Fire Management Plan

Tarawi Nature Reserve

July 1999 - July 2004

NSW NATIONAL PARKS AND WILDLIFE SERVICE

***"BUSH FIRES** - ....Three huge fires are raging in various parts of the lower Darling district and there is practically no hope of stopping them by ordinary human methods, even if water for fire-fighting carts were considerably handier than it is....The prolific growth of grass during the past two seasons has been responsible for the outbreak of fires in several places. A large fire, visible at night from Mildura, is burning at Lake Victoria Station down river, and another large fire is burning out towards the Darling on Arumpo Station. It is reported that the country is not heavily stocked, which is fortunate for the owners.... Tremendous efforts have been made to keep it within safe limits and head it off in the unsettled Scotia country which is all porcupine and mallee...."*

The Mildura Telegraph, January, 1918

FIRE MANAGEMENT PLAN
TARAWI NATURE RESERVE

July 1999 - July 2004

NSW National Parks and Wildlife Service
Lower Darling District
1999

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Cover Photo: Long unburnt Mallee-spinifex vegetation community at Tarawi NR

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EXECUTIVE SUMMARY

This Fire Management Plan has been developed to provide direction for fire management at Tarawi Nature Reserve (herein referred to as "Tarawi NR") for a period of five years. The plan has addressed the protection of life and property and proposed strategies for the appropriate ecological management of the natural and cultural heritage of Tarawi NR.

Tarawi NR has a number of significant plants and animals which contributes to its biodiversity values. These include the Bluebush Daisy, Bladder Senna, Malleefowl and Bolam's Mouse.

The plan process has involved the mapping of Tarawi NR's vegetation, fire history and significant species, development of mallee fire ecology guidelines for biodiversity, evaluation of fire regimes, the formulation of fire management objectives, strategies, research priorities, operational guidelines and works schedule.

FIRE MANAGEMENT OBJECTIVES

In accordance with the *Rural Fires Act (1997)* and the *National Parks and Wildlife Act (1974)*, **NPWS fire management objectives for Reserve management are**:

1. To prevent the occurrence of human caused unplanned bushfires on the reserve.

2. To suppress unplanned bushfires occurring on the reserve.

3. To minimise the potential for spread of bushfires on, from, or into the reserve.

4. To protect from bushfires, persons and property on, or immediately adjacent to, the reserve.

5. To manage bushfires to avoid the extinction of all species which are known to occur naturally within the reserve.

6. To protect from damage by bushfires all Aboriginal sites, historic places and culturally significant features known to exist within the reserve.

Specific biodiversity fire management objectives for Tarawi NR

Biodiversity guidelines have been formulated to derive specific fire management objectives:

- Prevent consecutive fires within a 20 year period in any one area.

- Maintain the current diversity of age classes, ensuring that the desired age class ranges are not exceeded.

- Investigate and clarify the biodiversity value and regenerative capacity of long unburnt vegetation communities.

- Promote patchiness during wildfire.

FIRE MANAGEMENT STRATEGIES AND ACTIONS

- Development of fire management "zones" to apply specific management strategies (Asset, Strategic and Heritage Area fire management zones).
- Development of fire management "units" defining containment areas during wildfire.
- Maintenance of designated fire trails.
- Strategic prescribed burning in designated Strategic Fire Management Zones.
- Maintain and refine the fire history database for Tarawi NR and develop a fire history database for the Scotia region.
- Produce detailed profiles and maps of each fire management unit showing fire trails and tracks, watering points, fire history, vegetation, zones, locations of significant species and cultural heritage sites (to be available during fire suppression operations).
- Increase fire water storage supplies.
- Initiate the preparation of an interstate communications plan, addressing the need for compatible radio communications between South Australian and New South Wales fire fighting agencies.

BIODIVERSITY RESEARCH AND MONITORING

- Several fire ecology issues that have the potential to have negative long term impacts on Tarawi NR's biodiversity have been identified in this plan. Research and monitoring projects proposed to address these issues are:
    - "Old growth" biodiversity project
    - Post-fire grazing impacts project
    - Flora fire ecology project (plant regeneration methods and post-fire life cycles)
    - Fauna fire ecology project (small mammals and threatened birds)
    - Monitoring prescribed burns project

OPERATIONAL (SUPPRESSION) GUIDELINES

- This plan recognises and describes several constraints in suppressing mallee wildfires. In consideration of these, guidelines for wildfire suppression are detailed under the following operational areas:
    - Aerial reconnaissance
    - Backburning
    - Chemicals
    - Containment strategies
    - Control lines (and heavy plant usage)
    - Operational management
    - Water supplies

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1. INTRODUCTION

This document describes the fire management guidelines and programs for Tarawi NR over the next five years. The plan provides a framework for the fire management of biodiversity and the protection of life and property relevant to the semi-arid mallee environment.

The plan process has involved:

- mapping and survey of Tarawi NR's vegetation, fire history, significant species and cultural heritage sites,
- development of mallee fire ecology guidelines for biodiversity,
- an evaluation of Tarawi NR's fire history,
- formulation of fire management objectives and strategies
- development of a works program for fire research and monitoring and fuel management,
- development of operational guidelines for fire suppression, and
- three months public exhibition period of the draft plan.

This plan is supported by the *Lower Darling District's Incident Action Plan* which details standard procedures, communication details and contact lists by which the Service will respond to fires and other incidents on a District-wide basis. The Incident Action Plan is revised and reproduced annually.

1.1 Legislation

Under the *Rural Fires Act (1997),* the National Parks and Wildlife Service (NPWS) is a prescribed fire organisation and is responsible for the control and suppressing of all fires on areas that it manages. This responsibility also extends to fuel management with the Service being responsible for the implementation of fuel management programmes to protect life and property.

Section 50 of the *Rural Fires Act (1997)* sets up provisions for the establishment of District Bush Fire Management Committees (DBFMCs) with the task of developing and coordinating co-operative fire management between fire authorities across the state. The Service is a member of these committees which are responsible for the development of both cooperative fire-fighting and programmes for the management of bushfire risks.

Tarawi NR is situated within the Wentworth Shire. The Lower Darling District is a member of the Wentworth Bush Fire Management Committee. Under Section 52 of the *Rural Fires Act*, each Bush Fire Management Committee is to prepare two types of bush fire management plans for the rural fire district or other part of the state for which it is constituted. These plans are:

- A plan of operations, and
- A bush fire risk management plan.

Under the *Rural Fires Act* when a fire occurs on 'prescribed land', the Shire's Fire Control Officer, must comply with the conditions set out by the agency for that prescribed land, in any relevant bush fire management plan or "other relevant plan"

agreed to by the authority responsible for the prescribed land. This fire management plan is such a plan under Sections 38(4) and 44(3) of the *Rural Fires Act 1997*.

The Service has statutory obligations under the *Rural Fires Act 1997* to protect life and property on its lands and to prevent fire from leaving its property. The NPWS is a recognised Fire Authority under this Act. The Act provides for the authority to undertake appropriate measures to prevent fire from entering or leaving its estate. As a prescribed organisation the NPWS is required to implement the provisions of Bush Fire Management Plans. The Service can act to suppress fires up to eight kilometres from its reserve boundaries in collaboration with local brigades and park neighbours in accordance with provisions of local bushfire plans.

1.2 NPWS fire management policies and objectives

Specific NPWS policies concerning fire and fire management include the following:

- The Service regards fire as a natural phenomenon; one of the continuing physical factors of the Australian environment.
- The Service recognises the evolutionary adaptation of many native species of plants and animals to fire regimes.
- The Service accepts that fire can be a useful management tool.
- Fire is and will be used as a fuel reducing agent where this does not conflict with management objectives.
- Where life and property are directly threatened by fuel conditions, all steps will be taken to minimise risks, with other management needs regarded as secondary considerations.

The NPWS's standard fire management objectives and their performance indicators are:

1. To prevent the occurrence of human caused unplanned bushfires on the reserve.
(Performance indicator: Unplanned fire ignitions on the reserve, caused by humans, are progressively reduced over the planning period)

2. To suppress unplanned fires occurring on the reserve.
(Performance indicator: Fires occurring on the reserve are suppressed within appropriate control lines, safely, with minimum environmental damage and cost during the planning period)

3. To minimise the potential for spread of wildfires on, from, or into the reserve.
(Performance indicator: Fires starting in the reserve are suppressed within the reserve and fires starting outside are prevented from entering the reserve, safely, with minimum environmental damage and cost during the planning period)

4. To protect from bushfires occurring on the reserve, persons and property on, or immediately adjacent to, the reserve.
(Performance indicator: No death or injury to persons, or destruction of property, caused by on park bushfires in the planning period)

5. To manage bushfires to avoid the extinction of all species which are known to occur naturally within the reserve.

(Performance indicators: Fire regimes are maintained within specified ecological thresholds across more than 50% of the area of each plant community on the reserve. No significant decline of species population (common or endangered) due to inappropriate fire regimes, suppression operations or other fire management works, occurs during the planning period)

6. To protect from damage by bushfires all Aboriginal sites, historic places and culturally significant features known to exist within the reserve.

(Performance indicator: No damage caused to Aboriginal sites, historic places and culturally significant feature as a result of bushfires during the planning period)

1.3 NSW biodiversity strategy

The *NSW Biodiversity Strategy (1999)* was developed by the New South Wales Government and develops a collaborative approach to biodiversity conservation. Its over-riding goal is "to protect the native biological diversity of NSW and maintain ecological processes and systems".

The strategy has identified “inappropriate fire regimes” as one of the seven key threatening processes that is effecting the biological diversity of NSW. This issue is targeted within Objective 3.4 “Improve fire management regimes”, specifying the following actions;

- Action 43: Manage fire in accordance with Ecological Sustainable Development principles.
- Action 44: Improve the consideration of fire threat in land-use planning and incorporate the results of applied fire research, including the knowledge and experience of Aboriginal and local communities, in land management and land-use planning.
- Action 45: Continue a research program to examine the effects of fire on biodiversity.

1.4 Reserve management objectives

The overall management of the Tarawi Nature Reserve is prescribed by objectives stated in the *National Parks and Wildlife Act, 1974* and the Reserve’s Draft *Plan of Management*. It is a requirement under the Act that no operations and actions are to be undertaken that are contrary to the Plan of Management.

The purposes for dedicating *Nature Reserves* in New South Wales as described in the *National Parks and Wildlife Act (1974)* are:

- The care, propagation, preservation and conservation of wildlife,
- The care, propagation, preservation and conservation of natural environments and natural phenomena,
- The study of wildlife, natural environments and natural phenomena, and
- The promotion of the appreciation and enjoyment of wildlife, natural environments and natural phenomena.

The **policies** contained in draft *Tarawi Nature Reserve Plan of Management* which affect fire management of the Reserve are:

- Fire will be managed to ensure:
  - protection of life and property,
  - fire regimes are compatible with the conservation of biodiversity,
  - maintenance of species and habitat diversity,
  - protection of Aboriginal sites, historic places. scientific study sites and management infrastructure.
- All wildfires will be contained as required by the incident and in accordance with policies detailed in the Reserve Fire Management Plan.
- Prescribed burning may be used where appropriate and will generally be timed to approximate the desirable natural fire regime.
- Preference will be given to fire suppression techniques which have the least impact on the landscape. Use of heavy equipment off existing roads and tracks will be avoided where possible.
- Liaison will be maintained with Rural Fire Service, fire brigades, shire councils and local land owners/leasees to ensure co-ordination in suppression of wildfires in the reserve and adjoining land.
- The Service will continue to develop co-operative strategies with other authorities and landholders as a basis for fire management.
- Research and monitoring will be encouraged into:
  - the behaviour of fire in mallee ecosystems,
  - the effects of fire on mallee community vegetation and fauna,
  - the effects of fire in woodland communities,
  - identification of fire sensitive flora and fauna.

The **actions** contained in the draft *Tarawi Nature Reserve Plan of Management* which effect fire management of the Reserve are:

- A fire management plan will be prepared for Tarawi Nature Reserve. It will detail fire management objectives, strategies, programs, co-operative arrangements and resource and neighbouring lands protection considerations based on an analysis of fire history and species requirements. Incremental reviews of the plan may be undertaken in response to major wildfires, research findings and other significant events.
- The Service will aid facilitation of section 41AB District Co-operative Fire Management Plans and fuel management plans in conjunction with local District Fire Committees.
- Records of fire occurrence, patterns and effects will be maintained and post-fire regeneration will be monitored.
- All existing internal and perimeter fire breaks will be maintained.
- The co-operation of all relevant authorities will be sought in reducing the severity of unplanned fire in the reserve and surrounding properties.

2. DESCRIPTION OF THE RESERVE

2.1 Location and regional setting

Tarawi Station was purchased by the NPWS in September 1994, and gazetted in April 1996 as Tarawi Nature Reserve for the purpose of conserving a portion of the "Scotia" mallee landsystem. There is no recreational infrastructure provided for public visitation.

Tarawi NR is approximately 33,620 hectares in area and is located in the far south-west of New South Wales adjoining the South Australian border, approximately 150 kilometres north-west of the township Wentworth and 65 kilometres due north from the Murray River (Figure 1).

Situated on Tarawi NR's western boundary in South Australia is the large Danggali Conservation Reserve. On the northern boundary is Scotia Sanctuary, owned and operated by Earth Sanctuaries Ltd. Adjoining the southern and eastern boundaries are Western Lands Commission leases, Belmore, Wenba and Belvedere Stations. The primary land-use on these leases is sheep grazing on native pastures.

Regionally, sheep production on unimproved native pastures is the dominant land-use. A relatively small amount of mechanical clearance of vegetation has occurred although in some areas particularly around the many watering points, substantial landscape modification has taken place.

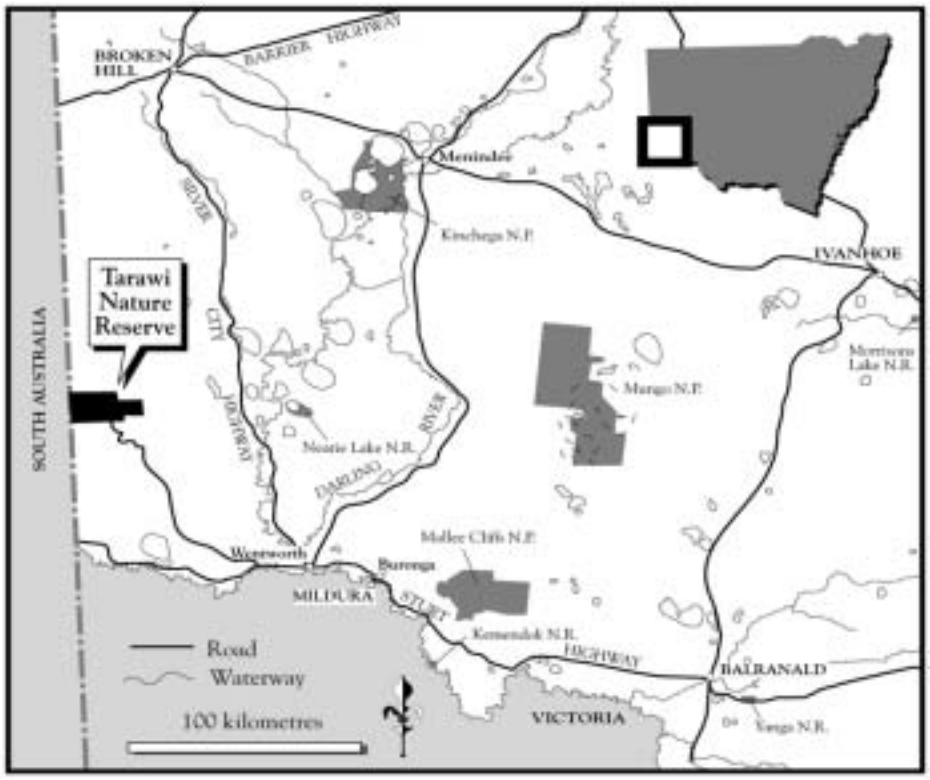

Figure 1: Location of Tarawi NR

2.2 Climate

The Scotia region is towards the northern most extent of mallee in New South Wales extending into the arid climatic zone of less than 250 millimetres of annual rainfall. The region experiences hot and usually dry conditions from December to March with maximum temperatures reaching over 40 degrees Celsius. However, thunderstorms can be common during summer months and are often associated with little or no rainfall. Prevailing winds are generally northerly in summer and southerly in winter.

