Fire Management Plan

Tinderry Nature Reserve

Acknowledgements

This plan is based on the draft fire plan and geographic information prepared by consultants IFERM in 1996 and the vegetation survey and mapping report prepared by Michael Doherty (CSIRO) in 1997. Information about the cultural values is from the Cultural Conservation Management Plan prepared by Michael Pearson of Heritage Management Consultants in 1999.

Since 1996 this draft plan has been reviewed and the draft was finalised by the Queanbeyan Area office of the National Parks and Wildlife Service in June 2001.

The draft was put on public display from 4 April 2003 and public submissions closed on 6 June 2003.

Cover Photograph: *Tinderry Nature Reserve*

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SUMMARY

Planning and Consultative Process

This fire management plan has been developed to provide direction for fire management activities, including bushfire suppression, in Tinderry Nature Reserve. The plan outlines strategies and actions for the protection of life and property, and natural and cultural heritage. It includes information and direction on the adoption of appropriate fire regimes for the conservation of biodiversity.

The plan is based on the results of surveying and mapping of the reserve's flora, fauna and fire history. It includes an analysis of the fire threat to life and property, and natural and cultural values within the reserve. It sets out management objectives, actions, operational guidelines and works programs for the management of fire within the reserve.

The plan was developed under the guidance of a steering committee with representation from senior fire officers of the Yarrowlumla and Cooma- Monaro Rural Fire Service and NPWS officers.

While every effort has been made to use the most accurate data available, additional information is continually being collected. The level of knowledge regarding fire management, particularly with respect to biodiversity management of dry tableland forests, is also evolving. It is therefore proposed that this plan will be valid for five years from the date of the final plan, after which a review will be undertaken.

NPWS Fire Management Objectives

In accordance with Sections 63 & 64 and Part 1, Section 3 of the *Rural Fires Act 1997* and the *National Parks and Wildlife Act 1974,* the primary objectives for fire management in Tinderry Nature Reserve are to:

- Prevent the occurrence of human caused unplanned bushfires on the reserve.
- Suppress unplanned bushfires occurring on the reserve.
- Minimise the potential for spread of bushfires on, from, or into the reserve.
- Protect from bushfires persons and property on or immediately adjacent to the reserve.
- Manage bushfires to avoid the extinction of any species which are known to occur naturally within the reserve.
- Protect from bushfire damage all Aboriginal sites, historic places and culturally significant features known to exist within the reserve.
- Work co-operatively with neighbours and rural fire brigades in managing fire in and adjacent to the reserve.

Strategies for Life and Property Protection

Strategies for the protection of life and property from the effects of bushfires included in the plan are to:

- Reduce the risk of fire leaving the reserve and damaging assets in areas of identified high risk by maintaining and enhancing a strategic system of fire trails and watering points and by maintaining fuel levels to a safe level in dry forests on the western portion of the reserve;
- Undertake rapid deployment and suppression of fire in the reserve; and
- Reduce risk of illegal fire lighting in the reserve by managing illegal entry and effective neighbour liaison.

Strategies for Heritage Management

Strategies for the management of the natural and cultural values are to:

- Apply Bushfire Management Zones in fire planning and on-ground fire management;
- Exclude/suppress fire in moist montane and sub-alpine forests including areas of swamp and heath, particularly in the central granite area featuring Tinderry Peak and Tinderry Twin Peak;
- Exclude/suppress fire in the cypress-pine vegetation community for at least 80 years;

- Use any prescribed burning of dry forests to promote a mosaic, with no areas burnt at intervals of less than 25 years. Burning is to be of low intensity;
- Avoid proliferation of aerial fuels, such as the shrub kunzea, through the application of prescribed burns;
- Prevent damage to Aboriginal and historic sites by identified site protection works and comprehensive briefing and supervision of ground crews;
- Attempt to prevent any single large fire events in the reserve and reduce the risk of fire entering or spreading in areas of high biological diversity and areas of identified heritage value; and
- Prepare a comprehensive reserve fire operations map for use by management teams and on-ground crews.

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1. INTRODUCTION

1.1 Scope and Purpose of the Plan

This plan documents the fire management guidelines and programs for Tinderry Nature Reserve. It provides a framework for fire management in relation to the conservation of biodiversity and the protection of life and property, and natural and cultural heritage over the next five years. It contains objectives, strategies and actions for the prevention and control of bushfires, the management of bushfire threat and the protection of fire fighters.

It contains information about the biodiversity and heritage values of the reserve, its fire history, climatic features and life and property protection requirements both on and adjacent to the reserve.

The plan has been developed in accordance with the provisions of the *Rural Fires Act 1997* and other relevant legislation in consultation with the Rural Fire Service and other stakeholders, through the Tinderry Fire Plan Steering Committee.

The Tinderry Nature Reserve Fire Management Plan will contribute to both the Cooma and Yarrowlumla District Bushfire Management Committee (DBMC) Risk Management Plans. Under Section 50 of the *Rural Fires Act 1997* these committees are responsible for the development of bush fire risk management plans and a plan of operations.

This plan provides, in accordance with section 38(4) of the *Rural Fires Act 1997*, the compliance conditions for fire management operations that may be undertaken in the reserve by fire control officers.

1.2 The Planning Environment

The Tinderry Nature Reserve Fire Management Plan is developed within the provisions of key legislation, policies and plans. The NPWS has legislative and statutory responsibilities to adequately consider both environmental impacts and life and property protection in the development of fire management objectives and strategies.

Legislation includes the *Rural Fires Act 1997, National Parks and Wildlife Act 1974, Threatened Species Conservation Act 1995* and *Environmental Planning and Assessment Act 1979*. NPWS responsibilities under such legislation as the *Rural Lands Protection Act* and the *Noxious Weeds Act* are also considered.

Polices and plans include the Murrumbidgee Catchment Action Plan, Tinderry Nature Reserve Plan of Management 1998 and Cooma and Yarrowlumla shire local and regional environmental planning instruments.

1.2.1 Legislative basis

Rural Fires Act 1997 and Rural Fires Regulations 1997

Under the *Rural Fires Act 1997*, the NPWS is a designated fire fighting authority with responsibilities for the prevention, control and suppression of fires on NPWS estate. Under this Act the NPWS co-operates with local RFS brigades to suppress fires up to eight kilometres from its reserve boundaries.

Members of local RFS brigades are authorised to enter and control fire in the reserve in accordance with NPWS access policy, operational guidelines identified in this plan and in accordance with the provisions of the District Bushfire Management Committee (DBMC) Operational Plan. The NPWS Queanbeyan Area is a member of the Cooma and Yarrowlumla DBMCs. These committees' task is to develop and coordinate cooperative fire management between fire authorities.

National Parks and Wildlife Act 1974

Under the *National Parks and Wildlife Act 1974* the NPWS is responsible for the care, control and management of natural and cultural heritage within protected areas, and the protection of flora, fauna and Aboriginal heritage across the state. Fire management plans contribute to the development and review of plans of management prepared under the *National Parks and Wildlife Act 1974* and the local Bushfire Risk Management Plans prepared under Section 52 of the *Rural Fires Act 1997*.

Environment Planning and Assessment Act 1979

The *Environment Planning and Assessment Act 1979* provides for the assessment of the impact of a proposed activity on the environment. Part III and IV require the NPWS to consider any relevant environmental planning instrument in relation to activities it proposes. Part V requires the assessment of impact of activities on lands for which it is the determining authority.

Threatened Species Conservation Act 1995

The *Threatened Species Conservation Act 1995* provides for the protection of all threatened plants and animals native to NSW (excluding fish) and places specific responsibilities on determining authorities in the fields of environmental planning, development control, recovery planing and threat abatement. High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition is listed as a key threatening process under schedule 3 of the Act.

1.2.2 NSW Biodiversity Strategy

The NSW Biodiversity Strategy was prepared by the NSW Government in 1999 and outlines a collaborative approach to biodiversity conservation in the State. Its primary goal is to protect the native biological diversity of NSW and maintain ecological processes and systems.

The Strategy identifies inappropriate fire regimes as a threat to biodiversity. The Strategy aims to improve fire management in NSW with the following actions by managing fire in accordance with ecological sustainable development principles (ESD).

It notes that the key mechanism for achieving ESD is through the Bushfire Risk Management Plans and Regional Vegetation Management Plans, and emphasises the importance of improving research and monitoring of the impacts of fire on biodiversity.

1.2.3 Local and regional environmental plans

Tinderry Nature Reserve is located within the Cooma-Monaro and Yarrowlumla Local Government Areas. Each of these areas has a Local Environment Plan (LEP) with land zoned for particular purposes. Generally, the freehold lands around the reserve are zoned for agricultural purposes with some areas utilised for more densely settled rural subdivision. Within the LEP all lands reserved under the *National Parks and Wildlife Act 1974* are zoned 8(a). Shire councils have no statutory role or control over activities within these lands.

1.2.4 NPWS fire management objectives and plan performance indicators

NPWS fire management is based on some generally accepted premises. These are that:

- Fire is a natural phenomenon and one of the continuing physical factors of the Australian environment;
- The evolutionary adaptation of many native species of plants and animals has been in response to fire;
- Fire can be a useful management tool for reducing fuels and establishing appropriate fire regimes for biodiversity conservation; and
- Where fire and fuel conditions are directly threatening life and property the NPWS will give priority to minimising risk.

