

FINAL

Fire Management Strategy



Blue Mountains National Park

**NSW
NATIONAL
PARKS AND
WILDLIFE
SERVICE**



**Department of
Environment and Conservation (NSW)**

our environment *it's a living thing*

ACKNOWLEDGMENTS

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Other acknowledgments go to Blue Mountains, Hawkesbury, Oberon, Lithgow and Wollondilly District Bush Fire Management Committees who have provided valuable input on earlier Drafts of the Strategy.

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EXECUTIVE SUMMARY

This Fire Management Strategy provides direction for fire management activities within Blue Mountains National Park (the Reserve) to fulfil the Service's obligations under various legislation and Government policy.

Importantly, under the Rural Fires Act, 1997, NPWS is both a fire fighting authority and a public authority and therefore has dual responsibilities for fire fighting and land management. The NPWS is therefore seeking the cooperation of all fire authorities in adopting the management guidelines contained within this Strategy to fulfil our obligations under S.38 (4) of the Rural Fires Act, 1997. The Strategy will be reviewed every five years. The next review is due in 2009.

The Reserve covers an area of approximately 267,000 hectares and is located 60 – 100 kilometres west of Sydney.

The Reserve forms part of a large and important conservation continuity of Kanangra Boyd NP, Yerranderie SRA, Nattai National Park and Wollemi National Park.

It falls within Blue Mountains City, Hawkesbury, Lithgow, Mulwaree, Oberon, Penrith, Wingecarribee and Wollondilly Bush fire Districts and is bisected by two major east west transport and settlement corridors; the Great Western Highway (and railway) and the Bells Line of Road. These corridors are inhabited by in excess of 80,000 people.

Most of the Reserve is classified within the Blue Mountains World Heritage Area (WHA) and parts are gazetted Wilderness. Catchments within the Reserve provide the basis for clean drinking water for Sydney and the Blue Mountains urban areas.

This plan identifies the primary objectives and performance indicators for fire management operations, the characteristics of the bush fire environment and a summary of the major assets, natural heritage, cultural heritage, and recreational values of the Reserve.

The Blue Mountains National Park has been divided into Fire Management Zones based on the similar approach within District Bush Fire Risk Management Plans (RMP's). The Strategy has assessed the risks to life, property, natural heritage and cultural heritage values. The Strategy then details bush fire management actions for each zone to minimise these risks.

The major impacts of the Strategy over the next five years are:

- Adoption and communication of the Strategy within District Bush Fire Management Committees;
- Maintain and develop bush fire management information systems;
- Assessment and implementation of new Asset Protection Zones;
- Development and implementation of annual works schedules for prescribed burning and APZ maintenance to meet Fire Management Zoning and best practise standards;
- Implement standard APZ maintenance agreements and partnerships with Councils, neighbours and fireguard community groups;
- Development and implementation of a fuel and bush fire impacts monitoring program, and;
- Develop public education and communication strategies.

This Strategy was put on public exhibition during May 2004. Comments by interested parties and stakeholders were collated, evaluated and included where appropriate.

The Strategy is proposed for review in 2009. Its objectives and strategies will be reviewed following an assessment against the performance indicators and in consultation with stakeholders.

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1 INTRODUCTION

1.1 Scope and Purpose

This Plan provides the framework that the National Parks and Wildlife Service (NPWS) will implement within the Blue Mountains National Park to meet its fire management obligations under the *Rural Fires Act 1997*, *National Parks and Wildlife Act 1974*, *Threatened Species Conservation Act 1995* and other associated legislation. The Strategy will be reviewed every five years, next due in 2009.