The average rainfall at Tarawi NR is 250mm (calculated from data collected at Tarawi from 1941 to present). However, characteristic of the western region of NSW, this rainfall is unpredictable and extremely variable in terms of both annual and seasonal patterns. This is reflected in the distribution of monthly rainfall through the year using averaged data from 1941 to 1996 (Figure 2). There is no obvious discernible seasonal pattern of rainfall through the year. Figure 3 shows the large annual variation in rainfall at Tarawi NR.

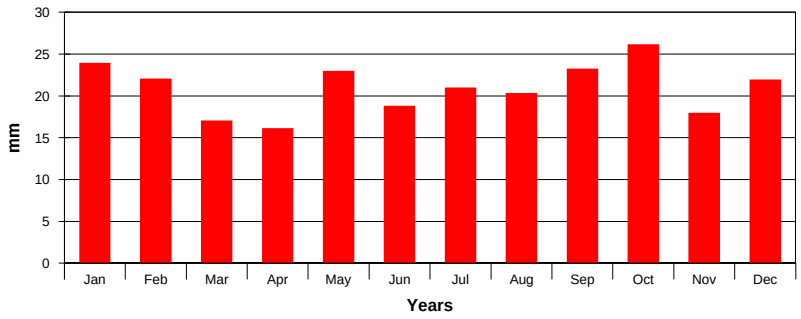

Figure 2: Average monthly rainfall (1941-1996)

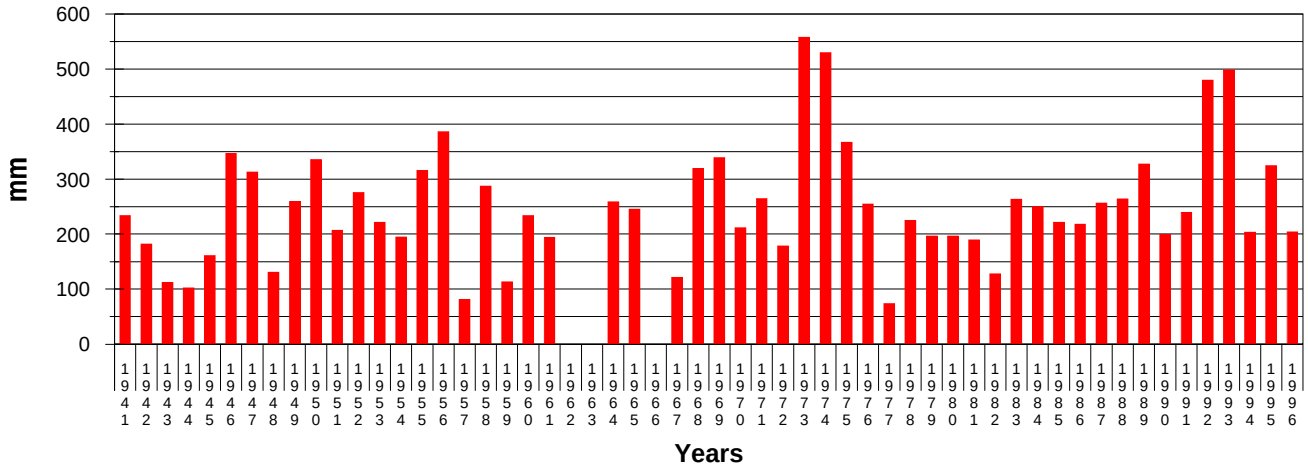

Figure 3: Historical yearly rainfall (1941-1996)

(Note: data missing for 1962, 1963 and 1966)

2.3 Terrain

Tarawi NR is located in the Scotia and Ennisvale land systems (NSW Department of Land and Water Conservation). The dominant landform consists of parallel dunes with narrow sandy swales and small to large open calcareous swales. The dunes travel in an east-west direction and are up to ten metres in height. Individual dunes may form an unbroken line to six kilometres in length. There are also patches of sandy interdune plains up to twenty square kilometres in area. The other dominant landform type is flat extensive plains of calcareous loamy sands overlying light clay sub-soil. Surface flow of water is limited due to the sandy nature of the soils. However, moisture accumulates in the swales and open flats where the soil texture is heavier.

2.4 Biodiversity

The conservation significance of Tarawi NR can be summarised as follows:

- Species-rich mallee vegetation alliance which has been subject to low levels of vegetation clearance.
- A diversity of long unburnt and recently burnt mallee communities are present.
- Good example of the Scotia landsystem in NSW.
- Relatively short commercial grazing history. Sheep grazing at Tarawi commenced around 1929.
- Relatively low grazing pressure from commercial stock (particularly in northern areas of the Reserve) due to a restricted number of artificial watering points and the low grazing value of the Mallee-spinifex vegetation community.
- Several threatened, vulnerable and other significant mallee flora and fauna species are present.

2.4.1 Flora

Preliminary mapping has been undertaken of the vegetation of Tarawi NR. Four broad vegetation communities are described below (with percentage area represented within the Reserve) and illustrated in Map 1 (Section 9). The fire potential of these communities are assessed and discussed in Table 1.

1. <u>*Eucalyptus* tall mallee shrubland with spinifex understorey</u>
("Mallee-spinifex") (55%)
Occurs in patches or in broad areas. Consists mainly of *Eucalyptus socialis* and *E. dumosa* with the dominant *Triodia scariosa* (spinifex or porcupine grass) understorey occurring on the east-west parallel sand dunes or inter-dune dunefields. Shrub layer species include *Beyeria opaca, Acacia spp.* and *Olearia spp.* The Mallee cypress pine (*Callitris verrucosa)* may occur as small sparsely distributed clumps on the dunes. The desert poplar (*Codonocarpus cotinifolius)* may be a common tree in areas burnt up to fifteen years previously. This community has been broadly mapped to include the swale areas which occur in between the sand dunes. In the swales the soil is more heavily textured and *Triodia* is replaced by shrub species such as *Acacia colletioides, Senna* and *Eremophila* species and Hopbush (*Dodonea viscosa*

ssp. angustissima). Scattered Belah (*Casuarina cristata)* may occur in larger swales.

2. *Eucalyptus* tall mallee shrubland with a mixed shrub understorey ("Mallee-sandplain") (13%)

Occurs in patches on large red sandy plains (as distinct from "swales") consisting mainly of Pointed Mallee (*E. socialis* and *E. gracilis)* overstorey. The understorey is variable and diverse, consisting of mainly perennial shrub species (including *Acacia, Olearia,* and *Pimelia* species*,* Comb Spider-flower (*Grevillea heugelii)* and Smooth Wallaby-bush *(Beyeria opaca)*), herbaceous species (*Zygophyllum spp*.) and various chenopod species. Scattered clumps or individuals of Belah (*Casuarina cristata)* may occur throughout this community.

3. *Casuarina cristata* woodland with a mixed understorey ("Belah woodland") (15%)

Occurs in patches or in broad areas on the heavier textured brown calcareous soils and often associated with Rosewood (*Alectryon oliefolius)*. The understorey may consist of a diverse mixture of various chenopod, herbaceous and shrub species, or can be quite sparse and un-diverse. Belah woodlands can have a variable structure from being quite dense to very open.

4. Mixed open shrubland/woodland (17%)

Occurs in broad areas on calcareous clay soil. Overstorey species may include Belah or Mallee trees. Other tree species such as Wilga (*Geijera parviflora)* may be dominant in localised patches. Open areas of Pearl Bluebush (*Maireana sedifolia)* and Black Bluebush (*Maireana pyramidata)* are also present. Ground layer species are generally very sparse or absent. Patches of Hopbush (*Dodonea viscosa ssp. angustissima)* and *Eremophila* species occur particularly in areas where grazing pressure has been high near watering points, where ground layer species can also be very sparse or absent. This community has been subject to historically high grazing pressure from domestic livestock. Currently, in some areas grazing pressure remains high from feral and native herbivores.

Table 1 below summarises the fire potential assessment of the broad vegetation communities of Tarawi NR in different fuel conditions typically experienced in semi-arid mallee.

Broad Vegetation Community	Perennial fuel conditions ("normal" years)	Perennial plus ephemeral (speargrass) fuel conditions
1. Mallee-spinifex	High *(presence of spinifex, mallee and litter on dunes and dunefields, particularly in long unburnt Mallee-spinifex)*	High *(as for perennial fuel conditions, plus ephemeral fuel in dune swales)*
2. Mallee-sandplain	Moderate *(perennial vegetation (mallee and shrubs) plus litter occurs in discrete clumps with sparse fuel in between, require extreme weather conditions for fire to travel)*	High *(perennial fuel present in clumps with ephemeral fuels in between)*
3. Belah woodland	Low *(generally sparse ground fuels present)*	Low-Moderate *(ephemeral fuels only present in more open Belah woodlands)*
4. Mixed open shrubland/ woodland	Low *(perennial fuel sparse with generally sparse ground fuels present)*	High *(perennial fuel present with ephemeral fuels)*

Table 1: Fire potential assessment of the broad vegetation communities

Note: see section 3.2 for definitions of "perennial" and "perennial plus ephemeral" fuel conditions. The "fire potential" is a general assessment referring to the flammability of the community and the likelihood for fire to spread through the community given suitable weather conditions

Several significant plant populations have been identified at Tarawi NR. In this plan, the term "significant" is used to describe plant populations or species which may be "Endangered" or "Vulnerable" (listed in the NSW Threatened Species Act, 1995), considered "Restricted" in distribution (Bowen and Pressey, 1993) or considered to be locally unique or under threat for a variety of reasons. The status and fire potential of significant plant populations at Tarawi NR is described in Table 2 and their locations illustrated in Map 2 (Section 9).

2.4.2 Fauna

Tarawi NR supports a diversity of mallee species including several endangered and vulnerable species. From biodiversity survey work recently conducted in the Reserve by the NPWS, the number of native species present are: 127 birds, 48 reptiles, 16 mammals and 2 amphibians (as at 31/3/98). More recent survey work has revealed the presence of approximately 32 reptile species in the Mallee-spinifex community alone (total number of species combined for long unburnt and recently burnt habitats). Table 3 lists the significant fauna species recorded at Tarawi NR and their status classifications. See Appendix 1 for information on the fire ecology of these species.

2.5 Cultural heritage

At present little is known regarding past Aboriginal occupation of Tarawi NR. However, two main areas have been identified in the Reserve (near House tank and Canegrass bore) which consist of scattered stone flakes and fire place sites (Map 3, Section 9). Several European heritage sites are also present in the Reserve (Map 3). These are mainly old brush or post and rail yards used in the early pastoral period.

Significant Plant Populations	VegC	Distribution & Status	Fire Potential & Ecology
Desert spider-flower *(Grevillea pterosperma)* Classified "Restricted" (Bowen & Pressey, 1994)	1	Two main isolated patches in recently burnt areas. Considered restricted in the region.	**High** fire potential due to surrounding Mallee-spinifex. May require fire to promote seedling recruitment.
Mallee cypress pine *(Callitris verrucosa)*	1	Isolated occurrences in Tarawi with little seedling recruitment evident, generally restricted in the region.	**High** fire potential due to Mallee-spinifex habitat.
Bladder senna *(Swainsona colutioides)* Classified "Endangered" (TSC Act, 1995)	1	Known locations in NSW are only in Tarawi NR and Scotia Sanctuary in recently burnt areas.	**Low** fire potential as the plant only survives for 2-3 years post-fire during which time no fire can re-occur. Fire important for promoting germination of soil-stored seed.
Bluebush daisy *(Cratystylis conocephala)* Classified "Endangered" (TSC Act, 1995)	2-3	Isolated occurrences. Little or no recruitment evident.	**Low to moderate** fire potential due to sparse surrounding understorey♣.
Needlewood/ Hooked needlewood *(Hakea leucoptera/ Hakea tephrosperma)*	2-4	Considered restricted and uncommon in the region. Little or no recruitment evident.	**Low to moderate** fire potential due to generally sparse surrounding understorey♣.
Quorn mallee *(Eucalyptus porosa)*	4	Very old and large trees, considered restricted in the western region of NSW (Bowen and Pressey, 1993). No recruitment evident.	**Low** fire potential due to sparse understorey♣.
Mulga *(Acacia aneura)*	4	Two very small patches known on Tarawi NR. Considered restricted and uncommon in the region. No recruitment evident.	**Low** fire potential due to sparse understorey♣.
White cypress pine *(Callitris glaucophylla)*	4	Isolated occurrences in Tarawi with little seedling recruitment evident, generally restricted in the region.	**Low** fire potential due to very sparse degraded understorey♣.
Red mallee *(Eucalyptus socialis)*	4	Small patch of extremely old growth woodland. Considered unique.	**Low** fire potential due to sparse degraded understorey♣.

Table 2: Distribution, fire potential and ecology of significant plant populations

Note: "fire potential" is a general assessment referring to the flammability of the community and the likelihood for fire to spread through the community.

- VegC = the broad vegetation community (described previously) the population is known to inhabit.

♣ = the low fire potential for communities which occur in the Broad Vegetation Communities 2,3 and 4 may increase to high in perennial plus ephemeral (speargrass) fuel conditions after effective seasonal rainfall.

	Species	VegC	Endangered	Vulnerable	Concern
Birds	Black-eared Miner (hybrid only) (*Manorina melanotis*)	1-2	*		
	Malleefowl (*Leipoa ocellata*)	1	*		
	Chestnut Quail-thrush (*Cinclosoma castanotum*)	2		*	
	Gilbert's Whistler (*Pachycephala inornata)*	2		*	
	Grey Falcon (*Falco hypoleucos*)	1-4		*	
	Pied Honeyeater (*Certhionyx variegatus*)	1-2		*	
	Pink Cockatoo (*Cacatua leadbeateri*)	1-4		*	
	Purple-crowned Lorikeet (*Glossopsitta porphyrocephala*)	2-4		*	
	Shy Hylacola (*Sericornis cautus*)	1-2		*	
	Southern Scrub-robin (*Drymodes brunneopygia)*	2		*	
	Striated Grasswren (*Amytornis striatus*)	1		*	
	Mallee Jacky Winter *(Microeca leucophaea assimilis)*	1-2			#
	Red-chested Button-quail *(Turnix pyrrhothorax)*	2-4			#
Mammals	Bolam's Mouse *(Pseudomys bolami)*	1-4	*		
	Southern Ningaui (*Ningaui yvonneae*)	1		*	
	[Bat species] (*Eptesicus baverstocki*)	1-4		*	
	Little Pied Bat (*Chalinolobus picatus*)	1-4		*	
Reptiles	Western Blue-tongue Lizard (*Tiliqua occipitalis*)	1-2		*	
	[Skink species] *(Ctenotus brachyonyx)*	1			1
	Mallee Dragon *(Ctenophorus fordi)*	1			1
	Jewelled Gecko *(Diplodactylus elderi)*	1-2			2
	[Snake-lizard species] *(Delma australis)*	1			2
	Common Scaly-foot *(Pygopus lepidodus)*	1-2			3

Table 3: Significant fauna species and status classifications

Note: Information to 31/3/98. *See Appendix 1 for distribution and fire ecology details*.
Definitions of column headings:

- VegC = the broad vegetation community (described previously) the species is known to inhabit.
- "Endangered" = Schedule 1 and "Vulnerable" = Schedule 2 from the NSW Threatened Species Conservation Act (1995).
- "Concern" classification from Smith etal (1995):

= possibly threatened in Western Division

- "Concern" classification from Sadlier & Pressey (1994):

1 = concern at National level, 2 = State level, 3 = Regional level.

3. FIRE ENVIRONMENT

Mallee communities may have a variety of flammable understorey types. In south-western NSW spinifex is a dominant perennial fuel on lightly textured sandy soils on sand dunes and dunefields. Dune swales have a lower fire potential as they support less spinifex and a sparser ground layer. Other communities such as Belah-Rosewood on heavier soils support a variety of understorey types but generally have lower fuel loads and a less flammable perennial understorey. The amount of seasonal rainfall is extremely important in determining annual fuel loads in all mallee communities. Such fuel dynamics combined with the major type of ignition, lightning, makes mallee wildfires highly unpredictable and irregular in occurrence (Noble and Vines, 1993).