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

Objective	Performance Indicator
To prevent the occurrence of human caused unplanned bushfires on the reserve.	Unplanned fire ignitions on the reserve, caused by humans, are progressively reduced over the planning period.
To suppress unplanned bushfires occurring on the reserve.	Fires occurring on the reserve are suppressed within appropriate control lines, safely, with minimum environmental damage and cost effectively during the planning period.
To minimise the potential for spread of bushfires on, from, or into the reserve.	Fires occurring on the reserve are suppressed within the reserve and fires starting outside are prevented from entering the reserve, safely, with minimum environmental damage and cost effectively during the planning period.
To protect from bushfires, persons and property on, or immediately adjacent to, the reserve.	No death or injury to persons, or destruction of property, caused by on-park bushfires in the planning period.
To manage bushfires to avoid the extinction of all species which are known to occur naturally within the reserve.	Fire regimes are maintained within the specified ecological thresholds across more than 50% of the area of each plant community on the reserve. No significant decline of species populations, common or threatened, due to inappropriate fire regimes, suppression operations or other fire management works, occurs during the planning period.
To protect from damage by bushfires all Aboriginal sites, historic places and culturally significant features known to exist within the reserve.	No damage caused to Aboriginal sites, historic places and culturally significant features as a result of bushfires during the planning period.

1.2.5 Tinderry Nature Reserve Plan of Management objectives

The overall management of the Tinderry Nature Reserve is prescribed by the *National Parks and Wildlife Act 1974* and the reserve's Plan of Management (NPWS, 1998), which is a statutory document. 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 following general objectives relate to the management of nature reserves in NSW:

- Conserve biodiversity, maintain ecosystem functions, and protect geological and geomorphological features and natural phenomena;
- Conserve places, objects, features and landscapes of cultural value;
- Promote public appreciation, enjoyment and understanding of the reserve's natural and cultural values; and
- Provide for appropriate research and monitoring.

2 TINDERRY NATURE RESERVE

The policies contained in the Tinderry Nature Reserve Plan of Management state that fire will be managed in the reserve to:

- Protect human life and property within and adjacent to the reserve;
- Protect rare species and fire sensitive species and communities;
- Maintain those plant communities and plant or animal species which require a particular fire frequency or intensity;
- Create or maintain diversity of habitats for native animals;
- Protect Aboriginal sites and historic places;
- Protect the scenic values of the Tinderry massif;
- Protect catchment values; and
- Protect specified scientific research and reference points from damage.

The following fire management policies outlined in the Tinderry Nature Reserve Plan of Management 1998 include:

- When determining the appropriate strategy and actions for fire suppression operations, consideration will be given to the potential for damage to natural and cultural heritage and the necessity or otherwise for immediate action;
- Use of retardants will be avoided in heath areas and within 100 m of watercourses and swamps;
- Within sub-alpine and montane areas wildfires will be contained to as small an area as is feasible and consistent with minimising damage caused by suppression operations;
- As far as possible, areas disturbed by fire suppression operations will be rehabilitated as soon as practicable after the fire;
- Prescribed burning may be carried out in areas of identified high fire risk to protect adjacent properties, cultural heritage, fire sensitive vegetation and species diversity;
- Prescribed burning programs will be based upon assessment of fuel hazard and risks to life and property and biophysical values;
- Where appropriate, the NPWS will seek to involve neighbours in cooperative hazard reduction works for mutual protection;
- Prescribed burning will not be undertaken in low risk areas or within *Eucalyptus pauciflora* associations, other sub-alpine and montane associations, areas of *Callitris endlicheri* or rare and threatened plant species;
- Records will be kept of all fires within the reserve;
- Fire trails will be maintained to a high standard of stability;
- Research will be encouraged into the effects of fire on *Acacia costiniana* and other rare and threatened plant species; and
- Community awareness and appreciation of fire management in relation to the maintenance of natural and cultural values of the reserve will be promoted.

2.1 Location and Regional Setting

Tinderry Nature Reserve was originally gazetted in 1981. It has over the last twenty years grown to its current size of approximately 15,000 hectares. Prior to gazettal the area was mainly vacant Crown lease utilised for grazing. Significant amounts of area were also used as part of an eucalyptus distillery industry.

The reserve is located 25 km south of Queanbeyan, and lies about 10 km east of the NSW/ACT boundary near the town of Michelago. Refer to Map 1 for location.

Most of the reserve is surrounded by private property limiting the number of access points available to the public. The most common authorised public use of the reserve is bushwalking and educational and cultural visits.

The adjacent areas are primarily used for grazing with a mix of freehold and leasehold lands adjoining the reserve. Individual properties are reasonably large and mostly cleared with scattered farmhouses and infrastructure. There are also important areas of forested lands adjacent to the reserve.

There are recent rural sub-divisions near or adjacent to the north, north-west and southern boundaries with an increasing number of dwellings and other infrastructure present.

The northern part of the reserve lies within the Yarrowlumla LGA, while the southern part falls in the Cooma-Monaro LGA. The reserve is within the volunteer RFS brigades of Burra, Michelago, Anembo and Colinton. Refer to Map 2.

The reserve forms part of the catchment of the upper Queanbeyan River, which provides water for Canberra and Queanbeyan at Googong Dam before joining the Murrumbidgee River.

The reserve area is represented on parts of the standard 1:25,000 map sheets - Williamsdale, Captains Flat, Michelago and Tinderry.

2.2 Terrain, Soils and Geology

The high rocky peaks of the Tinderry Range, which runs in a north-south direction, dominate the landscape of the reserve. The topography ranges from undulating to very steep. Elevation ranges from 840 metres in the south-west to 1618 metres at Tinderry Peak (refer to map 3). More than 23 % of the reserve has slopes greater than 20^0 (refer to map 4). More than 8 % of the reserve is above 1350 metres. About 53 % of the reserve has a northwesterly aspect (refer to map 5).

The underlying geology consists of metamorphosed sediments with intruded granite in the higher areas along the Tinderry Range (refer to map 6). The soils on the central rocky, steeper granite areas are generally shallow non-cohesive, well-drained organic lithosols. They are generally very highly acidic, of low fertility, and highly erodible with high potential aluminium toxicity (Jenkins, 1993). The topsoil depth varies from less than 20 to 80 centimetres. The soils on the surrounding metasediments are similarly of low fertility and have poor water retention and nutrient levels, and are highly erodible. Active erosion is continuing to deepen incised alluvial deposits in basins and catchments.

2.3 Biodiversity Values

Tinderry Nature Reserve protects a significant proportion of the Tinderry Range. It contains a number of plant species and communities representative of the sub-alpine, montane and drier tableland forests. A number of regionally significant plant species at the limit of their distribution are found in the reserve. The reserve supports a diversity of fauna species including threatened species such as the Powerful Owl.

2.3.1 Vegetation

The most widespread vegetation types within the reserve consist of dry forests, with smaller areas of moist forests and sub-alpine woodlands on the higher, cooler and wetter areas of the reserve.

Vegetation survey and mapping of the reserve (Doherty, 1997) identified six broad over-storey vegetation communities. They are:

- *Eucalyptus macrorhyncha / E. mannifera / E. nortonii / E. rossii* on the western side of the reserve on metasediments;
- *Eucalyptus bridgesiana / E. dives / E. melliodora* on metasediments mostly on the lower fringes of the reserve;

- *Eucalyptus bridgesiana / E. dives / E. rubida* primarily on the eastern side of the reserve on metasediments;
- *Eucalyptus dalrympleana /E. pauciflora* occurring primarily in the central granite area; and
- *Eucalyptus viminalis* primarily along creeks on metasediments.

There are three broad groups of understorey species. On the western side the understorey is generally species poor and shrubby in some areas but is mostly dominated by *Cassinia longifolia* and *Joycea pallida*. The east has greater diversity with grasses, forbs and shrubs including heaths and plants in Fabaceae family. The central granite area with its sheltered aspects is species rich with a variety of herbs and heaths featuring a *Poa tenera* ground layer (Doherty, 1997).

Refer to the vegetation map on map 7.

Many of the regionally significant plants found on the central granite area are at their limits of distribution or represent disjunct populations. These species include the wattle *Acacia costiniana*, and restricted occurrences of *Eucalyptus latiuscula, E. fastigata, E. glaucescens and E. perriniana.*

The only recorded threatened plant species recorded in the reserve is *Eucalyptus parvula*, listed as vulnerable under the *Threatened Species Conservation Act 1995*.

ROTAP species recorded in the reserve include *Acacia costiniana*, *Olearia montana*, *Olearia rhizomatica*, *Eucalyptus latiuscula, Eucalyptus parvula*, *Taraxacum aristum* and *Dampiera fusca* (Doherty, 1997).

2.3.2 Fauna

The reserve has a diverse range of fauna consistent with its diversity of vegetation types and range of altitude.

The following species, recorded in or adjacent to the reserve are listed as vulnerable under the *Threatened Species Conservation Act 1995.* The tiger quoll *Dasyurus maculatus*, large bent-wing bat *Miniopterus schreibersii*, eastern false pipistrelle *Falsistrellus tasmaniensis,* koala *Phascolarctos cinereus*, eastern pygmy-possum *Cercartetus nanus*, yellow-bellied glider *Petaurus australis*, squirrel glider *Petaurus breviceps,* Rosenberg's monitor *Varanus rosenbergi,* powerful owl *Ninox strenua* and barking owl *Ninox connivens.*

Other threatened species not recorded, but that are likely to occur in the reserve include, Glossy Black-cockatoo *Calyptorhynchus lathami*, Diamond Firetail *Stagnopleura guttata*, Speckled Warbler *Chthonicola sagittata*, Masked Owl *Tyto novaehollandiae*, Olive Whistler *Pachycephala olivacea*, Pink Robin *Petroica rodinogaster* and Peregrine Falcon *Falco peregrinus*.

2.4 Cultural Heritage

2.4.1 Aboriginal

Tinderry Nature Reserve was used extensively by Aboriginal people. It contains evidence of widespread use of the area with surveys locating over 70 open artefact scatter sites. The social and ceremonial significance of the area to Aboriginal people remains largely unrecorded, although the area is significant to present day Aboriginal communities. All Aboriginal sites are protected in the reserve and it is an offence to destroy known sites.

2.4.2 Historic

Over 30 historic sites containing evidence of European use are recorded in the reserve. The most significant of these are the remains of eucalyptus distilleries and associated historic landscape features containing coppiced and brachiated peppermint trees and the remnants of old trails. The eucalyptus distillery sites and associated landscapes are considered to have state and national significance and are vulnerable to fire events and activities (Pearson, 1999).

