- (vi) The use of heavy machinery for fire suppression within a wilderness area will be prohibited except:
 - (a) where it is considered to be the only way of preventing greater long-term loss of wilderness quality;
 - (b) where specific machinery use techniques, that do not result in significant disturbance to the landscape or create a new access network, are considered the only feasible method of preventing long-term loss of wilderness quality; or
 - (c) to mitigate hazard to human life, where alternative measures which do not impact on the wilderness quality of the area are unavailable.
- (vii) Wherever possible, fire management practices designed to protect land adjacent to or within a wilderness area will be conducted outside the wilderness area.

Section 3.10 Emergency and Essential Management Operations

- (i) All emergency and essential management operations will be carried out with the least possible impact on wilderness quality.
- (ii) Actions that cause short-term degradation of wilderness quality but are necessary for emergency and/or essential management operations will be permitted. The only specific situations acknowledged in this Code as possibly requiring such actions are:
 - control or eradication of non-indigenous species;
 - conservation of threatened species, communities and habitats;
 - protection of fire-sensitive species and communities;
 - management of visitor use;
 - management action or use of devices to mitigate hazard to human life;
 - restoration of natural processes, communities and habitats; and
 - research.

Where degradation has occurred as a result of these activities, rehabilitation will be undertaken as soon as practicable.

The plan will also comply with the *DEH Fire Policy and Procedure for Wilderness Fire Management*.

Appendix 2: Key to South Australian (SA) Conservation Status Codes

- 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.
- V Vulnerable:** rare and at risk from potential threats or long-term threats which could cause the species to become endangered in the future.
- T Threatened:** likely to be either Endangered or Vulnerable but insufficient data 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 threats, but warrants monitoring and protective measures to prevent reduction of population sizes.
- K Uncertain:** likely to be either Threatened or Rare but insufficient data for a more precise assessment.
- Q Of Possible Significance:** not yet assessed but flagged as being of possible significance.
- U Uncommon**
- N Assessed but not considered of conservation significance.**

The list of Endangered, Threatened and Vulnerable flora and fauna species is updated at regular intervals in Schedules 7, 8 and 9 under the *National Parks and Wildlife Act 1972*. To view the most recently gazetted version go to:

Endangered http://www.austlii.edu.au/au/legis/sa/consol_act/npawa1972247/sch7.html

Threatened http://www.austlii.edu.au/au/legis/sa/consol_act/npawa1972247/sch8.html

Vulnerable http://www.austlii.edu.au/au/legis/sa/consol_act/npawa1972247/sch9.html

KEY TO EPBC ACT CONSERVATION STATUS CODES

Conservation status

The IUCN devised the following red list categories (Groombridge, 1993), with species categorised based on a series of five criteria:

- **Extinct (EX):** A taxon is Extinct when there is no reasonable doubt that the last individual has died.
- **Extinct in the Wild (EW):** A taxon is Extinct in the Wild when it is known only to survive in cultivation, in captivity or as a naturalised population (or populations) well outside the past range. A taxon is presumed Extinct in the wild when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.

- **Critically Endangered (CR):** A taxon is Critically Endangered when it is facing an extremely high risk of extinction in the wild in the immediate future, as defined by any of the criteria A to E.
- **Endangered (EN):** A taxon is Endangered when it is not Critically Endangered but is facing a very high risk of extinction in the wild in the near future, as defined by any of the criteria A to E.
- **Vulnerable (VU):** A taxon is Vulnerable when it is neither Critically Endangered nor Endangered, but is facing a high risk of extinction in the wild in the medium-term future, as defined by any of the criteria A to E.
- **Lower Risk (LR):** A taxon is Lower Risk when it has been evaluated, does not satisfy the criteria for any of the above categories. Taxa included in the Lower Risk category are separated into three subcategories:
 - **Conservation Dependent (CD):** Taxa that are the focus of a continuing taxon-specific or habitat-specific conservation program targeted towards the taxon in question, the cessation of which would result in the taxon qualifying for one of the threatened categories above within a period of five years.
 - **Near Threatened (NT):** Taxa that do not qualify for Conservation Dependent, but which are close to qualifying for Vulnerable (see criteria below)
 - **Least Concern (LC):** Taxa which do not qualify for Conservation Dependent or Near Threatened.
- **Data Deficient (DD):** A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. A taxon in this category may be well studied, and its biology well known, but appropriate data on abundance and/or distribution is lacking. Data Deficient is therefore not a category of threat or Lower Risk. Listing of taxa in this category indicates that more information is required and acknowledges the possibility that future research will show that threatened classification is appropriate. It is important to make positive use of whatever data are available. In many cases great care should be exercised in choosing between DD and threatened status. If the range of the taxon is suspected to be relatively circumscribed, if a considerable period of time has elapsed since the last record of the taxon, threatened status may well be justified.
- **Not Evaluated (NE):** A taxon is Not Evaluated when it has not yet been assessed against the criteria.