3.1 Fire history

Map 4 (Section 9) illustrates the recent fire history (both wildfires and prescribed burns) in and around Tarawi NR.

Wildfires, ignited by lightning, account for approximately half of the fires mapped since 1969 in and around Tarawi NR. Most of these mapped wildfires are relatively small, have occurred relatively infrequently and at an irregular interval. Also, most mapped fires (wildfires and prescribed burns) have been in the Mallee-spinifex vegetation community (see Table 4). Due to mapping difficulties as discussed below, there has probably been more Mallee-sandplain burnt in recent years than indicated in Table 4.

From anecdotal information and other fire history research, it appears that the most recent large-scale wildfire that occurred in and around Tarawi NR prior to the fires mapped in Map 4 was in the summer of 1917-18 (see newspaper article extract on cover page). This is also evidenced by numerous old burnt stumps that can be found throughout Tarawi NR in all vegetation communities. It is further assumed that most, if not all of Tarawi NR was burnt in this wildfire as was a large proportion of the Scotia region. This event was preceded by two well above-average rainfall seasons when ephemeral fuel loads would have been extremely high. Most of the white background in the fire history map of Tarawi NR (Map 4) can therefore be generally considered as burnt in 1917-18.

Map 4 also illustrates the prescribed burns that have been conducted in Tarawi NR in recent years. These burns were undertaken by previous owners for pastoral reasons (largest in 1979) and by CSIRO scientists for experimental reasons (large fire in March 1984 - very patchy because it was lit by aerial incendiaries). Previous owners were fairly active in burning to encourage the growth of more palatable post-fire grasses and herbs for stock feed, particularly in the Mallee-spinifex vegetation community. Generally these fires were lit in cool conditions (often while mustering stock) and were often very small in size (John Martin, pers comm. 1996). Recently the NPWS has conducted small prescribed burns in three areas (Map 4).

BROAD VEGETATION COMMUNITY			MAJOR FIRES																			
			1997			1996			1985			1984			1979			1979 ?			1969		
	Area ha	% Res	Area ha	% Veg	% Res	Area ha	% Veg	% Res	Area ha	% Veg	% Res	Area ha	% Veg	% Res	Area ha	% Veg	% Res	Area ha	% Veg	% Res	Area ha	% Veg	% Res
Mallee-spinifex	18360	55	416	2	1	66	<1	<1	63	<1	<1	2673	15	8	949	5	3	111	<1	<1	145	<1	<1
Mallee-sandplain	4429	13	5	<1	<1	6	<1	<1	6	<1	<1	3	<1	<1									
Belah woodland	4980	15										61?	<1	<1	4	<1	<1	3	<1	<1	30	<1	<1
Mixed open shrubland/woodland	5852	17										353?	6	1	2	<1	<1						
TOTAL	33620	100	421		1	72		<1	69		<1	3092		9	954		3	114		<1	175		<1

Table 4: Fire history of broad vegetation communities

Note: Areas in 1984 column marked "?" denotes that it is unlikely that such large areas of these communities burnt in these fires, it is more likely the areas burnt were Mallee-spinifex or Mallee-sandplain communities. This problem is due to limitations of the vegetation mapping database, as discussed in the main text.

Figure 4 graphically illustrates how long unburnt mallee ("80+") is the dominant age class of Tarawi NR. However, as explained below this should be qualified - the mapped fires could be regarded as a conservative estimate of fire activity, therefore there is probably slightly less long unburnt mallee than is portrayed in Figure 4.

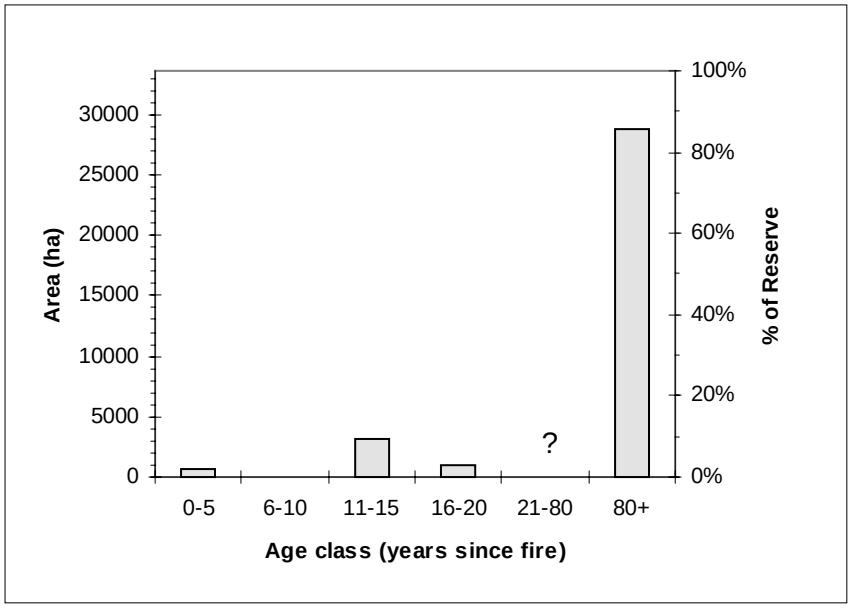

Figure 4: Fire history age classes (as at July, 1998)

The mapped fire history of Tarawi NR should be regarded as a conservative indication of recent fire activity, in and around the Reserve. Until recently, accurate records of fires have not been maintained. From anecdotal information, there are at least two fires where the location is only generally known. The boundary of these fires are not mappable and are shown as a general point locations only in the fire history map (Map 4), and as "?" in Figure 4. In addition, there were probably more small fires deliberately lit during this period by previous owners that are too small and/or too old to be able to be mapped with any confidence.

Despite the fire mapping limitations, it is clear that the fire frequency of Tarawi NR has been relatively low over this century. Since the large fire of 1917-18, the majority of fires and the largest fires have been in the last 20 years and mostly in the Mallee-spinifex vegetation community. Approximately 15% of the Reserve has been burnt twice this century, the remainder probably burnt only once. However, due to mapping limitations as explained above, the 15% is probably the minimum area that has burnt twice. Only a small area (approximately 50 hectares) is known to have burnt three times where the November 1997 fire re-burnt a portion of the March 1984 fire (with the assumption that the area also burnt in 1917-18).

Historically there were lightning strikes in Tarawi which only burnt the immediate vicinity of the strike before naturally extinguishing due to lack of fuel and/or wet conditions associated with the lightning storms (John Martin, pers comm.). It is plausible that the larger areas burnt by prescribed burning may have impeded the development of more wildfires ignited by lightning strikes.

It is important to give a regional perspective when describing the fire history of Tarawi NR. Besides the 1917-18 event, other recent wildfires that have occurred in the region include:

- 1950: Large fires in and south of Danggali Conservation Park.
- 1974-75: Large fires in properties north of Tarawi NR and in the rest of south-west NSW.
- 1977, 1979, 1984-85: Large fires in Danggali Conservation Park.
- 1996: Several small to moderately large fires in Scotia region north of Tarawi NR (the closest being approximately five kilometres from the north boundary).
- 1997: Three small fires in Danggali Conservation Park and north Scotia region.

In summary, Tarawi NR has been subjected to relatively few fires this century. Except for the 1917-18 event most have been relatively small (particularly on a regional scale). Since 1918, it appears most fire activity has occurred only since the late 1970's and approximately half of the fires (excluding recent NPWS burns) have been prescribed burns. Historically, there has been considerable wildfire activity around the Reserve though there is still large areas of long unburnt vegetation present. During the last 20 years at least, previously burnt areas in and around Tarawi NR may have impeded the development of more wildfires from observed lightning strikes which potentially could have burnt large areas, particularly in the long unburnt Mallee-spinifex vegetation. Considering the high fire potential of the vegetation present and the large wildfires that have occurred historically in the region, it is probably only by chance that there has not been more wildfire activity in Tarawi NR.

3.2 Conditions associated with bush fires

The conditions associated with wildfires in the NSW south-west mallee can be separated into *weather* and *fuel conditions.*

Weather Conditions

During summer high fire potential periods occur when large high pressure systems are stationary in the south-east corner of the continent causing northerly winds to carry hot and dry air from inland Australia.

High fire danger weather conditions are characterised by high temperatures, low relative humidity and strong northerly winds. Ignition potential is increased when approaching low systems (from either south-west of the continent or from monsoonal influences in the north) create atmospheric instability causing lightning storms. Often these storms are "dry" so that lightning ignition more readily causes wildfire.

Depending on the origin of the approaching low system, a predictable wind shift usually occurs as the storm passes. Fires often travel from north to south initially but then can turn as the wind shifts southerly as the low pressure passes and dominates. Fires often then turn and burn in a northerly direction. A suppression strategy commonly used for mallee fires is to concentrate on controlling a particular flank in anticipation of the forecasted wind shift.

Fuel Conditions

The influence of effective seasonal rainfall on fuel loads can be dramatic and is a primary determinant of high fire potential in semi-arid mallee country. **Effective rainfall** is used in this plan to describe:

> *Rainfall that causes an ephemeral herbage response which when cured, greatly increases the ignition potential and spread of wildfire.*

These seasons after effective rainfall are locally termed “speargrass years” as the ephemeral fuel loads are dominated by *Stipa* (speargrass) species. Effective rainfall may be very much above the annual average, or can be average rainfall but timed appropriately during warm seasons (autumn or spring) which gives rise to good germination conditions for speargrass. Historically, the best speargrass years have been caused by effective rainfall over two years and often following drought.

The speargrass dominates in heavier textured soils which normally have sparsely distributed and light ground fuel loads, such as occurs mallee sandplain, mixed open shrubland/woodland, dune swales and the more open of the Belah woodlands. Speargrass will generally not form high fuel loads in the sandier soils on dune-fields and dune crests.

The increased cover and flammability of the fuel in speargrass fuel conditions increases the chance of ignition by lightning and increases the spread and intensity of wildfires. The result is an almost continuous highly flammable fuel state throughout the mallee communities. In south-west NSW these extreme fuel conditions have only occurred a few times this century - the most recent during the summer of 1974-75 after two years of extremely high rainfall (in Tarawi NR, for example, approximately two times the average rainfall was received in 1973 and 1974). The same conditions were probably experienced before the 1917-18 wildfires in SA and NSW.

> ***“Speargrass to one metre in height covered the southern two-thirds of the Western Division, producing a fuel load of the order of 5-6 tons per acre (12-15 tonnes per hectare), linking fuel types which would otherwise be very different in fire behaviour.” (Annual report, Western Lands Commission, 1975)***

As important as the amount of rainfall that occurs is the **seasonal timing** of the rainfall. Good autumn and spring rainfall is generally required to encourage the germination of ephemeral species which when cured the following summer may present a high fuel hazard. A cumulative effect can occur whereby the following seasonal conditions are favourable for the germination of the increased soil seed storage (from the preceding season), which presents an even greater standing fuel hazard the next summer. Such conditions occurred in western NSW during 1973-74 and extensive wildfires resulted in the summer of 1974-75, as described above. However, at Danggali National Park in South Australia a “speargrass” year in the summer of 1984-85 which caused large wildfires resulted from only an “average” annual rainfall of approximately 250 millimetres in both 1983 and 1984. In this instance although the annual totals were relatively insignificant, the seasonal timing of the rainfall was the over-riding factor in encouraging speargrass germination (Mate Osborne, pers comm.). In contrast, speargrass conditions did not prevail when in 1992 and 1993 there was 480mm and 498mm (respectively) rainfall recorded at Tarawi NR (nearly double the annual average).

These examples highlight the importance of the seasonal timing of the rainfall in determining whether a "speargrass year" will result . One characteristic of speargrass years is that it appears they often follow at least two years of drought conditions. Other related factors affecting speargrass germination may include soil and air temperatures during and following the rainfall. Bradstock (1990) states that "the task of describing and understanding the nature of fuels and fire behaviour in mallee, in a quantitative manner, is in its infancy".

For the purposes of this plan, the description of fuel conditions associated with fire will be divided into:

- **Perennial fuel conditions** - consisting primarily of mallee trees and litter, shrubs and spinifex. This is the "normal" state of mallee fuel experienced in the majority of years. Fires that occur during these conditions are variable in size and intensity and are mainly restricted to the Mallee-spinifex community, and to a lesser extent the Mallee-sandplain community.

- **Perennial plus ephemeral fuel conditions** - Fuel state occurring infrequently consisting of perennial vegetation plus ephemeral species of various grasses and herbs, but particularly the highly flammable speargrass (*Stipa* species) which dominates in the Mallee-sandplain, open Belah woodland and Mixed open shrubland/woodland communities, after **effective** rainfall. Under these conditions there is a more continuous fuel load across all communities than in "perennial fuel conditions". Most fires that occur during these conditions are often large in size and moderate to high in intensity.

In summary, the fuel conditions associated with major wildfires depend largely on the presence of ephemeral growth which is in turn reliant on the amount and seasonal patterning of rainfall. The fire potential of different mallee vegetation communities is thus dynamic through time and space according to the type and extent of prevailing fuel conditions. Table 1 (Section 2.4.1) describes the fire potential of Tarawi NR's broad vegetation communities according to seasonal fuel conditions.

3.3 Conditions suitable for prescribed burns

The conditions associated with prescribed burning in the NSW south-west mallee (which are applicable to Tarawi NR) can be separated into weather and fuel conditions.

Weather Conditions

In general, the most favourable periods for prescribed burning occur when there is:

- Decreasing temperature and increasing humidity;
- Even breeze less than 15km/h,
- High level of moisture recovery in fine fuels at night,
- Low probability of dry north-westerly winds.

However, due to the often patchy nature of fuel in mallee communities, fire will not carry well when conditions are too cool, humidity too high and/or wind too light. Most burning is undertaken late afternoon before these conditions are reached later in the evening. Highest levels of moisture recovery in fine fuels at night will occur from mid autumn to early spring. There is a high probability for fire to be self-extinguishing

during this period, minimising the risk of prescribed burns becoming uncontrolled fires.

Analysis of computerised weather data currently being collected at Tarawi NR will assist in planning prescribed burning operations. The data will also be used to as a learning tool by relating fire behaviour with weather conditions.

Fuel Conditions

As described in Section 3.2, depending on rainfall patterns, there are two broad fuel conditions which determine fire potential in the NSW south-west mallee. Prescribed burning (for whatever purpose) may be undertaken under either fuel conditions. However, problems with prescribed burning under speargrass conditions may include:

- A narrow "window of opportunity" in spring-summer after the ephemeral fuels are cured enough to burn and before weather conditions become unsuitable for "safe" burning to be undertaken,
- The risk of hidden woody embers (underground and aerial components) continuing to smoulder after burning, and re-flaring when conditions warm,
- The risk of speargrass resprouting and curing during summer if soil moisture remains high and/or enough summer rainfall is received.

3.4 Fire behaviour potential

The vegetation in mallee communities is generally extremely flammable. The fire-promoting characteristics of mallee communities which encourage sometimes extreme and unpredictable fire behaviour include:

- Resinous E*ucalyptus* foliage,
- Often a low tree canopy promoting crowning fire behaviour,
- Annually shedding bark which often remains as suspended fuel and acts as a flammable link between the understorey and the canopy,
- High (and highly aerated) litter fuel loads combined with flammable shrub and/or grasses, particularly in long unburnt Mallee-spinifex and Mallee-sandplain,
- High spotting potential during wildfire due to combination of flammable understorey, suspended bark fuel and *Eucalyptus* foliage,
- Association with highly flammable perennial spinifex (*Triodia scariosa*) understorey,
- Association with highly flammable ephemeral speargrass (*Stipa spp*.) after effective seasonal rainfall.

Mallee is one of the most flammable rangeland types in Australia (Noble, 1984). In south-western NSW, this is evidenced by extensive wildfires that have been recorded such as those in the summer of 1974-75. As described in Section 3.2 these events have primarily occurred when effective seasonal rainfall has produced abundant speargrass fuel loads in communities that would normally carry low ground fuel loads. Fires that occur during these periods have historically been large, intense with a fast rate of spread and very difficult to suppress. Suppression operations are also hampered by difficulty of access particularly in remote mallee areas (as in the Scotia region).