2.5 Recreational use and facilities

Recreational facilities are not provided in the reserve. This is consistent with its nature reserve status under the *National Parks and Wildlife Act 1974* and policies outlined in the plan of management. The reserve is largely used by bushwalkers. Illegal activities such as pig shooting, hunting, trail bike riding and four-wheel driving also occur.

3. BUSHFIRE ENVIRONMENT

Bushfire behaviour in Tinderry Nature Reserve is influenced by the regional climate and local environmental variations including terrain and altitude, forest types, patterns of rural settlement and sources of ignition.

The area within and adjoining Tinderry Nature Reserve contains both dry forest types with potentially high fire danger and higher-altitude moist forests. About 65% of the reserve is considered dry and 35% moist forest.

The potential for rapid fire spread in the reserve is mitigated by the Southern Tableland's milder climatic conditions and fewer days of severe fire danger (in comparison to the coastal areas and western slopes), combined with lower temperatures at higher altitudes and moist forests. However, during periods of prolonged dryness, low soil moisture and extreme fire days, these mitigating effects may be ineffectual and crowning may spread fire to the east and southeast, irrespective of the fuels available for combustion in the understorey.

3.1 Fire history and frequency

Fire history includes the collection of information on origin, cause, size, intensity and frequency of known fire events. It is difficult to assess the frequency of fires before European settlement affected land use. Aboriginal use of fire is likely to have been mainly confined to open areas or areas near water.

In the period 1957-1980 a number of significant fire events are recorded for the reserve. Since gazettal in 1981, 1,592 hectares have been burnt in planned fires and about 400 hectares in unplanned fires.

3.1.1 Wildfires in the reserve

In southeast NSW there is a significant relationship between increased settlement and the incidence of unauthorised fires, in particular arson. For example, since 1981 more than 80% of wildfires in the area adjacent to the reserve were caused by people (IFERM, 1996).

Of the 12 known recorded wildfires in the reserve people started all except two. Arson accounted for more than 50% of fires. Map 8 shows the location and dates of fires and the percentage of each vegetation group burnt.

Table 1. Summary of recorded wildfire events in the reserve

Arson	Lightning	Negligent acts (burning off, agricultural)	Unknown	Total fires
7 (50%)	4 (28%)	1 (7%)	2 (14%)	14

Table 2. Recorded wildfires (unplanned) in the reserve.

Fire ID	Date	Area Res (ha)	Location	AMG (centre)	Ignition source	Comment
57/001	1957	All	All of reserve and nearby areas.	Entire reserve	Negligence	Large fire, which burnt for 3 weeks.
81/001	1981-82	12	East Tinderry	129502	Unknown	Unknown
85/007	1-7-1985	1.5	Queanbeyan River	147506	Arson	Suspected arson
86/001	6-9-1986	15	Tussock Ridge Trail	125488	Unknown	
87/002	27-2-1988	200	Urialla and Keewong Trails	042575	Lightning	
90/001	18-5-1991	65	Near Keewong Trail	028555	Arson	Suspected arson
93/002	18-1-1994	25	Big Tinderry Station	115535	Arson	Suspected arson
94/001	28-7-1994	70	Jacobs Ladder Trail	013490	Arson	
94/002	26-8-1994	25	Keewong Trail	420548	Arson	Suspected arson
94/003	30-8-1994	5	Northwest corner of reserve	019578	Arson	Suspected arson
94/004	2-9-1994	3	Reserve northern boundary	029588	Arson	Suspected arson
97/005	1-2-98	2	Tinderry Twin Peak	044494	Lightning	Lightning
2001/001	3-12-2001	8	Mt Woolpack	140460	Lightning	Lightning
N/A	Aug 2002	5	Mt Woolpack	148469	Unknown	Lightning

The most significant wildfire event occurred in 1957. This fire, started by eucalyptus oil distillers working south of the reserve, reputedly burned for three weeks and burnt out the reserve and much of the surrounding forests. It is likely that some areas were burnt more intensely than others were.

Since gazettal in 1981, 436 hectares (less than 3%) predominantly in the northern and eastern parts of the reserve have been burnt by wildfire. Lightning started both of the most recent fires in 2001 and 2002. Rapid detection and direct attack together with aerial support minimised the burn area to less than fifteen hectares.

In the local area thunder storms and associated lightning are reasonably common during the summer period. However, the fire history suggests that fires in the reserve are rarely caused by these events.

Arson fires in the reserve are typically ignited near access trails. To date most arson fires have been lit on the northwestern side of the reserve, which is adjacent to a public road.

3.1.2 Prescribed or Planned Fires

Following gazettal fuel reduction burns have totaled about 1,500 hectares or 12.5 % of the reserve. In 1973 aerial ignition fuel reduction was carried out on 8,100 hectares of the higher areas of the central massif. It included the area bounded by the East and West Tinderry Trails. The eastern part was burnt satisfactorily, while the southwest was not ignited owing to equipment malfunction. There was extensive crown scorch on the steeper slopes (IFERM, 1996). The central granite area was burnt again in May 1980. Refer to map 9.

Table 3. Recorded prescribed (planned) fire history of reserve.

Fire ID	Date	Area Res (ha)	Location	AMG	Ignition source	Comment
73/001	April 1973	8,100	Block 56	060490	Prescribed	Before gazettal
79/001	23-5-1980	5,265	Block 56 (lower parts)	060490	Prescribed	Before gazettal
1981/001	1981-82	unknown	East Keewong Trail	053565	Prescribed	
1984/001	1984&85	unknown	Most trails		Prescribed	Windrows beside trails
84/004	29-5-1985	8	East Tinderry Trail	094505	Prescribed	
85/001	12-6-1986	15	Mount Allen Trail	012505	Prescribed	
85/002	12-8-1986	24	Keewong Trail	089527	Prescribed	
85/004	28-4-1986	450	West Tinderry Trail	016502	Prescribed	
85/006	14-8-1985	40	West Keewong Trail	017555	Prescribed	
86/003	3-8-1986	5	Tussock Ridge Trail	131477	Prescribed	
90/002	4-5-1991	1050	NW corner of reserve, north of Keewong Trail	030580	Prescribed	Also 100 ha outside reserve.

3.2 Fire Weather

3.2.1 Climate

The Southern Tablelands experience a temperate climate characterised by warm to hot summers and cool to cold winters. In summer hot days are generally followed by cooler nights. Frosts are frequent between mid April and mid October and snow often falls on the higher peaks. The prevailing summer winds are generally from the north and northwest. Droughts or periods of prolonged dryness may occur resulting in low fuel loads and soil moisture (IFERM, 1996).

The western side of the reserve is in a rain-shadow, tending to be drier than the eastern parts of the reserve. Coastal influences bring moisture-bearing easterly air streams to the eastern and higher areas of the reserve.

Rainfall for the reserve is highly variable. Mean annual rainfall for Michelago and Burra are about 650 mm. At higher elevations on the Tinderry Range mean annual rainfall can be as high as 1100mm. Map 10 shows rainfall variation across the reserve. Map 11 shows temperature variation and relationship with altitude.

On the Southern Tablelands dry periods generally result in lower fuel loads and less propensity for fire in pasture grasslands but an increased fire risk in forested areas. Conversely, in years with good winter and spring rains there will be vigorous growth in grasslands but fuels in forest areas will be moist, reducing forest fire risk. The higher rainfall and slower evaporation in the higher areas of the reserve slows the drying of forest fuels so that the reserve fire danger generally tends to lag behind the dry forests of lower altitudes.

3.2.2 Conditions associated with wildfires

Except in very mild seasons, several days of very high or extreme fire danger can be expected on the Southern Tablelands. These are characterised by high temperatures and very low humidity with strong winds backing from the northwest to west, often followed by a cool change with westerly or southwesterly winds. (IFERM, 1996).

Severe fire seasons in the Southern Tablelands are characterised by some or all of the following:

- High KBDIs (exceeding 50 for several weeks);
- Strongly negative southern oscillation index (-12 or less);
- Absence of rain bearing events from the north-west of the continent;
- Absence of cyclone events to the north and north-east of the continent;
- Normal summer weather patterns (of pressure systems and associated cold fronts); and
- Low pressure systems and upper air turbulence associated with lightning patterns.

Three broad categories of fire season can be identified as severe, mild and moderate.

It is worthwhile to note that historic fire patterns in the reserve are not strongly correlated to severe seasonal conditions, but appear to be driven primarily by human caused ignition events close to or in the reserve.

Table 4. Comparison of some recent fire seasons

Fire Season	Category	Description	BKDI range	SOI * *
1982-83	Very severe	Worst drought in recent years	126-168	- -
1985-86	Moderate	Cool summer, very dry autumn	4-130	-
1987-88	Severe	Hot and dry January, February and March	0-92	-
1989-90	Moderate	Cool with hot spell in January, then dry	12-66	+
1991-92	Moderate	Cool and wetter than usual	20-40	-
1992-93	Mild	Cooler December than average temperatures	0-37	-
1993-94	Severe	Drier and warmer than usual (widespread fires in Sydney)	0-99	- -
1995-96	Very mild	Cooler and cloudier than usual, dry autumn	0-66	+ +
1997-98	Severe	Prolonged dry period; numerous wildfires started from lightning in region	4-150	- -
2002-03	Very severe	Prolonged dry period; numerous wildfires started from lightning in region (including major Canberra fires)	120-170 (estimate)	- -

* * Southern Oscillation Index. - - indicates pronounced negative value; - indicates negative value; + indicates positive value; ++ indicates pronounced positive value

3.2.3 Conditions suitable for prescribed burns

Prescribed burns are best conducted in mild weather with a low probability of dry northwesterly winds and under moist soil conditions with a high level of moisture recovery in fine fuels at night. Under these conditions there is a greater margin to control the intensity of the fire through management of ignition patterns and timing of ignition, and a high probability for fires to be self extinguishing thereby minimising the risk of prescribed fires becoming wildfires.