Even under perennial fuel conditions when the dominant ground fuels are spinifex and shrubs, fires can be very difficult to suppress. Prescribed burns can also be difficult to contain. Wildfires may burn many hundreds of hectares and travel many kilometres until it is safe enough to commence suppression operations, usually only after fire weather conditions ameliorate.

3.5 Damage potential

The damage potential of wildfires in and around Tarawi NR can be placed into three categories: life and property, natural heritage and cultural heritage.

Life and Property
Regionally, the resident population around Tarawi NR is very low and sparsely distributed. There are no nearby towns. The threat to life is mainly applicable to fire fighters during fire suppression operations.

The main damage potential to properties around Tarawi NR includes commercial stock (also including enclosed native animals at Scotia Sanctuary), fencing and other infrastructure. There is no infrastructure such as homesteads and workshops within at least five kilometres of the Tarawi boundary. Conversely, wildfire may also enter Tarawi NR from neighbouring properties particularly where Mallee-spinifex and Mallee-sandplain vegetation is continuous across the boundary.

Natural Heritage
Section 4 details fire management biodiversity objectives and strategies to address the known ecological requirements of the vegetation communities and fauna of Tarawi NR. Operational guidelines relating to the appropriate use of heavy plant during fire suppression operations are detailed in Section 4.4. This is important as in semi-arid environments the effects of soil damage and vegetation clearance from control line construction can be evident for many years.

Cultural Heritage
Aboriginal and European cultural heritage sites known within Tarawi NR are shown in Map 3 (Section 9). Aboriginal sites are mainly remnants of campsites consisting of scattered flaked stones. The European sites are mainly different types of old timber stock yards.

At Tarawi NR all cultural heritage sites are situated in low fire potential vegetation communities under “perennial” fuel conditions. However, under speargrass fuel conditions, some sites may be at risk from wildfire particularly the flammable timber stock yards. In addition, sites may be threatened by inappropriate use of heavy plant used during fire suppression operations.

4. FIRE MANAGEMENT

4.1 Biodiversity conservation

Conservation is about the maintenance of ecosystem processes and the management and the prevention of the extinction of species (especially extinction brought about by the action of humans). Contemporary ecological research in fire

prone and fire promoted ecosystems of the kind represented in Tarawi NR has established some general **principles** about the fire regimes needed to avoid the extinction of species and thus conserve biodiversity:

- **Groups of plant and animal species respond to fire according to characteristics of their life-history.** Therefore it is generally not necessary to individually specify fire regimes for the conservation of every species. Rather an overview is needed of the requirements for broad groups of species. Requirements for most plant species can be summarised on the basis of a small number of groups. Knowledge of requirements for groups of animals is less advanced.

- **Animals and plants are interrelated.** Plant communities are integral as habitat for animals. Fire management must consider this important interaction.

- **A diversity of fire regimes is required to maintain biodiversity.** This means that over time there is a place for fires of high, low and moderate intensity, differing frequency, season and size. Extinction may be likely when fire regimes are relatively fixed or static. Variability both in species responses and in fire regimes has been recognised as a factor that allows persistence and resilience of plant and animal communities (Bradstock and Keith, 1995).

- **For many groups of species or communities, thresholds (or guidelines) separating desirable and undesirable fire regimes for conservation can be defined**. There is a threshold that demarcates a critical change from high species diversity to low species diversity. Once thresholds are defined as management guidelines, management becomes more flexible because it is not aimed at directing an ecosystem toward a single state but rather maintaining it within a range of states within the guidelines. Biodiversity guidelines for fire management have been formulated for Tarawi NR using available scientific and local knowledge on mallee fire ecology. Tarawi NR's fire history has been evaluated according to these guidelines and management objectives and strategies are proposed.

4.1.1 Mallee fire ecology

Vegetation:
Mallee dominated communities contain plant species which are generally fire tolerant while some may be considered fire promoted. Mallee trees and other perennial species regenerate after fire in a variety of ways.

For mallee eucalypts, the regeneration method can be from seed or vegetative regrowth. Fire will kill all the above ground parts of the plant and regeneration will occur from the lignotuber (or other underground parts in many other mallee woody shrubs) or from seedling recruitment. Very low intensity fires may only lightly scorch the foliage and regeneration may occur from aerial buds on the branches.

In mallee ecosystems, fires are important in the release of nutrients for growth as the processes of decay and oxidation are slow in semi-arid climates. Immediately post-fire, there is a dramatic increase in the availability of many limiting nutrients, particularly nitrogen and phosphorus (Humphreys, 1969).

Fire creates an opportunity for many species to reproduce and increase their populations with new individuals in mallee communities. Shortly after fire there is usually a “flush” of short-lived ephemeral grasses and herbs which germinate from soil stored seed and temporarily increase local plant diversity. A combination of factors including increase in topsoil nutrients, disturbed soil crust and the lack of competition from the perennial components for light and nutrients enable the germination, reproduction and dominance of the ephemerals for 1-4 years post-fire. Fire enables these short-lived opportunistic species to reproduce and “top up” their soil-stored seed banks.

Many perennial species may also regenerate by seedling recruitment taking advantage of the post-fire conditions described above, such as *Eucalyptus*, *Myoporum* and *Acacia* species. Some perennial species can only regenerate by seed germination after fire such as *Callitris verrucosa*, *Beyeria opaca, Dodonea viscosa* and some chenopod species. The plants of such species are generally easily killed by fire and they are unable to regenerate vegetatively.

For many mallee plant species, seedling recruitment is very low or absent without the occurrence of fire, which is why mallee is often termed a “fire-promoted” or “fire-dependant” vegetation type. This species includes *Eucalyptus*, many *Acacia* species and spinifex. Without fire, new individuals are not normally recruited into their populations. “Hotter” fires may promote increased seedling recruitment of such species compared to “cool” less intense fires.

Perennial plant species that depend on fire to provide a major stimulus or opportunity for seedling recruitment are susceptible to decline by too frequent fires. After fire, there needs to be enough time for seedling germination and establishment, through to maturity and reproduction (flowering, seed set and seed shedding). There may need to be several periods of reproduction so that soil-stored seed banks are adequately “topped up”, so that the species or community can successfully respond to the next fire. This post-fire life-cycle can be relatively slow for perennial plants in the semi-arid mallee environment (eg. at least 5 years from seed germination to first flowering for spinifex and at least 8-10 years for mallee and ungrazed pine).

As described in Section 3.2, major regional fires in the mallee usually occur under speargrass fuel conditions after effective seasonal rainfall. When these fuel conditions occur for a few years running, it is possible that two consecutive fires can occur within 3-5 years particularly in Mallee-sandplain and open shrubland/woodland communities. In Mallee-spinifex, it is unusual for consecutive fires to burn at less than 15 years, as the very sandy soils are not preferred by ephemeral grasses. In this community, it is mainly the development of the slow-growing spinifex and ground litter which determines when the next fire can carry. However, in extreme fire weather conditions in November 1997, a wildfire at Tarawi NR was able to burn a small area of 13.5 year old Mallee-spinifex, before weather conditions abated. Strategies proposed in the is plan will aim to prevent the occurrence of too-frequent wildfires like this.

The amount of post-fire rainfall and post-fire grazing from native and feral herbivores may have an important influence on post-fire regeneration. For example, small fires may be particularly prone to heavy post-fire grazing when seasonal conditions are dry. Grazing animals will be attracted to the ephemeral growth of a regenerating burn if there is little feed elsewhere in the area. This has been observed at Tarawi NR and may have a significant short and long term effect on local post-fire biodiversity.

While some information is known on the time period that mallee plant species or groups of species (eg. “Acacias” or “Eucalypts”) require to enable germination and maturity, little is known on the maximum fire interval that fire-dependant or fire-promoted communities can tolerate. That is, whether some plant populations decline if no fire occurs after many years, and whether the habitat value for fauna is also then diminished. This concern has also been described by Cheal (1979) for mallee birds and reptiles.

It is clear that fire is a very important part of the mallee ecosystem. However, it is difficult to be specific when discussing the fire regime characteristics and requirements for mallee vegetation communities and fauna. While information is known about response mechanisms of many mallee plant species, the extremely variable nature of fire in the mallee (for example, very irregular frequency, variable size depending on vegetation and seasonal characteristics) *makes it difficult to ascribe the “ideal” fire regime for vegetation communities or for a whole Reserve*. Determining appropriate mallee fire regimes is also made more complex in fragmented habitats caused by vegetation clearance and habitat degradation.

Table 5 below briefly describes the variable fire regime characteristics applicable to the mallee communities of Tarawi NR. The fire ecology of Tarawi NR's significant plant species was briefly described previously in Table 2.

Vegetation Community	Fire Regime	Fire Regime Characteristics
Mallee-spinifex	Frequency	Variable. Consecutive fires can range from every 15-20 years to at least every 80-100 years. Unknown "ideal" frequency.
	Season	Fires mostly occur from early November to late March.
	Intensity	Variable, depending on weather conditions and spinifex structure therefore fires exhibit a wide range of intensities. Intensity usually higher in old mallee due to higher ground cover of spinifex and litter.
	Extent	Variable. Fires usually less patchy in old mallee due to higher ground cover of spinifex and litter. Fires larger if ephemeral fuel loads high in dune swales.
Mallee-sandplain	Frequency	As above for Community 1.
	Season	As above for Community 1.
	Intensity	Variable, depending on weather conditions and ephemeral fuel loads therefore fires exhibit a wide range of intensities.
	Extent	Usually small due to patchy perennial vegetation unless ephemeral fuel loads high.
Belah woodland	Frequency	Variable but generally fires less frequent than Vegetation Communities 1 and 2 due to mostly low ground fuel loads.
	Season	As above for Vegetation Community 1 and 2.
	Intensity	Usually moderate-high intensity as fires will only occur when ephemeral fuel loads are high.
	Extent	Usually large as fires will only occur when ephemeral fuel loads are very high after effective rainfall.
Mixed open shrubland/ woodland	Frequency	As above for Community 3.
	Season	As above for Community 3.
	Intensity	As above for Community 3.
	Extent	As above for Community 3.

Table 5: Fire regime characteristics of mallee vegetation communities

The fauna fire ecology requirement descriptions below summarises the known fire ecology requirements of fauna species, and also summarises the information presented in Appendix 1 on significant species occurring in Tarawi NR.

Birds:
Many bird species will readily utilise regenerating burnt areas at differing post-fire ages. It is unknown for many species at what stage a post-fire habitat is suitable for breeding (ie. residency). Density of birds may be greater in younger post-fire habitats but species diversity is greater in long unburnt vegetation. Many threatened or vulnerable species recorded at Tarawi NR may prefer long unburnt vegetation while some will also utilise younger vegetation.

Fire Regime/Management	
Frequency	*Minimum* 20 years, *maximum* at least 40-60 years
Season	Fires in the breeding months of spring and early summer would be disruptive for many species
Intensity/Extent	High intensity fires (large areas and non-patchiness) undesirable as recolonisation more difficult particularly for sparsely distributed species
Proposed Strategies	• Maintain large areas of long unburnt mallee communities (at least 40-60 years old) • Manage to promote patchiness during wildfire • Initiate survey and monitoring of bird's habitat requirements in relation to fire age

Reptiles:
Mallee reptile species are probably less affected by direct impacts of fire than other types of fauna. Some species are favoured by young post-fire habitat, while others favour older post-fire habitat. Well developed spinifex cover is important for many burrowing and non-burrowing species. Very old senescing spinifex may provide less habitat value than younger developing spinifex.

Fire Regime/Management	
Frequency	Minimum 15 years, maximum unknown but probably at least 30-40 years
Season	Fires in the breeding months of spring and summer would be disruptive
Intensity/Extent	High intensity fires (large areas and non-patchiness) undesirable as recolonisation more difficult particularly for restricted and sparsely distributed species
Proposed Strategies	• Maintain a range of age classes to cater for species diversity • Manage to promote patchiness during wildfire

Mammals:
Little known fire ecology in the semi-arid mallee (small mammals usually trapped in very low numbers). Most small mammal species found at Tarawi NR present in both young and long unburnt vegetation (this supported by preliminary survey results at Tarawi NR). Most bat species require hollow logs for nesting.

Fire Regime/Management	
Frequency	Estimated minimum 10-15 years, maximum unknown.
Season	Fires in the breeding months of spring (some species breed opportunistically) may be disruptive
Intensity/Extent	High intensity fires (large areas and non-patchiness) undesirable as recolonisation more difficult particularly for restricted and sparsely distributed species
Proposed Strategies	• Maintain a range of age classes to cater for species diversity • Manage to promote patchiness during wildfire • Initiate survey and monitoring of mammal's habitat requirements in relation to fire age

Amphibians and Invertebrates:
Not enough known information to describe fire regime requirements.

4.1.2 Biodiversity conservation guidelines, objectives and strategies

Background to the Biodiversity Guidelines:
Using the above information, available knowledge from current scientific literature, anecdotal information and observations, fire management guidelines are proposed for biodiversity management at Tarawi NR. These biodiversity guidelines for fire management *combine flora and fauna fire ecology requirements* (including significant species). The fire history of Tarawi NR is evaluated in relation to each guideline and management strategies are proposed. The guidelines act as flexible criteria to be evaluated through time to produce management objectives and strategies for biodiversity. The guidelines may be amended in the next review of this plan after further research and monitoring is conducted at Tarawi NR and a review of general scientific knowledge.

Three biodiversity guidelines for fire management have been devised for Tarawi NR:

Guideline 1	**Consecutive fires should be a minimum of 20 years apart in any one area.**

Justification	• Young Mallee-spinifex and sandplain communities are capable of re-burning from approximately 14 years post-fire (sooner if speargrass fuel conditions are experienced). A minimum 20 year interval will ensure post-fire maturity and reproduction of most perennial components and obligate seed regenerators. Ensure post-fire maturity and reproduction of many fauna species.

Mallee-spinifex

Fire History Evaluation	• Approximately 23% (4273 ha) of this community burnt in last 20 years. Only small areas have burnt between prior to 20 years ago and 1917-18.
Proposed Strategies	• Implement strategic burning programs to assist in excluding wildfire (and promote patchiness in the event of a passing wildfire) from areas that have burnt within the last 20 years. Concentrate programs in and near high fire potential areas and where natural low fuel breaks are absent or restricted.

Mallee-sandplain

Fire History Evaluation	• Very small areas only have burnt in last 20 years. Only small areas have burnt between prior to 20 years ago and 1917-18.
Proposed Strategies	• Currently no recently burnt areas of this community require protection in relation to this guideline.

Belah woodland

Fire History Evaluation	• As above for Mallee-sandplain community.
Proposed Strategies	• As above for Mallee-sandplain community.

Mixed open shrubland/woodland

Fire History Evaluation	• As above for Mallee-sandplain community.
Proposed Strategies	• As above for Mallee-sandplain community.

Guideline 2	**A range of post-fire ages younger and older than approximately 40 years should be present in the reserve:** • **at least 50% of Mallee-spinifex and Mallee-sandplain communities should be more than 40 years old.**

Justification	• Ensures a range of age classes for a diversity of flora and fauna species. • Emphasis on long unburnt mallee ensures development of a mature tree canopy, ground layer vegetation and well developed litter layer, important for many fauna species.

Mallee-spinifex

Fire History Evaluation	• 76% (13941 ha) is more than 40 years old (mostly 79 years old). • 24% (4417 ha) is less than 40 years old (mostly 14 and 19 years old). • Fire history of this community is compatible with this guideline but heavily weighted towards very long unburnt mallee.
Proposed Strategies	• Manage young and old mallee by implementing strategic burning programs to assist in excluding wildfire and to promote patchiness in the event of a passing wildfire. Concentrate programs in and near high fire potential areas and where natural low fuel breaks are absent or restricted. • Initiate accurate mapping, research and monitoring of long unburnt mallee to determine biodiversity value, species regenerative capacity and future fire management. Experimental burning will be considered.

Mallee-sandplain

Fire History Evaluation	• No significant areas of this community have burnt at least since 1917-18, therefore the majority of this community is more than 40 years old. • This community's fire history is not compatible with this guideline.
Proposed Strategies	• Initiate accurate mapping, research and monitoring of very old communities to determine biodiversity value, species regenerative capacity and future fire management. Experimental burning will be considered.

Belah woodland

Fire History Evaluation	• No significant areas of this community have burnt at least since 1917-18, therefore the majority of this community is more than 40 years old.
Proposed Strategies	• Due to the difficulty in managing for a diversity of fire ages in this community (very low ground fuel loads and infrequent occurrence of wildfire), no specific management actions for Belah woodland are proposed in relation to this guideline. However, actions proposed for Guideline 3 (see below) may assist in promoting a diversity of age classes.

Mixed open shrubland/woodland

Fire History Evaluation	• As above for Belah woodland community.
Proposed Strategies	• As above for Belah woodland community.

Guideline 3	**Promote patchiness in wildfires.**

Justification	• Many mallee fires leave no unburnt patches of vegetation, or small and widely dispersed patches, increasing the chance of local extinction of fire sensitive and restricted flora and fauna populations. Patchy fires assist recolonisation, increase post-fire diversity and contribute to the long-term variety of fire ages. • Such fires are more likely to occur under perennial plus ephemeral fuel conditions ("speargrass years") and/or in extensive Mallee-spinifex communities in "normal" perennial fuel conditions.

Mallee-spinifex

Fire History Evaluation	• Relatively large (over 400 hectares) non-patchy fires have occurred. • No severe extensive fires burning the whole community area have occurred probably since 1917-18, though speargrass conditions across the whole Reserve has been experienced at least two times subsequently.
Proposed Strategies	• Implement prescribed burning programs (to restrict wildfire spread and promote patchiness). Concentrate burning strategically in extensive areas of Mallee-spinifex and where significant species require enhanced protection. • Ensure proportions of fire ages required for biodiversity as described in Guideline 2 are conservative and flexible enough to cater for unscheduled extensive wildfires.

Mallee-sandplain

Fire History Evaluation	• No severe extensive fires burning the whole community area have occurred probably since 1917-18, though speargrass conditions across the whole Reserve has been experienced at least two times subsequently.
Proposed Strategies	• Implement prescribed burning programs (to restrict wildfire spread and promote patchiness) particularly when ephemeral fuel loads are high. Concentrate burning in strategic areas where fire potential is greatest and where significant species require enhanced protection. • Ensure proportions of fire ages required for biodiversity as described in Guideline 2 are conservative and flexible enough to cater for unscheduled extensive wildfires.

Belah woodland

Fire History Evaluation	• As above for Mallee-sandplain community.
Proposed Strategies	• As above for Mallee-sandplain community.

Mixed open shrubland/woodland

Fire History Evaluation	• As above for Mallee-sandplain community.
Proposed Strategies	• As above for Mallee-sandplain community.

Biodiversity guidelines and fire history: summary evaluation

As discussed in Section 3.1, the known fire history of Tarawi NR is characterised by a very irregular fire occurrence with a relatively low fire frequency. Since the extensive fire of 1917-18, the Reserve has been subject to several fires. The majority have been in the last 20 years and mostly in the Mallee-spinifex vegetation community.

Generally, the recent fire regime of Tarawi NR has not "exceeded" the biodiversity guidelines proposed in this plan. It is considered that the frequency of fires have not been too close to negatively affect biodiversity, although in the Mallee-spinifex community this is a potential cause for concern over the coming years as "recently" burnt areas regenerate and are prone to another fire too soon.

There is an adequate diversity of age classes represented within the reserve as a whole. Within the Mallee-spinifex vegetation community there is an emphasis on long unburnt vegetation, considered important for many fauna species. However, it is the prevalence of very long unburnt vegetation in this community which is also one potential concern to biodiversity (due to observations of senescence and lack of recruitment). This community is prone to relatively extensive non-patchy fires which may lead to local extinction of fire sensitive restricted flora and fauna populations.

Similarly, the Mallee-sandplain community is dominated by very old and uniformly-aged vegetation. To clarify this concern, management emphasis will be on research and monitoring in this and the Mallee-spinifex community. At the same time, management will aim to prevent fire burning large areas of these communities and to promote patchiness in the event of fire.

The Belah woodland and mixed open shrubland/woodland communities also have a low diversity of fire ages. However, because these communities are less fire-dependant (and generally less flammable) there is less of a concern for biodiversity. However, in speargrass fuel conditions, it will be very important to mitigate the effects of extensive and intensive fires, promote patchiness in all communities and to prevent too-frequent fire intervals.

In the previous pages, the fire history of Tarawi NR has been evaluated for each biodiversity guideline and each vegetation community, and management strategies proposed. It has been recognised that there may be limitations to this evaluation because of constraints experienced with mapping the fire history and vegetation. Nevertheless, the guidelines enable the development of specific fire management objectives which address the maintenance and conservation of biodiversity in Tarawi NR.

Table 6 below is a summary of the biodiversity guidelines and proposed fire management strategies.

Guideline 1:
Consecutive fires should be a minimum of 20 years apart in any one area.

Management Strategies:

- For the Mallee-spinifex community, implement strategic burning programs to assist in excluding wildfire (and promote patchiness in the event of a passing wildfire) from areas that have burnt within last 20 years. Concentrate programs in and near high fire potential areas and where natural low fuel breaks are absent or restricted.

Guideline 2:
A range of post-fire ages younger and older than approximately 40 years should be present in the reserve:

- *at least 50% of Mallee-spinifex and Mallee-sandplain vegetation communities should be more than 40 years old.*

Management strategies:

- The Mallee-spinifex community has a range of fire ages and is compatible with this guideline, therefore management will focus on maintaining these by implementing strategic burning programs to assist in excluding wildfire (and promote patchiness in the event of a passing wildfire) in young and long unburnt areas. Programs will be concentrated in and near high fire potential areas and where natural low fuel breaks are absent or restricted.
- For Mallee-spinifex and Mallee-sandplain communities, initiate accurate mapping, research and monitoring of very long unburnt vegetation to determine biodiversity value, species regenerative capacity and future fire management. Experimental burning will be considered.
- For Belah woodland and Mixed open shrubland/woodland (low fire potential communities) no specific management actions are currently proposed in relation to this guideline.

Guideline 3:
Promote patchiness during wildfire

Management strategies:

- Implement prescribed burning programs (to restrict wildfire spread and promote patchiness) in the Mallee-spinifex community and in all vegetation communities under speargrass fuel conditions, Concentrate burning in strategic areas where fire potential is greatest and where significant species require enhanced protection.
- Ensure proportions of fire ages required for biodiversity as described in Guideline 2 are conservative and flexible enough to cater for unscheduled extensive wildfires.

Table 6: Summary of fire management biodiversity guidelines and proposed strategies

Fire management objectives and strategies for biodiversity conservation

As per the NPWS general fire management objective (no. 5), the **overall management objective** for the conservation of biodiversity at Tarawi NR will be:

> "*Manage fire to avoid extinction of all native species known to occur within the Reserve*."

To meet this overall objective and to ensure this plan is relevant from an ecological perspective, the biodiversity guidelines have been used to formulate **specific biodiversity objectives and strategies** for the next 5 years. The tables below detail these (see following Section 4.3 for details and definitions of "management zones").

Objective 1:	**Prevent consecutive fires within a 20 year period in any one area** *(from guideline 1).*
Strategies:	Fire trail maintenance and strategic prescribed burning.
Management Zones:	Strategic Fire Management Zone, classes 1 and 2
Discussion:	A decline in species diversity may occur when consecutive fires occur too close together in any one area. An inter-fire period of at least 20 years will help ensure species post-fire maturity and reproduction. In addition, young mallee contributes to Tarawi NR's current diversity of fire ages that are required for biodiversity. A high standard of fire trail maintenance will assist in wildfire suppression. Prescribed burning adjacent to fire trails in areas of high fire potential will create low fuel "buffers" for up to at least 10 years and assist in containing wildfire.

Objective 2:	**Maintain the current diversity of age classes, ensuring that the desired age class ranges are not exceeded** *(from guideline 2).*
Strategies:	Fire trail maintenance and strategic prescribed burning.
Management Zones:	Strategic Fire Management Zone, classes 1 and 2
Discussion:	The long unburnt mallee contributes to Tarawi NR's current diversity of fire ages that are required for biodiversity, and is regionally unique. A high standard of fire trail maintenance will assist in wildfire suppression and prescribed burning. Burning adjacent to fire trails in areas of high fire potential will create low fuel "buffers" for up to approximately 10 years and assist in containing wildfire.

Objective 3:	**Investigate and clarify the biodiversity value and regenerative capacity of long unburnt vegetation communities** *(from guideline 2).*
Strategies:	Implement biodiversity survey and monitoring programs.
Management Zones:	Heritage Area Management Zone, class 1.
Discussion:	While Objective 2 recognises the importance of long unburnt mallee for biodiversity at Tarawi NR, biological survey work is warranted. There appears to be little or no plant species recruitment in these areas and clarification is required (due to limited available scientific knowledge) about the status of many fauna species in such very long unburnt semi-arid mallee, particularly in the more fire prone Mallee-spinifex and Mallee-sandplain communities.

Objective 4:	**Promote patchiness during wildfire** *(from guidelines 2 and 3).*
Strategies:	Strategic prescribed burning.
Management Zones:	Strategic Fire Management Zone, classes 2 and 3
Discussion:	Strategic prescribed burning will increase wildfire patchiness and thus protection of significant populations. Patchy fires assist recolonisation, increase post-fire diversity and contribute to the long term variety of fire ages. This plan recognises that there are several constraints that the NPWS faces in the suppression of mallee wildfires, some of which have direct implications for biodiversity conservation at Tarawi NR (see Section 4.9). Essentially, even in non-speargrass seasons, mallee fires may burn relatively large areas before suppression activities can commence. Fire trails alone are usually ineffective in halting or slowing wildfires. The large expanses of very long unburnt Mallee-spinifex in and around Tarawi NR has a very high fire potential, and therefore are prone to large-scale fires. In addition, in speargrass seasons, all vegetation communities may have a high fire potential and be prone to intense large-scale fires which can negatively effect biodiversity. Fire patchiness may or may not result according to the effect of variations in fuel and weather conditions on fire behaviour. Strategic prescribed burning will assist in mitigating these events by the creation of low fuel “buffers” which will help slow or halt the passage of fire and create unburnt patches.

The biodiversity conservation objectives and strategies will be translated to the Fire Management Zones (Section 4.3). The zones will detail where management strategies will be undertaken to assist in achieving the biodiversity objectives.

4.1.3 Fire ecology issues of concern

At Tarawi NR there are several fire ecology issues of concern which fire management must address, as they have the potential to negatively effect biodiversity values. Some issues are also relevant on a regional basis. The following issues are only briefly described and are not prioritised. They have been broadly categorised into five main issues:

"Old growth" biodiversity issue

- Due to lack of recruitment, senescence and competition, very long-unburnt mallee communities may be declining in plant species diversity. It is unknown how long a fire-dependant/promoted community such as semi-arid mallee can remain unburnt until biodiversity declines.
- There is insufficient knowledge of soil-stored seed longevity in the mallee. Very long unburnt communities may not adequately regenerate post-fire which may lead to a decline in biodiversity.

Post-fire grazing impacts issue

- Heavy post-fire grazing by native and introduced herbivores may seriously effect post-fire biodiversity.
- *Callitris verrucosa* (Mallee pine) may be becoming locally extinct due to adult mortality, insufficient post-fire seedling germination and/or heavy grazing of seedlings. This may also apply to *Acacia aneura* (Mulga) and *Callitris glaucophylla* (White cypress pine), and some other plant species.

Flora fire ecology issue

- There is insufficient knowledge on many mallee plant species regenerative methods and life history (post-fire life cycles, eg. time to maturity).

Fauna fire ecology issue

- There is insufficient knowledge on the fire ecology of small mammals in the mallee.
- There is insufficient knowledge on the fire ecology of threatened mallee birds

Fire suppression impacts issue

- Inappropriate use of heavy machinery during wildfire suppression may locally effect post-fire biodiversity.

4.2 Fire management units

The fire management **units** are management areas that define broad containment "blocks" in the event of a fire. They mainly serve as a convenient naming and mapping system to be used during fire suppression operations.

The fire management units for Tarawi NR have primarily been determined by the location of existing fire trails, and serve to define containment blocks during fire suppression operations. The units have been named after local features (ground tanks, tracks, etc) so that local NPWS staff, neighbours and nearby fire brigades can more readily familiarise themselves with them. Colours will also be used to identify the units (Figure 5). These areas and colours are already in use for other management activities which staff are familiar with.

Detailed profiles and maps of each fire management unit will be produced showing fire trails and tracks, reserve entry points, watering points, fire history, vegetation, fire management zones, locations of significant species and cultural heritage sites to be available during fire suppression operations.

Figure 5 below schematically illustrates the location and the names of the units (the bold lines represent fire trails).

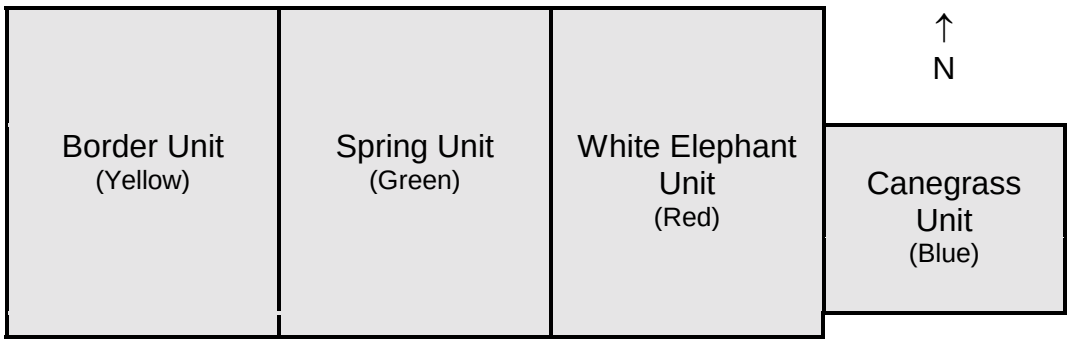

Figure 5: Fire management units

4.3 Fire management zones

As described, the fire management zones detail where management strategies will be undertaken to assist in achieving the biodiversity objectives. The naming of the zones and their primary purpose is consistent with NPWS policy. The zone "classes" are specific to Tarawi NR (see Table 7 below and Map 5, Section 9). See the following tables for details on the management of each zone class.

The zones for Tarawi NR have been determined by the vegetation communities, locations of significant species, fire history, locations of fire trails and infrastructure. The boundaries and management objectives of the zones may be altered when this plan is reviewed in five years.

Zone	Purpose	Methods/Classes
Asset Protection Zone (APZ)	To minimise the risk of bushfire damage to life and property.	**APZ:** Grading of nearby fire trails, slashing and residual herbicide around Reserve infrastructure, under speargrass fuel conditions.
Strategic Fire Management Zone (SFMZ)	To provide for strategic containment of wildfires, to provide safe access to bushfire fighters and to assist with the achievement of a regime of fire which is consistent with reserve management objectives.	**SFMZ-1:** Fire trails and Pinecamp-Springwood Road. **SFMZ-2:** Fuel management by prescribed burning under "perennial fuel" conditions. **SFMZ-3:** Fuel management by prescribed burning under speargrass fuel conditions.
Heritage Area Fire Management Zone (HAMZ)	To manage bushfires to meet the conservation needs of species, communities, wilderness areas or cultural heritage items which may be at risk of long-term damage as a result of inappropriate bushfire regimes.	**HAMZ-1:** Management of Reserve area covering all vegetation communities - refer to biodiversity guidelines and objectives. **HAMZ-2:** Fuel management by slashing ground fuels of cultural heritage sites (Aboriginal and European) under speargrass fuel conditions.

Table 7: Fire management zone summary

4.3.1 Asset Protection Zones

Assets include physical infrastructure on both the Reserve and neighbouring properties. See Map 5 for locations of APZ's.