In general, seasonal conditions in autumn and spring meet these criteria. However, as spring is subject to a drying cycle, windy conditions often prevail and there is a greater risk of a burn escaping its defined boundaries and of smouldering vegetation re-igniting later in the season. For this reason, autumn burning is generally preferred.

3.3 Bushfire behaviour potential and analysis

3.3.1 Landscape influences

The most significant landscape features of the reserve are the steep slopes on the western side and the altitudinal range that is between 840 and 1618 metres. The orographic effects of the range provide for increased moisture on the higher peaks.

About 50 % of the reserve consists of a dry north to northwesterly aspect where fuels can be expected to dry more rapidly.

3.3.2 Fuels

Recent fuel samples were recorded in 1996 (IFERM) and in 1999 (Beurle and Lupica). Refer to Map 12.

The 1999 sampling of 31 sites recorded fuels from 4.67 to 23.40 tonnes/ha. The frequency of sites by surface fine fuel weights recorded the following:

< 5 t/ha - 1 site

5–10 t/ha - 12 sites

10-20 t/ha - 13 sites

15-20 t/ha - 3 sites

20-25 t/ha - 2 sites

Sampling suggests that fuel levels in the dry open forests at lower altitude have stabilised at low to medium levels of between 5-10 t/ha (IFERM, 1996, Beurle & Lupica, 1999). Fuels are discontinuous and variable, especially on the poorer quality sites.

Fuel levels are highest in the moister forest types at higher elevation including *Eucalyptus viminalis, E. dalrympleana and E. pauciflora* recording 20 – 25 t/ha (Lupica and Beurle, 1999). In these forests the ground fuel moisture content is higher than the dry forests and the available combustible ground fuel is lower. This combined with cooler overnight temperatures, higher relative humidity and dew point reduces potential rate of fire spread and intensity.

Aerial fuels are high in the thickets of *Kunzea ericoides* on the eastern side of the reserve. Aerial fuel trends generally follow those for ground fuels. IFERM (1996) suggests that aerial fuels are linked to previous disturbance including prescribed burns. *Cassinia longifolia*, which ignites easily, is heavy along fire trails burnt in 1984/85.

Fuel loads for the reserve are considerably lower than those generally ascribed to dry and wet forests. For example, the RFS Risk Management Guidelines1998 lists fuel loads for dry and wet sclerophyll as 25 and 50 tonnes per hectare respectively. The comparison suggests that tableland forests including montane and sub-alpine forests may have lower fuel loads than represented by these broad classes. These forests may be responding to a different set of variables, including lower nutrient soils and different understorey characteristics, than those generally ascribed to the forests of southeast Australia.

Additional information is needed on the effects of different fire regimes on species diversity and fuel levels in dry tableland forests, especially in forests with grassy understoreys.

3.3.3 Likely bushfire behaviour potential

Bushfire behaviour potential is a relative term used to describe the likely behaviour of fire at a given location. Bushfire behaviour potential is assessed on factors known to affect bushfire intensity and rate of spread including slope, aspect, fuel characteristics, climate and fire weather conditions.

For southeastern NSW, the highest bushfire behaviour potential occurs in areas with heavy fuel loads on steep, dry, north to northwest facing slopes, which are subject to periods of hot, dry and windy weather. However, in extreme weather conditions fire may move through the canopy irrespective of ground or shrub fuels.

The areas in the reserve with the highest bushfire potential are the moist forests with heavier fuels and the drier forests on the steeper slopes on northwest aspects. Potentially damaging fires moving into the reserve are likely to come from the northwest and west. Under extreme conditions, once in the reserve fires could be intense with extensive crown scorch and defoliation on the west facing slopes and erratic fire behaviour on the lee side of crests (IFERM, 1996).

The east facing slopes are in the lee of the most dangerous winds with fires burning down-slope, generally in an easterly to southeasterly direction, before leaving the reserve. However, under extreme conditions fire may spot from higher areas ahead of the main fire.

3.4 Damage or risk potential

Damage potential is a term used to describe the likelihood of a bushfire causing damage to an asset. It is similar to the landscape risk analysis process identified in the NSW Bushfire Council Risk Management Guidelines.

The greatest potential for bushfires to cause damage occurs where high fire behaviour potential and high ignition potential are closely located to assets. The identification of such areas in close proximity to assets helps to prioritise those areas at risk from fire.

Using the Risk Management Guidelines the forested areas within and around the reserve are identified as areas of High Hazard. The assets within 100 metres of these forested areas are at greatest threat. Assets within 100 metres to 2.5 kilometres have a medium threat. This assessment does not account for the prevailing wind direction, negative slope or ignition potential.

When ignition history and fire behaviour potential are considered together, a more specific risk index can be determined for the reserve area.

The greatest potential for ignitions from illegal fires is in the northeast of the reserve away from community assets. To date these fires have been contained to small areas. Except for the 1957 fire no wildfires are recorded leaving the reserve area.

Climatic factors will reduce the potential for fire spread and severe fire behaviour, providing opportunities for containment and suppression.

The bushfire potential is highest in the central steep areas. Based on the relationship between bushfire behaviour and ignition potential assets at greatest risk are those to the south and southeast of the reserve.

3.4.1 Damage potential - community assets

Map 15 shows the community assets in the vicinity of Tinderry Nature Reserve. Assets include agricultural lands, buildings, powerlines and commercial pine plantations. The reserve is within an area used primarily for sheep and cattle grazing with rural sub-division development to the north, northwest and south.

There is a variety of land tenure surrounding the reserve including leased vacant crown land, timber leases and freehold.

Based on the evaluation of fire risk described above, the community and economic assets at highest risk from fires leaving the reserve are those to the south and southeast of the reserve, including properties near Kurrajong immediately adjacent to the reserve. Properties further away in the Calabash rural sub-division and nearby grazing lands to the southeast may be at some risk of fires leaving the reserve and entering the timbered lands to the south. The variability from easterly air streams may make fire behaviour unpredictable in this area.

There is limited potential for economic damage to grazing lands and pine forests to the east. Fires leaving the reserve and heading east to these areas must first travel down-slope, generally slowing fire rate of spread and assisting containment.

The risk to properties from fire leaving the reserve on the north, northwest and west of the reserve is considered low, as the prevailing winds will push fire away from these areas. The influence of easterly air streams is generally confined to the east, central and southwest of the reserve. Fire on the northerly side of the reserve presents a greater threat to the values within the reserve than to community assets.

The greatest threat to human life is the undertaking of fire fighting activities. Under extreme fire weather conditions the risk to fire fighters is very high in direct attack positions in the steeper central areas of the reserve including the lee side where fire behaviour may be erratic, and along higher fire trails. During a major fire event traffic along the Tinderry Road may also be at risk from smoke and heavy vehicles.

3.4.2 Damage potential - natural assets

The responses of plants to fire depends on fire frequency, intensity, season and extent. Extremes of these factors may reduce the structural and species complexity of plant communities or cause species loss. Vegetation communities that may be damaged by inappropriate fire regimes in the reserve include the sub-alpine swamps and heaths, moist forests and dry tableland forests if they are burnt too frequently. Refer to map 16.

The potential for damage to fauna populations in the short term depends mainly on the timing and extent of fires. Short-term effects are likely to be less damaging than long term changes to habitats induced by too frequent fires or very high intensity fires.

Soil and vegetation loss eventuating from a severe fire event on the steeper slopes (greater than 20 %) within the reserve is likely to result in increases in erosion, sedimentation and turbidity within the Googong Dam catchment.

3.4.3 Damage potential - cultural assets

The knowledge of existing Aboriginal sites is limited to actual recorded sites. Aboriginal sites may be severely damaged as a result of fire-associated suppression activities, in particular earth-moving operations.

Fire may permanently damage historic sites. The most important European historic sites in the reserve are the remains of eucalyptus stills and associated landscape features. Map 17 shows cultural assets of concern. The Conservation Management Plan for Cultural Sites and Landscapes within Tinderry Nature Reserve (Pearson, 1999) provides guidelines for protection of these sites from fire.

The landscape attributes of the high peaks of the reserve are important and may be damaged by intense fires moving through the high granite areas.

4 FIRE MANAGEMENT

4.1 Life and property

There are no assets in the reserve requiring protection from fire. Smoke and fire suppression activities may create a hazard along the Tinderry Road to the south of the reserve.

The NPWS through the Cooma-Monaro District Bushfire Management Committee will support cooperative fire prevention adjacent to assets near the southern boundary of the reserve.

Strategic fire control lines in the reserve, such as fire trails, aim to provide for rapid fire suppression and containment of fire within the reserve and the safety of fire fighters.

4.2 Biodiversity conservation and fire

Fire in the reserve is managed to avoid local species extinction and in a manner that supports the objectives of the Tinderry Nature Reserve Plan of Management to provide for adequate conservation of native habitats.

4.2.1 Plant responses to fire

Fire in Tinderry Nature Reserve has the potential to increase or decrease species diversity. This depends on the vegetation community and the frequency, intensity and time of the fire event. Many of the species found in the reserve have developed survival responses to fire events.

Fire may reduce biomass and competition, increase light to the forest floor providing opportunities for some dormant species to germinate and flourish. Intense fires may have a significant impact on the recruitment and composition of overstorey species. Too frequent fires may induce species loss.

Many of the eucalypts and woody plants in the reserve are of the type that re-sprout after fire. This does not necessarily mean that they require fire for their survival and reproduction or that fire is essential for plant species diversity. Species sensitive to frequent fire may already be lost from the reserve from frequent fires in some areas (Doherty, 1997).

Based on his work in the reserve Doherty (1997) suggests that fire may increase levels of live fuels in both moist and dry forests on granite and should therefore be used cautiously as a management tool. Moist forest types in montane and sub-alpine environments generally have long intervals between fires. This may reflect in part the higher precipitation, lower temperatures and higher soil moisture content found in these environments. Within the reserve these forests generally show a diversity of grasses, herbs and shrubs in the understorey. The overstorey in some areas features areas of dense young forest, which is likely to be the result of widespread fires in the 1950s. Fire in these areas tends to promote a shrubby understorey increasing the density and height of live fuels. A long period of fire exclusion and rapid suppression is advocated for these environments. In addition, areas within the reserve identified as old growth require fire regimes aimed at protecting arboreal fauna, forest owls and other hollow dependant species.