Asset Protection Zone (APZ)
Zone Objective: To minimise the risk of bushfire damage to life and property.
Description: Reserve infrastructure included in the APZ's are: • homestead/workshop/shearers quarters complex • feral goat traps (around House and Three by Two ground tanks) • fire water storage tanks (at Old Tarawi bore and Canegrass bore - see Map 5). The assets requiring protection from fire on neighbouring properties include: • infrastructure (houses, equipment sheds, workshops and fencelines) • livestock and enclosed native animals (Scotia Sanctuary). There is no neighbouring infrastructure closely adjoining the Reserve boundary, other than fencelines. At Tarawi NR all shared boundary fencelines fall within Strategic Fire Management Zones (see below) and are protected by routine fire trail maintenance. All **APZ's** are situated in very low fire potential areas (mixed open shrubland/ woodland). However, under speargrass fuel conditions, fire potential will be increased and there may be a risk to assets. These conditions occur infrequently but pro-active management will be required before ephemeral fuels cure in late spring/early summer.
Management: • Slashing to reduce ground fuels to a width of six metres immediately around the perimeters of infrastructure in APZ's, undertaken before grass fuels cure. • Residual herbicides will be used as required to control ephemeral fuel build up for a narrow width adjacent to the edges of buildings and on the fenceline of the goat traps, to control growth that the slasher will miss around the immediate edges of the infrastructure.

4.3.2 Strategic Fire Management Zones

Strategic fire management will mainly involves the management of designated *fire trails* and *prescribed burning.* Strategic Fire Management Zones (**SFMZ's**) have been sub-divided into classes to describe the primary strategies which will be employed to manage fire at Tarawi NR (Table 7). See Map 5 for locations of SFMZ's.

Strategic Fire Management Zone (SFMZ-1) ***(Fire Trails)***
Zone Objective: To provide for strategic containment of wildfires, to provide safe access to bushfire fighters and to assist with the achievement of a regime of fire which is consistent with reserve management objectives.
Description: Designated fire trails have been zoned as SFMZ-1. The Pinecamp-Springwood Road (a public road maintained by the Wentworth Shire to a width of approximately 15 metres) which cuts through the eastern section of the Reserve is also considered a SFMZ-1. Reserve fire trails have been constructed to a width of 6-8 metres, and will assist in the containment of wildfires. The fire trails also serve to divide the Reserve into fire control "units" (containment blocks) as described above. See Sections 5.1, 6.2 and Map 6 for further details on fire management trails.
Management: • Maintenance as required. See Sections 5.1 and 6.2 for details.

Prescribed Burning (SFMZ-2&3)

As discussed in the previous section, *prescribed burning is the primary means by which most of the biodiversity guideline objectives will be achieved*. Areas designated for prescribed burning have been zoned as **SFMZ-2** and **SFMZ-3** (Strategic Fire Management Zone - 2 and 3). The majority of these zones are adjacent to designated fire trails and their main function is to assist in managing the surrounding Heritage Area Management Zones (**HAMZ**) according to the biodiversity guidelines and objectives. The locations of these burning zones have been determined by existing fire trails, vegetation patterns, fire history and known locations of significant species. As outlined in Table 7, the prescribed burning zones for strategic fire management are:

- ***SFMZ-2*****:** Fuel management by prescribed burning under **"perennial fuel conditions"** (Fuel state consisting of perennial vegetation (mallee trees, litter, shrubs and spinifex). This is the "normal" state of mallee fuel experienced in the majority of years. Fires that occur during these conditions are variable in size and intensity and are mainly restricted to the Mallee-spinifex and to a lesser extent, Mallee-sandplain communities. The purposes of this zone addresses the biodiversity management objectives 1 and 2).

- ***SFMZ-3*****:** Fuel management by prescribed burning under **"perennial plus ephemeral fuel conditions"** (Fuel state consisting of perennial vegetation plus ephemeral species of various grasses and herbs, but particularly the highly flammable speargrass (*Stipa* species) which dominates in the Mallee-sandplain, open Belah woodland and Mixed open shrubland/woodland communities, after effective rainfall. Under these conditions there is a more continuous fuel load across all communities than in "perennial fuel conditions". Most fires that occur during these conditions are often large in size and moderate to high in intensity. The purpose of this zone mainly relates to the biodiversity management objective 4).

Unless a speargrass fuel conditions are experienced over the next five years, burning will only be conducted in the **SFMZ-2's**.

Strategic Fire Management Zone (SFMZ-2) ***(Prescribed burning under perennial ("normal") fuel conditions)***

Zone Objective:
To provide for strategic containment of wildfires, to provide safe access to bushfire fighters and to assist with the achievement of a regime of fire which is consistent with reserve management objectives.

Description:
Prescribed burning within SFMZ-2's will be in the form of "strip-burns" to 100-150 metres wide, situated mainly adjacent to fire trails where they are crossed by continuous expanses of Mallee-spinifex or Mallee-sandplain (moderate to high fire potential communities in perennial fuel conditions). Refer to Map 5 for locations. Other more specific reasons for locating each burning zone are described in Table 10 (Section 6.2).

The combined total area of the proposed prescribed burning (including previously undertaken) is approximately 440 hectares, or 2.5% of Mallee-spinifex community, or 1.3% of total Reserve area (see Table 10 for break up). Although the areas to be burnt are relatively small, it is considered that the strategic location and shape of the burns will provide maximum potential to assist in achieving the biodiversity objectives (ie. prevent too frequent fires, maintain current range of age classes and promote patchiness in the event of a fire), for at least 10 years. Recent "strip" burning at Tarawi NR has illustrated how effective this form of prescribed burning can be in managing and containing a wildfire (November, 1997).

Management:

- It is envisaged that all proposed burning in SFMZ-2's will be completed within the life of this plan (see works schedule, Section 6.2). Map 7 shows areas that have recently been prescribed burnt within the SFMZ's by the NPWS.

- Due to natural fuel variations and weather conditions during burning, the burns may be patchy. A minimum 75% burn area should be aimed for (i.e. maximum of 25% unburnt is acceptable). Burning will be undertaken in during autumn to avoid the main fauna breeding period (which is spring to early summer). The impacts of prescribed burning in autumn will be monitored. Noble (1984), observed good rates of spinifex and mallee seedling recruitment after an autumn burn. Vegetation monitoring sites within the SFMZ's will be established and quantitatively assessed before and continue after burning (see Section 6.1.1 for details).

- When this plan is reviewed in the future, consideration will be given to whether burning should continue in the SFMZ-2 zones. This may depend on many factors including the occurrence of wildfires or whether amendments have been made to the biodiversity guidelines and objectives as a result of new scientific information (including information from survey and monitoring work proposed and being conducted at Tarawi NR).

- If it is considered that prescribed burning should continue in future reviews of this plan, then it should be conducted on the other side of the zone (i.e. other side of fire trail), to provide a "fresh" fuel reduced zone for a further 10 years. Where the zone extends on to neighbouring property, burning will occur in consultation and co-operation with neighbours and local fire brigades. In the very long-term, if each side is burnt on a 10 year alternate rotation there will be an approximate 20 year interval on each side of the zone. However, this pattern should remain flexible in the long term due to the reasons stated in the above paragraph.

Strategic Fire Management Zone (SFMZ-3)
(Prescribed burning under perennial plus ephemeral (speargrass) fuel conditions)

Zone Objective:
To provide for strategic containment of wildfires, to provide safe access to bushfire fighters and to assist with the achievement of a regime of fire which is consistent with reserve management objectives.

Description:
Prescribed burning within SFMZ-3's will be in the form of "strip-burns" to 100-150 metres wide, situated mainly adjacent to fire trails where they are crossed by large and continuous expanses of Mallee-sandplain, open Belah woodlands and Mixed open shrubland/woodlands, where a *high potential* for speargrass fuel conditions exists after effective rainfall. Burning in these zones can and will *only* occur under speargrass fuel conditions (which are experienced infrequently and irregularly - about every 10-25 years).

Under these conditions, the ephemeral fuel loads across the Reserve are likely to be variable within the communities listed above, and burning will be *located opportunistically* within these zones where the fire potential is greatest. The SFMZ-3's to be burnt will also be prioritised according to where high fuel loads may pose a threat to known locations of significant species.

Management:
- As for SFMZ-2, if speargrass fuel conditions are experienced during the life of this plan.

- Any prescribed burning undertaken during speargrass fuel conditions should be regarded as largely experimental in relation to it's effectiveness. Post-fire regeneration of ephemeral fuels may be fast and remain a risk during the following fire season. Also, the timing of burning may have to be opportunistic according to curing and expected fire behaviour. Despite these possible limitations, the NPWS considers it important to attempt prescribed burning under speargrass fuel conditions to:
    - assist in achieving fire management objectives,
    - increase our knowledge and experience in prescribed burning under speargrass conditions.

Other related benefits of strip-burning adjacent to fire trails include:
- Increased effectiveness of fire trails
- Increased flexibility and safety for wildfire suppression strategies (in allowing some fires to be contained within previously burnt areas, safer back-burning with less risk of spot-overs),
- Reduce emphasis on heavy plant usage during wildfire suppression operations,
- Increased fire-fighter safety during wildfire suppression operations (more secure control lines).

Other forms of prescribed burning (for example, to promote the regeneration for a plant species or community or increase habitat value for a fauna species) may be undertaken in an experimental manner to address Biodiversity Objective 3 *(Investigate and clarify the biodiversity value and regenerative capacity of long unburnt vegetation communities).* However, the vegetation survey work proposed (see Section 6.1.1) in the areas to be prescribed burnt (SFMZ-2s) will assist in meeting this objective. Additional burning will also depend on the results of biodiversity survey work already underway to address the above objective. Pending this, advice will be sought from specialists as to the appropriate design of future

survey work including whether burning is required to further clarify the issue of "old growth" mallee to guide future management.

Effect of strategic fire management on biodiversity

A detailed environmental impact assessment of fire management activities accompanies this plan. The NPWS recognises that all activities including fire trail installation and maintenance, prescribed burning and wildfire suppression activities have at least a local impact on biodiversity. It is the NPWS's responsibility to minimise and monitor the impacts where possible, and to justify that the activities are necessary for the conservation of biodiversity across the whole Reserve.

4.3.3 Heritage Fire Management Zones

As outlined in Table 7, the Heritage Area Management Zones (HAMZ's) are designated for the fire management of natural heritage (HAMZ-1) and cultural heritage (HAMZ-2). See Map 5 for locations of HAMZ's.

Heritage Area Fire Management Zone (HAMZ-1) ***(Broad area - whole reserve)***
Zone Objective: To manage bushfires to meet the conservation needs of species, communities, wilderness areas or cultural heritage items which may be at risk of long-term damage as a result of inappropriate bushfire regimes.
Description: Broad area covering the whole reserve and all vegetation communities, which do not fall in to other zones.
Management: • The development of specific biodiversity objectives and strategies from the formulation and evaluation of biodiversity guidelines, as previously detailed, • Management of the SFMZ's (fire trails and prescribed burning) as described above. These are designed to facilitate management of the HAMZ-1. For example, prescribed burning in the SFMZ's are the primary means by which many of the biodiversity objectives for this heritage zone will be achieved.

Heritage Area Fire Management Zone (HAMZ-2)
(Cultural heritage sites)

Zone Objective:
To manage bushfires to meet the conservation needs of species, communities, wilderness areas or cultural heritage items which may be at risk of long-term damage as a result of inappropriate bushfire regimes.

Description:
The HAMZ-2 will address the fire management of cultural heritage (Aboriginal and European) sites. Map 3 (Section 9) illustrates the location and type of cultural heritage sites that are presently known at Tarawi NR and zoned as HAMZ-2's. These sites have been previously described in Section 2.4.

Management:
Most cultural heritage sites at Tarawi NR are situated in very low fire potential areas (Belah woodland and Mixed open shrubland/woodland). However, as previously identified, under speargrass fuel conditions, fire potential will be increased and pose a possible threat to sites. These conditions occur very infrequently but pro-active management will be required particularly to protect the European heritage sites which are comprised of flammable materials (eg. post and rail yards and brush yards) from wildfire. Many sites are located close to fire trails or vehicle tracks which will be used to advantage in fuel management activities and fire suppression operations. An additional threat posed to these sites is from accidental damage by heavy plant used during fire suppression operations.

The fire management of cultural heritage in HAMZ-2's will involve:

- Slashing of temporary six metre fire breaks around sites as required under speargrass fuel conditions, according to site characteristics and fuel loads,
- Maintaining an updated database and map of site locations,
- Heavy plant exclusion during fire suppression operations to within at least 100 metres of known sites (see Operational Guidelines, Section 4.4).

The known location of all cultural sites at Tarawi NR will be incorporated into the fire management "unit" maps which will be made available to Incident Management Teams during fire suppression. It will be the responsibility of the Incident Controller, Planning and/or Operations Officers to ensure that all possible actions are taken to prevent damage to these sites during fire suppression operations. The information will also be used in the planning of prescribed burns.

4.4 Operational guidelines

4.4.1 Fire suppression

The Incident Control System (ICS) is used by the NPWS in the management of all incidents, including fire. The ICS is used by many other land management authorities and enables a common method of determining chain of command and responsibilities. In the event of a fire report, the notification and first response procedures outlined in the District's Fire Action Plan, and the *Coordinated Fire Management Policies* of the Wentworth Shire's BFMC Operations Plan will be followed.

Currently, radio communication systems used between South Australian and NSW fire fighting agencies are largely incompatible. A communications plan involving all agencies is required, addressing this problem.

The NPWS is legislatively obligated to take actions to suppress wildfires. In addition, one of the NPWS fire management objectives is "to suppress unplanned fires occurring on reserve". However, this plan recognises that there are **several constraints in suppressing mallee wildfires**, which have implications for operational management at Tarawi NR. These constraints include:

- Notification and response times to mobilise staff and equipment to most Reserves can be relatively slow even with a high level of preparedness (for example, normal travel time to Tarawi NR from the District office/workshop is at least two hours).
- Neighbouring fire-fighters, including local RFS brigade members are sparsely distributed. In addition, there is only one NPWS staff member resident at Tarawi NR and it is considered unsafe and impractical for only one person to take even basic suppression actions before other fire fighters are mobilised.
- Fires (especially in Mallee-spinifex) during severe weather conditions can burn many hundreds of hectares (with a proportional increase in fire perimeter) before fire-fighters and equipment are on-site.
- During severe weather conditions the fire behaviour (especially in Mallee-spinifex) can be variable in intensity and rate of spread and therefore unpredictable. It is often too dangerous to take even basic suppression actions until the fire behaviour is such that risk to fire-fighters is minimised.
- Fires are more often than not "remote" from established fire trails or tracks making access and situation reporting difficult, and slowing response times and frustrating containment actions.
- During dry summer conditions, fire water supplies can be regionally very limited. Partly because of this, "dry" indirect methods of fire suppression are preferred in the mallee. Water is generally used only for mopping up.
- Standard width fire trails usually have little effect in halting or slowing a mallee wildfire and therefore should not be considered as effective "fire breaks" (though fire trails can be considered valuable in providing access and escape routes, fall-back areas or as control lines to back-burn from under appropriate conditions).
- Mallee roots can smoulder underground for many weeks after a fire, causing re-ignition of unburnt vegetation.
- Willy-willies are frequent after fire in burnt areas and can carry hot embers across control lines into unburnt vegetation.
- Dried foliage from burnt mallee trees can begin dropping (onto smouldering material) after 4-5 days, increasing the chance of re-ignition.

In consideration of the suppression constraints described above, the operational guidelines for wildfire suppression are described below in Table 8. These guidelines shall be used in conjunction with existing NPWS fire suppression policies.

Operational Area	Guidelines
Aerial reconnaissance	• Helicopters and fixed-wing aircraft will be considered as valuable resources particularly for initial reconnaissance and patrolling during and after wildfire containment.
Backburning	• Back-burning is a valid and useful fire fighting tactic in the mallee, but should only be conducted late afternoon or evening when weather conditions are suitable, by experienced personnel and after careful consideration by the Incident Management Team.
Chemicals	• The use of fire fighting chemicals will be permitted except near standing water (ground tanks and natural soaks). Mixing of chemicals should occur well away from standing water.
Containment strategies	• Ensuring the safety of fire fighters will be the primary objective when planning and implementing containment strategies. • Where possible and without excessively increasing fire size (consider biodiversity objectives), allow wildfires to be contained by previously burnt areas and natural low fuel areas (Map 8, Section 9) in preference to the construction of control lines by heavy plant. • Direct attack from slip-on units is permitted only in situations where the safety risk is minimal (e.g. for containing small low intensity fires in mild weather conditions, or for small outbreaks close to control lines where access is adequate). • Mopping-up and patrolling from slip-on units will be preferred over the use of heavy plant or fire tankers. • Intensive patrolling after containment should continue for at least two shifts to ensure re-ignition does not occur. Less intensive patrolling should then continue for at least 3 days. • In mallee a 0-10 year old previously burnt area (depending on size) will halt a fire. A 0-10 year old 100-150 metre wide prescribed burn will halt a low to moderate intensity fire (but spotting may occur), while a high intensity fire may only be temporarily slowed and broken up. Heavy speargrass fuel conditions may reduce the effectiveness of previously burnt areas in slowing wildfire.