Fire thresholds for dry forests often indicate shorter intervals between fire events to maintain species diversity. However, dry tableland forests on metasediments in the reserve may not be as resilient to fire as once thought. Species may be lost through the repeated application of fire, and soil and nutrient processes affected. In the eastern part of the reserve the dry forests exhibit the most diversity. From fire history records it is likely that this area has not been burnt for more than 40 years (Doherty, 1997). Research suggests that fire may change the structure rather than the diversity of these dry forests increasing the number of plants in the shrub layer with a corresponding increase in aerial fuels. Therefore, frequent fire in these forests may increase rather than decrease fire hazard. It is recommended that the responses of vegetation to the application of fire should be trialed and monitored before widespread application.

Some areas of the reserve that were once cleared now contain dense thickets of *Kunzea ericoides* and *Banksia marginata*. Fire is likely to provide for the rapid re-establishment of *Kunzea ericoides*. *Cassina longifolia* is denser in previously burnt areas such as fire trail windrows. This highly flammable species responds to fire with extensive seed germination. Frequent fire is likely to promote the abundance of this species (Doherty 1997).

High frequency fire is listed as a key threatening process under the *Threatened Species Conservation Act* 1995. High frequency fire can result in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition.

Table 5. Fire frequency thresholds for vegetation groups in the reserve.

Vegetation Group	% of Res.	Fire Frequency Thresholds (FFT) (Bradstock, R. A., Doherty, CSIRO)
Moist *E. viminalis* forests in creeks mainly on metasediments.	4.09	Two fires occurring less than 50 years apart may cause species declines in this community. Absence of fire for over 400 years may cause species declines in this community. The influence of the absence of fire is not known.
Moist forests predominantly on granite.	31.3	Two fires occurring less than 50 years apart may cause species declines in this community. Absence of fire for over 400 years may cause species declines in this community. The influence of the absence of fire is not known.
Dry Forests comprising *Eucalyptus bridgesiana* / *E. dives* / *E. rubida* on metasediments	40.9	Two fires occurring less than 25 years apart may cause species decline in this community. Absence of fire may or may not cause species decline.
Dry forests on lower west side on metasediments.	14.8	Two fires occurring less than 25 years apart may cause species decline in this community. Absence of fire may or may not cause species decline.
Dry forests outside the reserve.	0.51	Two fires occurring less than 25 years apart may cause species decline in this community. Absence of fire may or may not cause species decline.
Black cypress-pine association.	1.44	Two fires occurring less than 25 years apart may cause species decline in this community. Absence of fire may or may not cause species decline depending on other triggers to seed germination.
Swamp on granite.	0.40	Any fire may have a significant impact; if consecutive fires occur in less than 100 years species diversity may decline
Sub-alpine heath.	0.21	Avoid burning heath areas above 1,000m. Any fire may cause decline.
Disturbed dry forest.	1.35	Two fires occurring less than 25 years apart may cause species decline in this community. Absence of fire may or may not cause species decline.
Disturbed wet forest.	0.23	Two fires occurring less than 25 years apart may cause species decline in this community. Absence of fire may or may not cause species decline.
Heavily disturbed wet sclerophyll forest with Kunzea/ Banksia regrowth.	2.44	Two fires occurring less than 50 years apart may cause species declines in this community. Absence of fire for over 400 years may cause species declines in this community. The influence of the absence of fire is not known.
Cleared areas.	1.59	No fire or disturbance
Cleared with *Kunzea ericoides* regrowth.	0.65	No fire or disturbance

Significant plants

The fire ecology of rare, threatened and regionally significant species occurring in the reserve is not well known. A precautionary approach is advised for the use of fire as a management tool in areas of known rare, threatened or regionally significant species. Therefore, a policy of fire exclusion is recommended in the central granite area of the reserve, which contains the bulk of these species.

Overall, the species which seems most at risk from fire in the short term are *Podocarpus lawrencii* and *Callitris endlecheri*. Both species are fire sensitive and the stands in the reserve are relatively small (Doherty, 1997).

Refer to 2.3.1 for a list of rare and regionally significant species.

Weeds – Serrated Tussock

Serrated tussock *Nasella trichotoma* is listed under the *Noxious Weeds Act*. It occurs in the eastern part of the reserve. Its distribution is very wide and pervasive in nature. This species easily invades disturbed areas and will flourish after a fire event. Fire needs to be limited in areas of serrated tussock and immediate action taken to control its spread after a fire.

Soils

Sediment run-off after a fire can increase by ten times of that on unburned areas. Burnt areas also suffer severe losses of nutrients such as sodium, potassium, calcium, magnesium and phosphorus. Litter cycling of nutrients is halted with the destruction of leaf litter. Frequent fires will therefore lower soil richness, and the capacity to support plant and animal life.

The lower, steep slopes on the west side of the reserve are in some places devoid of plants such as grasses and shrubs. Elsewhere in the creeks and alluvial in-fill gullies active erosion is occurring and a decrease in vegetation cover through fire is likely to accelerate erosion in the affected catchments.

4.2.2 Animal responses to fire

Native animals

In the reserve the mosaic of forest structures and diversity of understorey characteristics provides habitat and food resources for a range of ground-dwelling and arboreal species. Widespread fire events are likely to extinguish local populations through reduced habitat and food resources. For example, fire will affect the availability of invertebrate species on which many ground dwelling fauna such as birds, mammals and reptiles rely.

Animal numbers may take years to recover after a fire event, particularly for those species dependent on the understorey, fallen logs and leaf litter layers. In order to protect the habitats of animals in the reserve it is important to retain in any fire event a proportion of a vegetation community or habitat to ensure that species are not lost or significantly impacted. Large-scale back-burning or broad-area burning will require careful planning and a strategic approach to ensure retention of a mosaic of vegetation communities.

The potential to damage fauna populations in the short term depends mainly on the timing and extent of fires. Short-term effects are likely to be less damaging than long term changes to habitats induced by too frequent fires or very high intensity fires. Fire regimes can also influence fauna populations by encouraging or discouraging a vigorous understorey (Catling, 1991). Forested lands contiguous with the south and southeast of the reserve boundary have important values that may be damaged by fire leaving the reserve.

Refer to 2.3.2 for a list of threatened species recorded in the reserve.

Table 6. Potential fire effects for threatened species recorded in the reserve.

Species	Habitat	Potential Fire Effects	Remarks /suitable fire regime
Spot-tailed quoll *(Dasyurus maculatus)*, yellow-bellied glider (*Petaurus australis*), squirrel glider (*P. norfolcensis*), koala (*Phascolarctos cinereus*) and eastern pygmy-possum (*Cercartetus nanus*)	Wet gullies, rocky outcrops, dry and wet eucalypt forests, dense understorey, large hollow logs, large hollow trees.	Frequent fire can reduce habitat and food sources. Hot scorching fires can destroy habitat (eg hollow bearing trees) and kill animals or force dispersal. Fires in winter and spring could destroy nests and affect food sources. Loss of cover would disadvantage and favour feral carnivores. Highest population densities known from long unburnt sites.	Retain fire free riparian zones. Retain large hollow logs and moist areas. Exclude fire from old growth forests with hollow bearing trees and avoid burning when feed trees flowering. Burn after young have dispersed in late autumn, leave mosaics of burnt and unburnt areas, preventing where possible hot crown fires.
Large bent-wing bat *Miniopterus schreibersii* and eastern false pipistrelle *Falsistrellus tasmaniensis*.	Require roosting sites (hollows and caves) and feeding areas that support both insectivorous and nectar dependant species.	Frequent or widespread fire will reduce feed trees and high intensity fires may destroy hollow bearing trees.	Retain a mosaic of burnt and unburnt areas. Exclude fire from old growth forests with hollow bearing trees and avoid burning when feed trees flowering. No burning during periods where maternity colonies are formed.
Rosenberg's monitor (*Varanus rosenbergi*)	Open forest and woodland where termite mounds occur.	Wildfire may affect habitat by destroying termite mounds (where eggs are laid) and reducing forest cover.	Retain mosaic of burnt and unburnt areas.
Powerful owl and barking owl.	Widespread feeding range; nest sites in tall old growth trees.	Widespread burns could affect habitats of prey species, especially yellow bellied glider and other arboreal animals.	Pre-burn check for nest sites. Exclude fire from active nest sites and avoid widespread crown scorch.

Pest animals

Foxes, goats, pigs and rabbits are the most significant pest species in the reserve.

Carnivorous pest species can change their feeding habits after fire. Populations of herbivores and omnivores can increase rapidly after fires. The interaction of these species on native fauna and vegetation will need to be considered in any post-fire events and appropriate control actions implemented.

Table 7. Effects of fire on pest animals in the reserve.

Group	Habitat	Remarks/suitable fire regime
Exotic herbivores/ omnivores: rabbits, house mice, pigs and goats.	Open forest, swamps, rocky peaks and grasslands.	Burning will provide more open conditions and regeneration of grasses. Increased movement of species will occur.
Exotic carnivores. wild dogs and feral cats	Open forest, swamps, rocky peaks and grasslands.	More open conditions following burning will favour hunting. Increased movement of species will occur.

4.2.3 Evaluation of current fire regimes

It is likely that the combination of historic planned and unplanned fires has impacted on the higher elevation forests with changes to the vegetation structure and age classes and possible loss of old growth forest. Anecdotal evidence suggests that prior to the 1957 fire the trees of the montane forest were larger and that there was a more open grassy understorey. Today much of the higher areas of the reserve are characterised by dense young forest with few older trees. In these forests and in the transitional dry forests there is significant timber fall of younger trees.