Table 8: Operational guidelines for fire suppression

Operational Area	Guidelines

Control lines
(and heavy plant use)
	• Construction of control lines by heavy plant is permitted but must be planned and implemented in relation to these guidelines.
	
	• The biodiversity objectives and locations of significant species will be considered when locating control lines. Link up with SFMZ's (prescribed burns and fire trails), recently burnt areas and natural low fuel areas (Map 8) *as much as possible* when planning and constructing control lines to provide for more effective fire containment, increased safety for fire-fighters and to minimise vegetation clearance and soil disturbance by heavy plant.
	
	• Where practicable, all attempts will be made to exclude the construction of control lines to within 100 metres of known:
	  • Cultural heritage sites (Map 3),
	  • Sites of significant plant populations (Map 2),
	  • Malleefowl nest locations, and
	  • Fauna survey sites.
	Detailed "Unit" maps will be made available to Incident Management Teams to facilitate this.
	
	• Experienced NPWS personnel will operate heavy plant in preference to contractors when practicable, in relation to the above guideline.
	
	• Experienced NPWS personnel will guide heavy plant when constructing control lines.
	
	• Construction of control lines with heavy plant along sandy dune crests will be avoided where practicable.
	
	• Dozers will operate with rakes in preference to blades to reduce soil disturbance. Graders will be preferred in speargrass fuel conditions in open vegetation communities.
	
	• Control lines will be rehabilitated (respreading of debris and top-soil) where possible, and should be commenced before the end of operations.

Operational management	• On-ground operations will be managed (either at Divisional or Sector level) by experienced NPWS staff members where more than one agency is involved in fire suppression.
Water supplies	• Fire water supplies at Canegrass Bore and Old Tarawi Bore should be utilised before the ground tanks retained for management purposes (Three By Two ground tank should be utilised before the House Tank).

Table 8: Operational guidelines for fire suppression (continued)

4.4.2 Prescribed burning

All prescribed burning proposed in this plan will be conducted according to the NPWS's "Minimum Operational Guidelines for Fire Management Works". This documentation also assists the NPWS in complying with the Environmental Protection Act to ensure that the environmental impact of works are minimised or within acceptable limits. Refer to the accompanying EIA document.

All prescribed burns proposed in this plan will be organised using the ICS structure which will increase the safety and effectiveness of burning procedures and act as valuable training sessions for staff.

Several cultural heritage sites and significant flora and fauna populations have been identified and mapped in the process of preparing this plan. This information will be used before each prescribed burn so that sites/populations can be avoided. In additional, areas to be burnt will be actively searched prior to burning.

4.5 Regional perspective of management

As previously described, Tarawi NR is bordered on two sides by other conservation reserves managing Scotia mallee communities. It is therefore especially important that fire management strategies proposed in this plan are relevant and compatible on a regional perspective.

Resource information on fire history and vegetation for the Scotia region (including Danggali CP) have been gathered. These data requires further analysis but it would appear there are several important similarities in fire history and ecology between the region and Tarawi NR. These include:

- The large fire event in 1917-18 probably burnt the majority of the Scotia region.
- Large continuous tracts of long-unburnt Mallee communities similar to those described in this plan.
- The most extensive wildfires have occurred under speargrass conditions after effective rainfall in a range of mallee communities.
- Relatively smaller fires have occurred in perennial fuel conditions and are mainly restricted to the Mallee-spinifex communities.
- Wildfire intervals have been irregular and events have been relatively infrequent (major events regionally in 1917-18, mid-1950's, mid-1970's, mid-1980's and late 1996).
- From available data, it appears most fires are quite "complete" in terms of the area burnt within the main fire boundary (ie. low degree of patchiness).

It is considered that the fire biodiversity guidelines for Tarawi NR described in Section 4.1.2 are relevant on a regional basis given the similarities in vegetation and fire histories. It is therefore considered that the objectives and strategies proposed are also relevant on a regional scale. Fire trail maintenance and the strategic prescribed burning proposed for Tarawi NR will assist in managing fire on a larger scale around the Reserve. Findings from the research and monitoring proposed and currently underway in Tarawi NR may be pertinent to the management of neighbouring conservation areas.

5. FIRE MANAGEMENT ASSETS

5.1 Fire trails and access

As described in Section 4.2.2, all fire trails are designated Strategic Fire Management Zones - 1. These trails and their locations are listed below in Table 9 and illustrated in Map 6 (Section 9). Fire trail intersections are sign-posted with metal night-reflective signs. All fire trails are suitable for access by most four-wheel drive fire fighting vehicles (to Category 1). However, for very heavy equipment (particularly transport float trucks) access is very limited due to numerous sandy dune crests on many fire trails. During fires, local knowledge and "unit" maps will be used to direct transport trucks to appropriate locations. Other vehicle tracks (Map 6) may be used for access during fire suppression operations mainly by slip-on units but generally are not suitable for larger fire tankers or for float trucks due to the narrow width and lack of turning space.

Fire Trail Name	Length (km)	Location
West	12.3	Internal, western section of Reserve
Central	12.1	Internal, central section of Reserve
East	11.9	Internal eastern section of Reserve, except northern part which borders Scotia Sanctuary
West Boundary	12.1	West boundary on South Australian/NSW border adjacent to Danggali Conservation Park
East Boundary	7.0	East boundary adjacent to Belvedere Station
Canopus	14.5	Internal from homestead to Canegrass bore
North Boundary	24.5	North boundary adjacent to Scotia Sanctuary
North-East Boundary	8.0	North-East boundary adjacent to Scotia Sanctuary
South Boundary	23.1	South boundary adjacent to Belmore Station
South-East Boundary	7.5	South-East boundary adjacent to Wenba Station
Total km	**133.0**	

Table 9: Fire trails (Strategic Fire Management Zones - 1)

5.2 Fire management utilities and facilities

Utilities are infrastructure that assist in the suppression of fire. At Tarawi NR they include water sources and the airstrip (Map 6). There are several sources of water that may be available at Tarawi NR that may be used for fire suppression operations. However, during very dry seasonal conditions, water supply may be limited. There is one water storage tank (manually-fed) available at the Old Tarawi Bore site on the West Fire Trail and two (bore-fed) at Canegrass bore in the eastern section of the Reserve. **This plan proposes that fire water supplies (enclosed tanks) be increased at the Old Tarawi Bore site and at the homestead/ workshop area.**

The two ground tanks retained for management purposes, the "House" tank and "Three by two" tank may be used as fire water supplies if storage levels are sufficient (see Section 4.4 for guidelines on fire water usage). Other ground tanks in the Reserve are gradually being decommissioned for pest management purposes and will become increasingly unreliable as a fire water supply in the future.

Fire management facilities at Tarawi NR which assist in the suppression of fire include an office with phone, fax and HF, UHF (both CB and Rural Fire Service sets) radio communications and weather station. These facilities enable the office to be used as a forward control centre during fire suppression.

Other facilities include a fully equipped workshop and staff shearers quarters with accommodation and kitchen facilities.

6. WORKS SCHEDULE

6.1 Biodiversity works schedule

6.1.1 Biodiversity/fire ecology research and monitoring

Several fire ecology issues that have the potential to have negative long term impacts on Tarawi NR's biodiversity have been identified in this plan (Section 4.1.3).

For the purposes of identifying a works schedule, the fire ecology issues described in Section 4.1.3 have been termed "projects":

"Old growth" biodiversity project

- The reptile and small mammal component of this project focusing in the Mallee-spinifex community (sites established in young and old areas to enable a comparison) commenced in November 1997. Bird surveys and quantitative vegetation assessments will commence in late 1998, after which data analysis will be undertaken. This program will be expanded to other vegetation communities in 1999, unless further surveys are required in the Mallee-spinifex community pending data analysis.

- Vegetation monitoring sites within the prescribed burning zones (SFMZ-2's) will be established and quantitatively assessed before and continue after burning. This will occur in both long unburnt and younger mallee to enable a comparison of responses between fire ages. Assessment will measure both floristic and structural characteristics. This project will assist in both monitoring the impacts of prescribed burning (including the effects of low-medium intensity burns) and assist in understanding the regenerative capacity of long unburnt mallee communities. It is considered that although the areas to be burnt are relatively small, vegetation assessments will still provide valuable fire ecology information on "old growth" mallee. A suitable assessment technique will be developed in consultation with the NPWS Survey and Research Division. It is envisaged that this project will commence in autumn 1999 when the first prescribed burns will be conducted after the adoption of this plan.

- The NPWS Survey and Research Division are assisting the Lower Darling District in assessing plant species abundance and soil-stored seed status in old growth mallee at Tarawi NR. The first survey was conducted in February 1998 and the second will be conducted in early 1999, after which data analysis will commence.

Post-fire grazing impacts project

- Exclosure experiments have commenced to assist in assessing post-fire grazing impacts on biodiversity in the Mallee-spinifex community, initially concentrating on *Callitris verrucosa* populations. Vegetation surveys and photo-points associated with this project will be conducted twice per year. This project will be expanded to other populations of concern pending the occurrence of wildfire.

- Feral goat and rabbit pest control programs are ongoing at Tarawi NR. In addition, the gradual closure of artificial watering points currently underway will also assist in reducing grazing pressure and pest populations. The results of this project may also assist in evaluating the success of pest control programs.

Flora fire ecology project (plant regeneration methods and post-fire life cycles)

- Survey work has commenced to assess plant species responses to fire and involves tagging and repeat monitoring of individual plants. However, this program needs to be expanded. It is envisaged that once more sites are established that surveys will be twice per year. This project has obvious links to the "old growth" biodiversity project.

Fauna fire ecology project (small mammals and threatened birds)

- The biodiversity issues of concern associated with this project will mainly be addressed in the "old growth" biodiversity project, initially in the Mallee-spinifex community. However, pending on the results, small mammal and bird surveys may continue in other vegetation communities. The Lower Darling District will continue to liaise with the NPWS Threatened Species Unit to encourage additional research on species with little-known fire ecology requirements.

Fire suppression impacts project

- Assessing impacts of fire suppression activities (mainly construction of control lines by heavy machinery) is mainly undertaken by photo-points and qualitative assessment. Photo-points have been established in recent fires at Tarawi NR and will be established where control lines are constructed in future fires.

Monitoring prescribed burns project

- Some prescribed burning has commenced at Tarawi NR and photo-points have been established to monitor post-fire vegetation regeneration. However, a more quantitative monitoring technique is required to properly evaluate the impact of prescribed burning, particularly comparing the fire responses of old growth and younger mallee. It is considered that this project will largely be addressed by the work proposed in the "old growth" project.

6.1.2 Fire mapping and database management

The computerised fire history map for Tarawi NR will be updated as fires and prescribed burns occur, and refined as additional gaps in the data are identified. The vegetation map will also be refined in areas where gaps have been identified. The NPWS considers this a very important management activity as it enables an ongoing assessment of fire regimes and evaluation of the biodiversity guidelines for future plan reviews.

It is also recommended that a computerised fire history map be developed for the Scotia region. This recognises that Tarawi NR is just a portion of the continuous mallee vegetation that is a feature of the region, and that the biodiversity value of the Reserve is also effected by regional fire regimes. A regional fire history database will also assist fire plan reviews for Tarawi NR in the future, and assist the preparation of the Wentworth Shire's Bushfire Risk Management Plan.

6.2 Operations works schedule

Prescribed Burning

Burning on one side in the Strategic Fire Management Zone - 2 will aim to be completed by the next review of this plan. The majority of burns will be conducted in autumn months (between late March and late April) when perennial fuel will still be relatively dry and weather conditions relatively mild.

The areas to be prescribed burnt within the SFMZ's have been prioritised to indicate the approximate ordering of burning over the next five years (Table 10). The priority rating has been determined by the fire potential and fire history of the surrounding area and locations of significant populations/species. Map 7 (Section 9) illustrates the location of the SFMZ-2's and their priority rating, and areas already prescribed burnt by the NPWS.

If major wildfires occur during the life of this plan, then the priority of the prescribed burning areas may change, depending on the location and extent of any wildfires.

As discussed in Section 4.3, prescribed burning in SFMZ-3's (Strategic Fire Management Zones - 3) will only be conducted under speargrass fuel conditions. When this occurs the ephemeral fuel loads across the Reserve are likely to be variable, and burning in these zones will be located opportunistically where the fire potential is highest and the threat to locations of significant species and cultural heritage sites are greatest. *Therefore, the SFMZ-3's areas are unable to be prioritised for burning*

SFMZ-2 map label	Priority rating	SFMZ location description	Burn distance/area	Burn location justification
A	1	Corner of North Boundary and Central FT's	3.5 km/ 35 ha	Protect nearby young mallee areas, remnant *Grevillea pterosperma* and *Callitris verrucosa* populations and known Malleefowl habitat SW of burn. Protect long unburnt mallee in Scotia Sanctuary
B	2	North Boundary FT(east)	10.0 km/ 100 ha	Protect nearby recently burnt areas and remnant *Grevillea pterosperma* and *Callitris verrucosa* populations. Protect long unburnt mallee in Scotia Sanctuary
C	3	Spring Track (north)	4.0 km/ 40 ha	Protect surrounding mosaic of recently burnt and long unburnt mallee, known malleefowl habitat and remnant *Callitris verrucosa* populations
D	4	North Elephant Track	2.0 km/ 20 ha	Protect nearby recently burnt areas, remnant *Grevillea pterosperma* populations and known malleefowl habitat south of burn areas
E,F	5	Centre FT (centre) and Centre FT (south)	2.5 km/ 25 ha 1.5 km/ 15 ha	Protect nearby recently burnt areas, remnant plant populations and known malleefowl habitat west of burn areas
G	6	West FT (north)	2.5 km/ 25 ha	Protect surrounding mosaic of recently burnt and long unburnt mallee and remnant *Callitris verrucosa* populations
H	7	North Boundary FT (west)	1.8 km/ 18 ha	Protect surrounding long unburnt Mallee-spinifex and large *Callitris verrucosa* population adjacent to FT
I	8	Corner West Boundary and South Boundary FT's	5.5 km/ 55 ha	Protect surrounding mosaic of recently burnt and long unburnt Mallee-spinifex
J,K	9	North Boundary FT (west), West Boundary FT (north)	1.8 km/ 18 ha 3.5 km/ 35 ha	Protect large long unburnt Mallee communities in NW of Tarawi
L	10	East Boundary FT (south)	1.8 km/ 18 ha	Protect isolated patch of nearby long unburnt mallee, with known *Ningaui yvonnea* population
M	11	South Boundary FT (east)	3.5 km/ 35 ha	Protect mosaic of recently burnt and long unburnt mallee north of burn area

Table 10: Priority rating for prescribed burning within the Strategic Fire Management Zones - 2

Note: FT = Fire Trail. Refer to Map 7. Burn area based on a strip width of 100 metres, but areas only *approximate* due to inherent variability of ground fuel loads which may produce patchy burnt areas. In addition, burning width will be *at least* 100 metres, to no more than 150 metres. Justification for locating all burns also includes the high fire potential of the surrounding large continuous areas of Mallee-spinifex that exists. Also refer to the biodiversity guidelines and objectives for further burning justification.

Maintenance of fire trails and Asset Protection Zones

No additional permanent fire trails will be constructed in the Reserve. Most fire trail maintenance will be undertaken on an annual basis according to the seasonal conditions that prevail. All trails will be maintained to the existing width of 6-8 metres using a combination of herbicide boom-spraying and mechanical methods. Herbicide application using will be the preferable method as it involves less soil disturbance but is generally more effective in areas with heavier textured soils. Spot-spraying of mallee and shrub re-growth on fire trails will also be undertaken as required and in preference to grading. Rates of application, types and combination

of chemicals used and seasonal timing of spraying are continually being evaluated within the District to determine the most effective spraying regime.