The lower elevation dry forests are generally more open. Those with longer periods since fire (eg lower altitude forests on eastern metasediments) appear to have a low shrub and grass understorey, while those areas more recently burnt have a middle canopy of wattle species and/or *Cassina longifolia.* The effects of different fire regimes on forests with low grass and shrubby understoreys requires further research.

Table 8. Fire frequency guidelines.

Vegetation Group	% of Res.	Fire Frequency – Guidelines
Moist *Eucalyptus viminalis* forests in creeks mainly on metasediments.	4.09	Current Fire frequency too high. Exclude/suppress fire in riparian zones.
Moist forests predominantly on granite.	31.3	Current Fire frequency too high – all this area burnt in 1957 and portions again in 1973 and 1980. Exclude or suppress fire in montane and sub-alpine forest for more than 100 years.
Dry Forests comprising *Eucalyptus bridgesiana / E. dives / E. rubida* on metasediments.	40.9	Trial burning, monitoring and assessment of responses should be completed before introducing burning. Fire frequency indicates that 100% burnt in 1957 and about 30% burnt in hazard reduction & wildfire in last 20 years. According to some threshold guidelines sections of this group may have reached or passed the upper threshold of burning intervals. However, this forest may have naturally very long fire intervals.
Dry forests on lower west side on metasediments.	14.8	As above for dry forests.
Dry forests outside the reserve.	0.51	As above for dry forests.
Black cypress-pine association.	1.44	Data from past fire events suggests that 30% of this association was burnt in 1979 and it was probably all burnt in the 1957 fire. Exclude fire for more than 30 years.
Swamp on granite.	0.40	As this area probably burnt in 1957 and 1973 and possibly 1979-80, fire should be excluded or suppressed in these areas for more than 80 years.
Sub-alpine heath.	0.21	As above for swamp on granite.
Disturbed dry forest.	1.35	As above for dry forests.
Disturbed wet forest.	0.23	As above for moist forests.
Disturbed wet forest with kunzea/ banksia regrowth.	2.44	Refer to moist forests.
Cleared areas.	1.59	Exclude fire.
Cleared with *Kunzea ericoides* regrowth.	0.65	Exclude fire or monitor the burning of small areas to assess species response. Information suggests that fire will encourage regrowth of this species.

4.2.4 Biodiversity conservation guidelines

Management of fire in Tinderry Nature Reserve is guided by the following general principles.

- Groups of plants and animal species respond to fire according to characteristics of their life history. Therefore it is possible to identify fire regimes that meet the requirements of broad groups of species;
- Plant communities provide habitat for animals. Fire management must consider this important interaction;

- Diversity in disturbance factors, such as fire, will maintain biodiversity. The maintenance of a rigid regime may cause species not adapted to that particular regime to become extinct. In contrast, most species will tolerate shorter-term deviation from their preferred conditions, and thus a variety of conditions will enable a broad range of species to survive; and
- For many groups of species or communities, thresholds separating desirable and undesirable fire regimes can be defined. Within these thresholds a flexible management approach can be maintained.

4.3 Protection of Cultural assets

Cultural heritage assets including Aboriginal sites and European sites will be protected through a range of measures as outlined in Table 10.

4.4 Fire Prevention and Protection

Fire management within the reserve is directed towards the protection of life and property both within and adjoining the reserve and maintenance and protection of biodiversity and cultural heritage within the reserve. Fire management is also directed towards the protection of environmental assets outside the reserve. Under the *Rural Fires Act 1997* and risk management guidelines the highest priority for fire management is to minimise the threat of fire to life and property in areas of highest risk.

This plan identifies key objectives, strategies and actions to meet these protection requirements and protect the natural and cultural assets of the reserve.

4.4.1 Fire management zones and units

The NPWS has implemented a system of land zoning in line with Bushfire Management Committees Risk Management Plans in this plan.

Zones

Two types of zones are ascribed to areas within Tinderry Nature Reserve. Strategic fire management zones (SFMZ) and heritage management zones (HMZ). Map 18 shows the location of the zones in the reserve.

NPWS will work cooperatively with neighbours and Cooma-Monaro DBMC to prevent fire from damaging life and property immediately to the south of the reserve, particularly near Kurrajong and in the Calabash area. This is the area of highest risk from fire leaving the reserve.

Units

In order to assist on-ground fire operations the reserve has been divided into a number of units (refer to map 18). The boundaries of these units follow existing fire trails and are for the purpose of fire suppression and burning operations. The units can be overlaid on the zones and will assist prescribed burning programs and other fire management programs.

Table 9. Bushfire Management Zones within Tinderry Nature Reserve.

Zone	Purpose	Zones in reserve
Strategic Wildfire Fire Management Zone (SFMZ)	The primary purpose of the Strategic Wildfire Fire Management Zones is to assist in the suppression of wildfires, prevent movement of fire to other areas, provide safer access for fire fighters and protect biodiversity values. They balance the need to protect life and property with the protection of biological diversity.	SFMZ 1 includes the strategic fire trail system in the reserve. SFMZ 2 is located on the eastern side of the reserve in an area where fire is less likely to occur and damage potential is less. SFMZ 3 is on the western side and contains predominantly *Eucalyptus bridgesiana, E. dives, E. rubida, E. pauciflora* and moist riparian zones. It is a strategically important zone for the prevention and containment of fire spread. SFMZ 4 contains predominantly dry forests on metasediments and includes *Eucalyptus melliodora, E. nortonii, E. rossii, E. mannifera, E. macrorhyncha.* It contains both grassy and shrubby understorey on undulating to steeper slopes as well as steep slopes showing loss of soil and plant species. It is a strategic zone for prevention and containment of fire and highest priority for undertaking trial burns and monitoring of fuels.
Heritage Area Fire Management Zone (HAMZ)	The primary purpose of Heritage Management Zones is to prevent permanent damage to natural and cultural assets. This includes the protection of biodiversity values through the application of appropriate fire regimes. There are a number of these zones in the reserve each with identified protection and suppression guidelines. Special Area Management Sub Zone – protects special items (SAMZ). Actions will be carried out to reduce fuel loads in the immediate vicinity of the sites.	HAMZ 1 provides for protection of the natural values of central granite area including moist montane and sub-alpine forest, swamps, heaths and cypress-pine. This zone also protects a sub-set of drier forests and disturbed wet forest in the Roberts Creek area. HAMZ 6 provides for the protection of the historic cultural landscape values associated with the eucalyptus industry. SAMZ are indicative only around the identified eucalyptus distillery sites and are not mapped for this plan.

4.4.2 Specific fire management objectives, strategies and actions

The following specific objectives apply to Tinderry Nature Reserve for the protection of life and property, and natural and cultural heritage:

- Primarily, reduce the risk of fire leaving the reserve and damaging assets in areas of identified higher risk to the south of the reserve and, secondarily, in areas of medium and low risk to the east and north east of the reserve, and reduce risk to fire fighters working in the reserve;
- Reduce risk of fire entering the reserve from the north, north-west, west and south-west and reduce illegal fire lighting in the reserve;
- Reduce the risk of fire entering or spreading in areas of high biological diversity in the central part of the reserve and in areas of identified heritage value;
- Maintain and /or enhance biological diversity in dry tableland forests;
- Protect moist forests and areas of special biological concern, including areas supporting rare, threatened or regionally important plants and animals, from inappropriate fire regimes and fire fighting activities; and
- Protect cultural assets such as Aboriginal sites and eucalyptus distilleries and associated landscapes from inappropriate fire regimes and associated fire fighting activities.

Table 10. Objectives, strategies and actions for fire management in Tinderry Nature Reserve.

Protection of Community Assets – Life and Property			
Key objective	**Strategy**	**Action**	**Zone*/Other**
1 Primarily reduce the risk of fire leaving the reserve and damaging assets in areas of identified higher risk to the south of the reserve and, secondarily, in areas of medium and low risk to the east and north east of the reserve, and reduce risk to fire fighters working in the reserve.	1.1 Develop co-operative fire management with adjacent land managers and landholders to reduce the risk to assets. 1.2 Maintain and enhance the Tinderry Nature Reserve strategic fire trail system to provide for safe and efficient access to assist fire containment and fire fighter safety. 1.3 Develop options for water supply during suppression and hazard reduction. 1.4 Undertake rapid deployment and suppression of fire in the reserve. 1.5 Prepare a Tinderry Nature Reserve Fire Operations Map. 1.6 Avoid increasing or introducing aerial fuels such as the *Cassina longifolia* and *Kunzea ericoides* except where shrubby understorey enhancement is required for biodiversity conservation. 1.7 Maintain fuel levels to a safe level in dry forest on the west side of reserve in accordance with biodiversity guidelines and fire thresholds.	1 Liaise with Cooma and Yarrowlumla DBFMC and neighbours regarding fire prevention works around high risk assets, and complementary management of fire trails and fire advantages outside the reserve. 2 Conduct cooperative inter-agency fire and reserve familiarisation days, and provide educational material to assist fire prevention, rapid containment and safety of neighbours. 3 Reduce fuels on both sides of trails using slashing and chemical treatment and conduct annual trail maintenance program. 4 Identify water points in the reserve and immediately adjacent to the reserve. 5 Construct refuge areas, turning points and passing bays on strategic fire trails. 6 Identify and sign trail sections that are unsuitable for tankers because of gradient. Sign all trails where necessary with their appropriate trail name. 7 Where wide breaks are already established remove fuels to a width of 3-5 metres either side of trail. 8 Complete a Tinderry Nature Reserve Fire Operations Map showing all necessary infrastructure, trails and significant environmental and cultural sites. 9 Exclude large area application of fire from areas of *Cassinia longifolia* and *Kunzea eroicides* at least until information is available from research & monitoring into effects of fire on these plants. 10 Monitor ground and aerial fuels. Conduct prescribed burns in a mosaic fashion.	DBFMC & neighbours NPWS & DBFMC All areas Sites primarily in SFMZ 3 &4

Protection of Natural Assets			
Objective	**Strategy**	**Action**	**Zone*/Other**
2 Reduce risk of fire entering the reserve from the north, northwest, west and southwest and reduce illegal fire lighting in the reserve.	2.1 Provide information about the important values of the reserve to neighbours and provide opportunities for neighbour field days in the reserve. Maintain close liaison with the RFS. 2.2 Increase NPWS presence during the fire season..	11 Provide opportunities for neighbour field days in the reserve. 12 NPWS staff to encourage information flow from neighbours on suspicious people in the reserve area.	Refer plan of management
3 Reduce the risk of fire entering or spreading in areas of high biological diversity in the central part of the reserve and in areas of identified heritage value.	3.1 Maintain and enhance the Tinderry Nature Reserve strategic fire trail system to assist rapid containment of fire. 3.2Undertake rapid deployment and suppression of all fires in the reserve with particular emphasis on rapid suppression using air attack in HAMZ 1 & HAMZ 6.	13 See actions under key objectives 1 and 2. 14 Provide aerial support for ground crews in inaccessible areas. 15 Apply reserve fire operations map and identify all available helipad landing sites for remote putdown and pick up.	All areas with emphasis on HMZ 1 & 6

4	Maintain and /or enhance biological diversity in dry tableland forests.	4.1 Encourage research and monitoring burn program in dry tableland forests to assess fire effects on biodiversity, soil nutrients, litter recycling, fuel composition and accumulation and structure and fire response. 4.2 Avoid increasing or introducing, through the application of planned fire, aerial fuels such as *Cassina longifolia* and *Kunzea ericoides*. 4.3 Avoid conducting fuel reduction burns on steep slopes which exhibit signs of soil and plant loss. 4.4 Use any prescribed burning of dry forests to promote a mosaic. 4.5 Prevent the spread of serrated tussock after a fire event.	16	Encourage monitoring and research, including experimental burns, in accordance with proposed research and monitoring. 17 Exclude planned fire from areas containing predominantly *Kunzea eroicides*. 18 Exclude/suppress fire from steep slopes on western slopes within SFMZ 4. 19 Burning is to be low intensity with no areas burnt at intervals of less than 25 years. 20 Exclude/suppress fire from areas in the east of the reserve with known infestations of serrated tussock. Initiate immediate control action in these areas after a fire event.	SFMZ 2-4
5	Protect moist forests and areas of special biological concern, including areas supporting rare, threatened or regionally important plants and animals, from inappropriate fire regimes and fire fighting activities.	5.1 Provide information to fire fighters on natural assets and areas requiring rapid suppression, including a copy of the fire operations map. 5.2 Provide information to fire fighters on fire suppression strategies for the central granite area to avoid the use of large-scale back-burning. 5.3 Protect cypress-pine communities.	21	Exclude fire from the central granite area and moist forest areas. 22 Ensure the reserve fire operations map is readily available to incident management and on-ground crews. 23 Initiate rapid direct attack with air support for fire starting or entering the central area. 24 Map exclusion areas for earthworks as part of incident management. 25 Provide fire suppression guidelines to incident management and ground crews to minimise the use of large scale back-burning of central granite area. 26 Review suppression strategies for the central granite area in cooperation with the RFS. 27 Exclude or suppress fire from cypress-pine communities.	HAMZ 1 DBMC HAMZ 1 – Cypress-pine

Protection of Cultural Assets			
Objective	**Strategy**	**Action**	**Zone*/Other**
6 Protect cultural assets such as Aboriginal sites, eucalyptus distilleries and associated landscapes from inappropriate fire regimes and associated fire fighting activities.	6.1 Establish protection zones around historic sites of identified state or national significance and protect Aboriginal sites from damage during fire fighting operations. 6.2 Maintain reference areas of unburned forest for protection of historic landscape.	28 Remove potentially damaging fuels on state/national significant sites and carry out preventative actions in accordance with cultural conservation plan recommendations Pearson (1999). Exclude as far as possible fire from HAMZ 6. 29 Ensure the reserve fire operations map is readily available to incident management and on-ground crews.	SAMZ 6 -Euc. Sites

*For zones refer to map 18.

4.5 Wildfire Control and Suppression

4.5.1 Detection and response

The ability to rapidly respond to fires in the reserve depends on early detection. Detection of fires in the reserve is either from vigilant neighbours, ACT fire towers or aircraft surveillance after storms. Fire detection in the reserve is a cooperative arrangement. Neighbour vigilance and aircraft surveillance after storms are key elements for early response to and rapid attack on fires in the reserve. Air surveillance systems are in place within the district and between the NPWS Queanbeyan Area and the RFS.

For fires accessible from trails on the lower slopes the first response is likely to be from local RFS brigades adjoining the reserve because of their proximity. Rapid response to fires in the steep inaccessible terrain in the central section of the reserve will be, by necessity, from helicopter support. Remote area helicopter landing opportunities will be mapped. Otherwise, RAFT teams will be flown into remote areas, depending on the fire conditions.

4.5.2 Control and suppression operational guidelines

All NPWS operations will be conducted within the Incident Control System (ICS) of management. The control of all fires in the reserve will be in accordance with this plan, NPWS Fire Management Policies, policies of the State Coordinating Committee, within the terms of any Section 44 declarations, and in accordance with cooperative arrangement between the NPWS and the Cooma and Yarrowlumla District Bushfire Management Committees. Depending on the location and category of the fire the Incident Management Team will operate from either the Cooma, Yarrowlumla or NPWS incident control centres.

Control strategies for fires within the reserve will be within the terms of the above policies and in accordance with the plan and suppression guidelines. The guidelines set out below address issues specific to the reserve to ensure the safety of fire fighters and protect the natural and cultural assets from undue damage. They do not necessarily reflect the broad policies and considerations that must be addressed by the incident management team.

Operational and NPWS policy guidelines are to be adhered to by all fire officers from authorised agencies undertaking fire suppression activities, prescribed burning or other fire-related activities in Tinderry Nature Reserve.

Table 11. Operational guidelines for fire suppression

Operational Area	Suppression Guidelines	Action
Safety		
Fire fighter safety	Potentially hazardous areas in extreme conditions are: ▪ West Tinderry Fire trail and adjacent areas ; ▪ Rugged western slopes in central areas and lee- side areas under granite peaks; ▪ Blue Bell Swamp Trail – no turn around points; and ▪ Areas with heavy ground fuels such as those in the higher areas on the eastern side. Refuge areas and main escape routes in the reserve are mapped on the reserve Fire Operations Map.	In extreme conditions do not undertake direct or close attack in these areas. Utilise air support to slow fire. Bluebell Swamp Trail is not a strategic fire trail and vehicles should not proceed along it Advise fire fighters of refuge areas and main access/egress routes at fire briefings. Ensure safe fire-fighter use of narrow winding section of Tinderry Rd – consider police support. Provide fire fighters with reserve operations map.
Public safety	Tinderry Rd may provide a hazard to the public with movement of heavy vehicles on narrow, winding section of road or from smoke.	Consider closing Tinderry Rd to public and engaging assistance from the police.
Medical support	Medical support on stand-by at forward control area.	Provided by ambulance or private paramedic provider.
Smoke management	Follow notification procedures.	Consider closing Tinderry Rd to public.
Communications	Use IMT and communication plans. Use consistent incident and communications plans and contact procedures. Ensure communications between ground crew and air support for effective water bombing.	Utilise the forward control communications. Provide hand-held NPWS radios to other agency sector and/or Divisional commanders as necessary. Use NPWS channel 8, remote repeater channel 16 and refer to listed frequencies for RFS.
On-ground management	If possible, a field commander should have very good local knowledge, ICS knowledge and appliance and experience with interagency firefighters.	NPWS to initially appoint NPWS field commander.

Operational Area	Suppression Guidelines	Action
Containment		
Water supply	Identify on-park water sources. Set up supply of water from outside sources.	Consult reserve fire operations map. Immediately organise out-of-area water, eg large tanker, air supply to buoy wall in remote area etc.
Air support/air attack	Develop cooperative arrangements for stand-by helicopter with bucket facilities in predicted high-extreme fire seasons. In inaccessible areas immediately engage air attack. Helicopters and fixed-wing aircraft will be utilised for initial detection, suppression and patrolling during and after wildfire containment. Inter agency notification will be undertaken before, during and after detection flights. Jet A1 refueling tanker will be activated, if required as early as possible. Information on location and quantity of Jet A1 drums and helicopter support equipment will be shared pre-season by fire agencies.	Apply the MOU with the ACT Rural Fire Service for use of ACT aircraft. Immediately engage air support. Immediately provide Jet A1 fuel at forward control.
Remote area fire fighting	Direct attack remote area fire fighting techniques with helicopter support should be utilised in the first instance whilst ensuring fall back control lines along existing trails are prepared. Where possible, and without excessively increasing fire size, wildfires are to be contained by existing control lines and natural low fuel areas in preference to the construction of control lines by heavy plant.	Deploy RAFT teams to remote areas by helicopter for initial rapid attack with due regard to safety requirements.
Backburning	Natural and climatic advantages will be utilised before applying backburning strategies. The use of broad-scale aerial incendiary backburning in the central granite area will not be a first option strategy. Where initial attack suppression is inappropriate to control fire, a backburn from East Tinderry and joining trails is recommended.	Thorough briefing must be conducted with the incident team and on-ground crews on backburning guidelines.