Maintenance of other vehicle tracks in Tarawi NR will mostly consist of the removal of over-hanging tree limbs and shrub growth. These tracks will not be widened and grading will only occur after effective rainfall when abundant speargrass is present.

As discussed, the maintenance of Asset Protection Zones will similarly be maintained as a low fuel area as required by seasonal conditions.

Fire water supply upgrade
There is a need to increase the fire water supply in the western section of the Reserve, where available water is restricted. It is proposed to install a second enclosed 45,000 litre tank at the Old Tarawi Bore site, which will be manually filled prior to each fire season. In addition, a 45,000 litre tank will be installed near the homestead/workshop area. It is hoped that the extra tanks will be purchased and installed during the 1999-2000 financial year.

Monitoring fuel loads
Methods to adequately monitor fuel levels in the mallee are yet to be developed. Most existing methods only measure the fuel load, rather than the spatial arrangement (i.e. cover characteristics). It is the latter which is probably more relevant in determining the fire potential of mallee vegetation, and which can vary extensively between different mallee communities and different seasons. An appropriate standardised technique for fuel monitoring needs to be developed for mallee environments. However, a new technique for monitoring fuel has been developed by Department of Environment and Natural Resources, Victoria, which will be investigated for use in the Lower Darling District. Vegetation surveys proposed in the previous section will assist in understanding fuel dynamics in different vegetation ages and communities.

7. PLAN ADMINISTRATION

Management of works
The works described in Section 6 will be identified in the annual Lower Darling District Operations Plan, which lists all Reserve management works to be conducted for each financial year. The performance of the works will be monitored by the Lower Darling District Manager and regular reports will be submitted to the District's Advisory Committee. Reports on all works will also be submitted annually to the:

- Wentworth Shire Bush Fire Management Committee
- South West Mallee Bush Fire Prevention Scheme
- NSW/SA/VIC Bush Fire Border Liaison Committee

Environmental assessment of scheduled works
An Environmental Impact Assessment (EIA) for all new fuel management activities proposed in this plan is in a supporting document. The EIA must be approved by the District Manager and the Regional Manager for the plan to be adopted.

Plan review

Following adoption, the currency of this plan is five years. The review will include an evaluation of all sections of the plan. A similar process of community consultation, public exhibition and environmental impact assessment will be followed in the preparation of the next plan.

8. REFERENCES

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9. MAPS

Map 1: Broad vegetation communities

Map 2: Preliminary map of significant plant populations

Map 3: Preliminary map of cultural heritage sites

Map 4: Recent fire history

Map 5: Fire management zones

Map 6: Fire trails and other fire management assets

Map 7: Areas for prescribed burning and their priority rating within the Strategic Fire Management Zone - 2

(refer to Table 10)

Map 8: Preliminary map of low fire potential areas (under perennial fuel conditions) for fire suppression operations

(note: includes low fire potential communities, recent wildfires and prescribed burns)

10. APPENDICES

Bird Species	Distribution	Breeding Season	Fire Ecology ♣
Black-eared Miner * (*Manorina melanotis*) * hybrids only at Tarawi NR	Dense old-growth mallee eucalypts, with a variety of understorey types, where it forages and nests in the mallee canopy	July to November	Restricted to probably at least 60 year-old post-fire vegetation for nesting and sheltering, but known to forage in much younger aged vegetation.

Malleefowl (*Leipoa ocellata*)	Mallee with mainly spinifex understorey.	September to March	Habitat unsuitable or reduced quality for 10-20 years post-fire. Habitat improved but not optimal quality for nesting at 20-40 years post-fire. After 40 years habitat is optimal quality for nesting. Optimal post-fire age probably in excess of 60 years. Regenerating burnt habitat may provide important foraging for birds nesting in adjacent unburnt patches.
Chestnut Quail-thrush (*Cinclosoma castanotum*)	Found in a variety of mallee communities.	August to December (variable)	Generally prefers old growth mallee. At Tarawi NR always observed in Mallee-spinifex communities.
Gilbert's Whistler (*Pachycephala inornata*)	Found in a variety of mallee habitats but usually associated with dense shrubby thickets for nesting and foraging.	September to December	Probably prefers old-growth vegetation but not restricted to one type of mallee habitat.
Grey Falcon (*Falco hypoleucos*)	Wide variety of habitats.	July to September	Little known but fire not a primary threatening process.
Pied Honeyeater (*Certhionyx variegatus*)	Wide variety of habitats with developed shrub layer (feed on nectar particularly *Eremophila* spp.)	September to February	Unknown but fire probably not a threatening process due to nomadic nature and relatively wide distribution.
Pink Cockatoo (*Cacatua leadbeateri*)	Wide variety of habitats.	May to November	Little known fire ecology but may require long unburnt vegetation for the provision of nesting hollows.
Purple-crowned Lorikeet (*Glossopsitta porphyrocephala)*	Observed at Tarawi feeding in flowering *Eucalyptus* in Mallee sandplain/spinifex	September to November	Unknown but fire probably not a threatening process due to nomadic nature of species.
Shy Hylacola (*Sericornis cautus*)	Found in many types of mallee communities. Probably prefers dense shrub cover. Nests on or near the ground.	July to November	Little known but is known to exploit and breed in mallee regrowth after fire (no age specified) and old growth vegetation.
Southern Scrub-robin (*Drymodes brunneopygia*)	Found in many types of mallee communities. Prefers dense shrub cover. Nests on the ground.	July to November	Little known but is known to exploit and breed in mallee regrowth after fire (no age specified) and old growth vegetation.
Striated Grasswren (*Amytornis striatus striatus*)	In NSW confined to mainly mallee with mature spinifex understorey (where it nests in the spinifex clump), may prefer mixed spinifex and shrub understorey.	Variable	Has been observed to be common in ten year old post-fire vegetation. Probably utilises both dune and sandplain mallee, preferring old-growth or at least 20 years for mature spinifex development.

Appendix 1: Distribution and fire ecology summary of significant fauna species

Mammal Species	Distribution	Breeding Season	Fire Ecology ♣
Bolam's mouse *(Pseudomys bolami)*	At Tarawi NR found in Belah and Wilga woodlands, and occurs in young and old Mallee-spinifex community.	Possibly in spring	Little known.
Southern ningaui *(Ningaui yvonneae)*	Prefers Mallee-spinifex community. At Tarawi NR found in young and old Mallee-spinifex communities. Also found in Belah woodland with relatively dense and diverse understorey.	Spring to early summer	Appears to have no specific fire-related requirements.
Little pied bat *(Chalinolobus picatus)* and *Eptesicus baverstocki*	Wide variety of habitats.	Variable	Little known fire ecology but may require long unburnt vegetation for the provision of nesting hollows.

Reptile Species	Distribution	Breeding Season	Fire Ecology ♣
Western Blue-tongue Lizard (*Tiliqua occipitalis*)	Wide variety of mallee habitats.	Summer	Little known but fire not a primary threatening process.
[Skink species] *(Ctenotus brachyonyx)*	Prefers Mallee-spinifex community.	Summer	Little known.
Mallee Dragon *(Ctenophorus fordi)*	Prefers Mallee-spinifex community. At Tarawi NR abundant in young and old Mallee-spinifex communities.	Summer	Little known but restricted to Mallee-spinifex community
Jewelled Gecko *(Diplodactylus elderi)*	Mainly Mallee-spinifex	Summer	Little known.
[Snake-lizard species] *(Delma australis)*	Wide variety of mallee habitats.	Summer	Little known.
Common Scaly-foot *(Pygopus lepidodus)*	Wide variety of mallee habitats.	Summer	Little known.

♣ = see tables pages 24-25 for general fire regime and management requirements for birds, mammals and reptiles

Appendix 1 (continued): Distribution and fire ecology summary of significant fauna species

Appendix 2: Definitions and principles

Most definitions described below come from the Australian Fire Authorities Council (AFAC) ***Glossary of Rural Fire Terminology*** *(March 1996).*

Aerial Detection The discovering, locating and reporting of fires from aircraft.

Aerial Fuels The standing and supporting combustibles not in direct contact with the ground and consisting mainly of foliage, twigs, branches, stems, bark and creepers.

Aspect The direction towards which a slope faces, eg north-east. Slopes on a west to north-westerly aspect are the most hazardous during fire fighting operations.

Assets at Risk The natural resources or improvements that may be jeopardised if a fire occurs. Examples include: threatened species habitat, rainforests, forestry coups, human built structures or infrastructures, park information signs, transmission poles etc. and may also include scenic values. For the fire manager it may also include natural values that may be threatened by a fire (eg water catchment quality).

Backburning A fire started intentionally along the inner edge of a fireline to consume the fuel in the path of a wildfire.

Buffer A strip or block of land on which the fuels are reduced to provide protection to surrounding lands.

Burning Programme All the prescribed burns scheduled for a designated area over a nominated period of time.

Bush Fire Management Unit (FMU) Management areas of a variable size that define containment blocks in the event of a wildfire. Alternatively they have also been designated as areas of specific ecosystem types defined by management authorities in order to monitor the long term effects of fire upon those areas.

Bush Fire Management Zone (BFMZ) Management areas (usually sub-sets of fire management units) where a specified fire management operational objective, strategy and performance indicator has been developed to mitigate against the threat of a wildfire.

special note about the above: *an* ***FMU*** *is usually a monitoring and containment block whilst a* ***BFMZ*** *is a sub-unit of an* ***FMU*** *where fire managers undertake activities such as prescribed burning, in order to achieve a set outcome (such as provide protection or slow the advance of a wildfire).*

Coarse Fuels Dead woody material, greater than 25mm in diameter, in contact with the soil surface (fallen trees and branches).

Controlled Burning *See Prescribed Burning*.

Crown Fire A fire burning in the crowns of trees and usually supported by fire in ground fuels. Its is a fast travelling fire that usually consumes all available fuels in its path.

Drought Index A numerical value, such as the Byram-Keetch Drought Index, reflecting the dryness of soils, deep forest litter, logs and living vegetation.

Ecosystem The interacting system of a biological community, both plant and animal, and its non living surroundings

Effective rainfall A term used in this plan to describe rainfall that causes an ephemeral herbage response (speargrass fuel conditions) which when cured, greatly increases the ignition potential and spread of wildfire (see page 19 for more detail).

Fine Fuels Grass, leaves, bark and twigs less than 6mm in diameter.

Fire The chemical reaction between fuel, oxygen and heat. Heat is necessary to start the reaction and once ignited, fire produces its own heat and becomes self-supporting. Removal of any one of the three elements of fuel, oxygen and heat will extinguish a fire.

Fire Behaviour The manner in which a fire reacts to the variables of fuel, weather and topography. Changes in any of these variables with result in a change in the fires behaviour.

Fire Break Any natural or constructed discontinuity in a fuel bed used to segregate, stop and control the spread of a wildfire, or to provide a fireline from which to suppress a fire.

Fire Extent The area burnt by a wildfire, measured in hectares. Within that area there will be "islands" of unburnt vegetation (these islands are generally included in the total fire extent).
NB: it is preferable that fire effect only part of a vegetation community at any one time so that nearby areas of more mature plants may provide a seed source for recolonisation and animals will have suitable unburnt habitat in order to seek shelter and forage.

Fire Front The part of a fire where the rate of spread, flame height and intensity are greatest, usually when burning downwind or upslope.

Fire Intensity The rate of energy released per unit length of fire front. This is usually expressed as kilowatts per metre (kW/m).

Fire Management All activities associated with the management of fire-prone land, including the use of fire to meet land management goals and objectives.

Fire Perimeter The entire outer boundary of a fire area.

Fire Potential General term used in this plan referring to the flammability of the vegetation community (fuel components and spatial arrangement of fuel) and the likelihood for fire to spread through the community given suitable weather conditions. Similar to *fire hazard*.

Fire Regime The history of fire in a particular vegetation type or area including the frequency, intensity and season of burning (season in this context refers to the time of the year in which the fire occurred). It may also include proposals for the use of fire in a given area.

Fire Season The period(s) of the year during which fires are likely to occur, spread and do sufficient damage to warrant organised fire control. In New South Wales the core fire season is from 1st October to the 31st March of the following year.
At the regional scale, the season may be introduced or extended by one month dependant upon the prevailing weather conditions, drought indexes and number of wildfire's that may already be burning within that area.

Flame Height The vertical distance between the tip of the flame and ground level, excluding higher flame flashes. Expressed in vertical metres.

Fuel Any material such as grass, bark, leaf litter and living vegetation which can be ignited and sustains a fire. Fuel is usually measured in tonnes per hectare of dry weight.

Fuel Arrangement A general term referring to the spacing and arrangement of fuel in a given area.

Fuel Load The oven dry weight of fuel per unit area. Usually expressed as tonnes per hectare.

Fuel Bed The arrangement and vertical profile of all readily combustible materials lying on the ground.

Fuel Management Modification of fuels by prescribed burning, manual removal, slashing, grazing, or other means. The objective is to reduce the fuel thereby reducing the risk posed by wildfire's.

Fuel Type An identifiable association of fuel elements of distinctive species, form ,size, arrangement, or other characteristics that will cause predictable rate of spread or difficulty of control under specified weather conditions.

Habitat A physical portion of the environment that is inhabited by an organism or population of organisms. A habitat is characterised by a relative uniformity of the physical environment and fairly close interaction of all the biological species involved.
Organisms within the a given habitat will express a level of co-dependency upon one-another. The loss of the physical characteristics of a given habitat can have sever and long term detrimental effects upon the organisms living in that habitat.

Hazard Reduction	*see Fuel Management*
Island	An unburnt area within a fire perimeter. Islands are critical for species survival and recruitment after a wildfire event.
NPWS	The National Parks and Wildlife Service of New South Wales.
Perennial fuel conditions	**C**onsisting primarily of mallee trees and litter, shrubs and spinifex. This is the "normal" state of mallee fuel experienced in the majority of years. Fires that occur during these conditions are variable in size and intensity and are mainly restricted to the Mallee-spinifex community, and to a lesser extent the Mallee-sandplain community.
Perennial <u>plus</u> ephemeral fuel conditions	**S**peargrass fuel conditions. Fuel state consisting of perennial vegetation plus ephemeral species of various grasses and herbs, but particularly the highly flammable speargrass (*Stipa* species) which dominates in the Mallee-sandplain, open Belah woodland and Mixed open shrubland/woodland communities, after **effective** rainfall. Under these conditions there is a more continuous fuel load across all communities than in "perennial fuel conditions". Most fires that occur during these conditions are often large in size and moderate to high in intensity.
Planning Period	5 years, the currency of Fire Management Plans, after a which a review is undertaken before re-adoption.
Prescribed Burning	The controlled application of fire under specified environmental and weather conditions to a predetermined area and at the time, intensity, and rate of spread required to attain planned resource management objectives.
RFS	The Rural Fire Service.
Rate of Spread	The forward progress per unit time of the head of the fire or another specified part of the fire perimeter.
Scorch Height	The height above ground level up to where foliage has been browned by a fire. This height is roughly ten times the actual flame height of the fire.
Slip-on Unit	Or Striker unit. A fire fighting unit that can be placed on to the back of a four wheel drive vehicle to convert it to a fire tanker. Most NPWS units carry 400 litres of water. *Depending upon the units water carrying capacity, a four wheel drive tray top vehicle could be converted to Category 2,7 or 9 fire tankers in a very short space of time.*
Spot Fire	Isolated fires started ahead of the main fire by sparks, embers or other ignited material, sometimes to a distance of several kilometres.
Structure Fire	A fire burning part, or all of any building, shelter, or other human made construction.
Tanker	A mobile firefighting vehicle equipped with a water tank, pump, and the necessary equipment for spraying water and/or foam on wildfire's. *Under NSW Dept. of Rural Fire Service guidelines, bushfire fighting tankers have been designated into nine 'Categories' delineating water carrying capacity and whether the unit is two or four wheel drive capable.*
Topography	The surface features of a particular area or region, ie the lay of the land, and includes mountains, rivers etc.
Unplanned Fire	*see Wildfire*
Wildfire	An unplanned fire. A generic term which includes grass fires, forest fires and scrub fires.

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