Earthworks & trailworks	Place on standby heavy equipment immediately a fire event occurs. NPWS personnel will guide heavy plant. The supervisor of heavy plant must be in possession of the reserve fire operations map. Exclude machinery from dozer exclusion zones. Generally, no earthworks in HAMZ1 & 6. In high and steep central granite areas, swamps and riparian areas heavy equipment will not be used. Earth moving equipment will be used to construct additional control lines, where possible along 'dormant' trails. Construction must be within the prescriptions of NPWS standard operating procedures for construction of fire trails. All attempts will be made to exclude the construction of control lines within 100 metres of known cultural sites. Reserve fire operation maps will be made available to Incident Management Teams and ground crews to facilitate this. Earthwork areas will be rehabilitated immediately post fire.	Standby dozer immediately. Immediately check trails and remove any fallen timber etc. Provide reserve fire operations map to supervisor of heavy plant and Incident Management Teams. NPWS personnel familiar with reserve to guide dozer.
Chemicals	Permission from NPWS must be obtained prior to use of wetting agents or retardant in the reserve. Chemical retardants are not permitted for use within 100 metres of watercourses and swamps. Chemicals should be mixed well away from water points.	NPWS permission for use of chemical mandatory prior to use in the reserve. Apply chemical retardant or foam early to fire in central granite areas if required.

Operational Area	Suppression Guidelines	Action
Protection of natural and cultural assets		
Central granite area and moist forests and riparian area	Minimise burn area and /or retain mosaic of burnt and unburned areas in all fire events.	Minimise area burnt in suppression operation.
Dry forests	Minimise burn areas and ensure mosaic of burnt and unburned areas retaining a range of age classes. Minimise burn areas in the eastern part of the reserve where serrated tussock infestation is prevalent.	As above
Aboriginal sites, historic sites and threatened species	Brief all personnel involved in fire trail works on locations containing known significant cultural and environmental sites.	Provide reserve fire operation maps to the Incident Management Team and all supervisors and crew leaders.
Post-fire	Reduce impacts of post-fire predation and disturbance from feral animals. Carry out appropriate rehabilitation of trails, disturbed area and manage potential erosion problems in creeklines. Initiate control measures to prevent the spread of noxious weeds, especially serrated tussock.	Implement appropriate pest control programs post-fire. Implement post-fire rehabilitation immediately. Implement weed control programs post-fire.

4.6 Fire control advantages and assets

Fire control advantages are natural and constructed items that may assist with the control of a fire. They include fire trails, fire breaks, helipads, watering points, cleared low fuel areas and areas of moist vegetation. Map 19 shows fire advantages for the reserve.

There are approximately seventy kilometres of management trails within the reserve. They are not for public use. Most of these trails form the strategic fire access system for the reserve. The main exception is the track into Bluebell Swamp. Dormant trails are mapped for possible use during a fire event.

All trails will be maintained to a year-round serviceable standard. Due to the erodable soils and dispersal of noxious weeds such as serrated tussock and nodding thistle, the aim of trail maintenance will be to as far as possible retain and encourage a grassy cover on or beside the trail. Woody vegetation will be controlled along the trails to enable safe passage of vehicles. Cooperative arrangements are in place to maintain linking trails on adjoining properties to the same standard.

Access to the reserve is along gravel roads. The Tinderry Road is narrow and winding on the southern side of the range and provision may need to ensure safety along this section if a fire event occurs in the area.

Water points are found both outside and inside the reserve. The Queanbeyan River on the eastern boundary of the reserve generally contains water even after prolonged periods of dryness. Other water access points such as creek crossings and dams are indicated on Map 19 and are indicated on the reserve fire operations map.

Bulk carting or the use of helicopters may be the most effective strategy for providing water supply at large fire events. Access to water supplies on adjacent private properties must be negotiated with property owners prior to any removal of water. Where these sources are utilised the dam water will be first pumped into buoy walls to ensure that contamination from retardants and other chemicals does not occur. At the end of a fire event water levels in dams utilised will be restored.

There are a number of helipad sites within and adjacent to the reserve. Potential assembly and refuge points are also indicated but these will change according to the fire event.

5 RESEARCH AND MONITORING

There are a number of areas where further information is required to understand the effects of fire on the vegetation types within the reserve, in particular dry forests. As the information is developed management practices will change or adapt to reflect the improved knowledge. This process is referred to as adaptive management.

There are other areas where the management of the reserve would benefit from improved knowledge including the habitat requirements and effects of fire on a range of animals found within the reserve, and the effects of fire on *Acacia costiniana* and other rare and threatened plant species.

For the life of this plan and in the near future, gaining a better understanding of the dynamics of dry forests is the highest priority. Investigation into the following areas will benefit not only the management of the reserve but will have application to other dry forest areas on the Tablelands.

Conduct research and monitoring of dry tableland forests in the following:

- Assessment of fuel accumulation rates and stabilisation periods for dry tableland forests;
- Effects of different fire regimes on forest structure and species diversity and abundance;
- Effects of fire on soil nutrient and humus cycling, dryness and soil exposure;
- Effects of fire on changes to composition and availability of ground and aerial fuels within different environmental parameters;
- Effects of fire on forest areas with an understorey of *Cassinia longifolia*, *Kunzea ericoides* and *Acacia* species;
- Determine 'biological triggers' and or management tools for biological diversity and establish the relative importance of fire for plant species diversity;
- Effects of grazing by native and introduced fauna on floristic structure, diversity and ground and shrub fuel availability; and
- Assessment of rate of spread of fires in dry forests under different fire regimes and fuels conditions.

There are a number of ways to gather this information. Simple monitoring of existing vegetation plots, establishing grazing exclusion plots and conducting experimental trial burns will provide some base data in the short term. Longer-term studies, in cooperation with research institutions, are required to provide more substantive information and monitor change over longer periods of time.

6 PROPOSED WORKS AND ENVIRONMENTAL ASSESSMENT

Table 10 summarises the proposed actions, activities and works identified in this plan.

Some fire management activities are procedural and are carried out in accordance with the NPWS fire management policies. This includes the continual recording of fire incidents. In the works table these activities are described generically and are identified as on-going works. Other activities and actions identified in this plan are given a preferred timeframe and priority to assist implementation.

All proposed activities require that a Review of Environmental Factors (REF) be prepared, unless otherwise notified.

Table 12. Summary of fire management works for Tinderry Nature Reserve

Activity or action	Priority	Preferred timeframe	REF* required
Fire control advantages and assets			
Prepare a reserve fire operations map showing all useful infrastructure information and the location of significant cultural and environmental sites.	H	Completed 2002	No
Prepare a trail maintenance program and implementation schedule for the reserve.	H	On-going	Completed 1999
Establish turn-around and passing bays on strategic fire access trails.	H	Completed 2002	Completed 1999
Updating of databases for fire incident and maintenance reporting.	M	On-going	No
Investigate water-holding capacity of West Keewong Dam.	L	Within 5 years	No
Research and monitoring of dry forests **(Research to be encouraged by NPWS for universities and other institutions)**			
Assessment of fuel accumulation rates and stabilisation periods for dry tableland forests	M	Within 5 years	No
Effects of different fire regimes on forest structure and species diversity and abundance.	L	Within 5 years	Yes
Effects of fire on soil nutrient and humus cycling, dryness and soil exposure.	L	Within 5 years	Yes
Effects of fire on changes to composition and availability of ground and aerial fuels within different environmental parameters.	L	Within 5 years	Yes
Effects of fire on forest areas with an understorey of *Cassinia longifolia*, *Kunzea ericoides* and *Acacia* species.	L	Within 5 years	Yes
Determine 'biological triggers' and or management tools for biological diversity and establish the relative importance of fire for plant species diversity.	L	Within 5 years	Yes
Effects of grazing by native and introduced fauna on floristic structure, diversity and ground and shrub fuel availability.	L	Within 5 years	Yes

Activity or action	Priority	Timeframe	REF Required
Prevention			
Liaise with Cooma and Yarrowlumla DBFMC and neighbours regarding fire prevention works around high-risk assets and complementary management of fire trails and fire advantages outside the reserve.	H	Within 2 years	No
Conduct cooperative inter-agency fire and reserve familiarisation days, and provide educational material to assist fire prevention, rapid containment and safety of neighbours.	M	Once every two years	No
Identify and sign those trail sections unsuitable for tankers because of gradient.	H	Within 1 year	No
Manage fire in the reserve in accordance with the identified Bushfire Management Zones.	M	On-going	No
Remove potentially damaging fuels on state/national historically significant sites and carry out preventative actions in accordance with cultural conservation plan recommendations Pearson (1999)	M	Within 5 years	Yes

7 PLAN REVIEW AND EVALUATION

The final Tinderry Nature Reserve Fire Management Plan is proposed for five years. The actions proposed in the plan will be written into the annual NPWS strategic operational plans and implementation reviewed annually. Performance criteria established by the NPWS will be used to assess the effectiveness of the plan in meeting its objectives. The effectiveness of proposed actions in meeting these objectives will also be assessed annually.

The plan's strategies and actions to achieve key objectives may be adapted to incorporate new research or information.

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APPENDIX 1 GLOSSARY OF TERMS

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 wildlife.
Byram-Keetch Drought Index (BKDI)	A numerical value reflecting the dryness of soils, deep forest litter, logs and living vegetation, and expressed as a scale from 0 - 200 points. When 100 points has been reached in an area, that area is said to be in drought.
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

Edge Burning	A term used to describe perimeter burning of an area in mild conditions prior to large scale prescribed burning. This practice is used to strengthen buffers and to reduce mop-up operations.
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).
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 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.
Fire Storm	Violent convection caused by a large continuous area of intense fire; often characterised by destructively violent surface indrafts, a towering convection column, long distance spotting, and sometimes by tornado-like whirlwinds.
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. Commonly 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 wildfires.
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.
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.
MOU	Memorandum of Understanding.
NPWS	The National Parks and Wildlife Service of New South Wales.
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.
RAFT	Remote Area Fire Team.
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	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.
Spot Fire	Isolated fires started ahead of the main fire by sparks, embers or other ignited material, sometimes to a distance of several kilometres.
Striker	A small four wheel drive fire tanker capable of carrying from 400 to 600 litres of water for fire fighting purposes. Also known as a Category 9 Fire Tanker.
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.
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*
Urban/Rural Interface	The line, area, or zone where structures and other human development adjoin or overlaps with undeveloped bushland. Also known as the urban/bush interface, urban interface or just the interface.
Wildfire	An unplanned fire. A generic term which includes grass fires, forest fires and scrub fires.