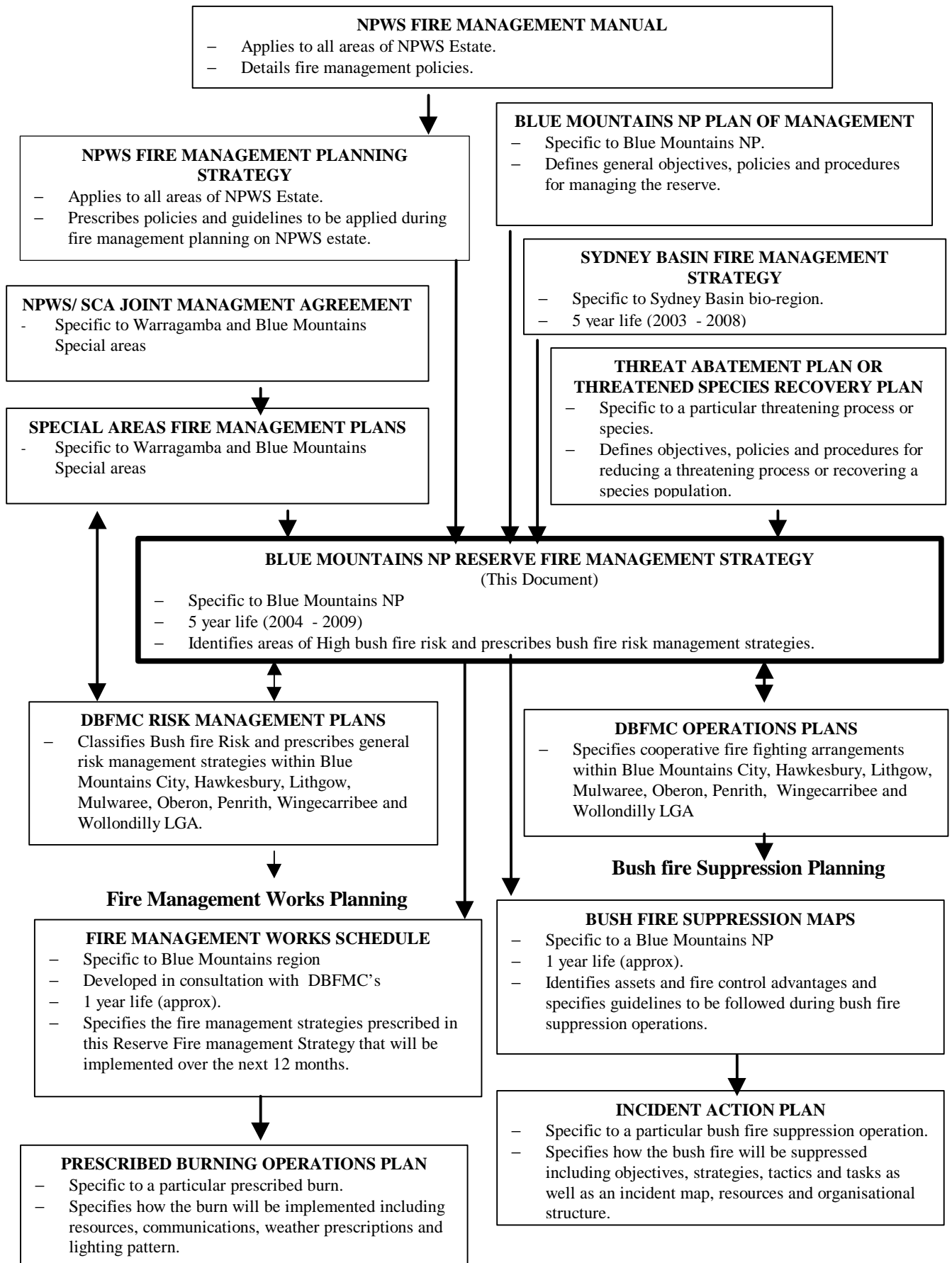
The relationship between this strategy and other fire planning and policy documents is illustrated in Figure 1.

This plan has been prepared in accordance with the policies and procedures detailed in the NPWS Fire Management Manual (NPWS, 2003), NPWS Fire Management Planning Strategy (NPWS, 2002) and the Blue Mountains National Park Plan of Management (NPWS, 2001b). The Strategy has considered the bush fire risks, risk management strategies and cooperative fire fighting agreements outlined in the Blue Mountains City, Hawkesbury, Lithgow, Mulwaree, Oberon, Penrith, Wingecarribee and Wollondilly District Bush Fire Management Committee Risk Management and Operations Plans.

This plan is supported by:

- Fire Management Works Schedules which are prepared annually and list the on ground fire management activities to be implemented each year,
- Bush fire suppression maps and mapping system updated annually which identifies natural, cultural and capital assets to be protected from bush fire each year and fire control advantages. This Strategy should be considered a relevant bush fire management plan under Section 38(4) of the Rural Fires Act 1997 and will be made available to relevant Fire Control Officers for use in multi-agency fire suppression operations involving NPWS estate. (As bush fire suppression maps may contain sensitive information (eg: cultural heritage sites and threatened species locations), these will be internal NPWS documents and will not be made available to the general public.)
- Blue Mountains Region Incident Response Procedures which are prepared annually and detail the levels of bush fire preparedness, duty officer responsibilities, incident response procedures, co-operative fire fighting agreements, administrative procedures, incident communications, the incident management system (ICS) and lists regional fire fighting resources.
- A contact lists for service staff, other agencies and neighbours, sources of accommodation, caterers and equipment suppliers.
- A Geographic Information System (GIS) database maintained by the NPWS Central Branch Office and disseminated regularly to area and Regional offices at Katoomba, Oberon, Mudgee, Richmond and Blackheath.

Figure 1: Relationship of Blue Mountains Reserve Fire Management Strategy to other fire planning and policy documents



1.2 Fire Management Objectives

The Blue Mountains Region of the NPWS aims to meet its statutory obligations and internal policies for fire protection and environmental management by implementing the following fire management objectives:

Objective 1: Protect persons and property, in, or adjacent to the Reserve from bush fires affecting the Reserve.

Indicators:

- Number of significant injuries and property losses caused as a result of fire on or leaving the Reserve.
- Area (ha) of fire management activities undertaken (i.e. fuel monitoring, prescribed burns, mechanical fuel reduction).
- Length (km) of fire management access constructed or maintained.

Objective 2: Manage fire regimes to protect water quality and the natural biodiversity of the Reserve and avoid the extinction of any species.

Indicators:

- Proportion of Reserve managed for heritage, strategic and asset protection values.
- Proportion of Reserve managed within appropriate fire regime frequency tolerances.
- Population numbers and trends of endangered and other indicator species following post fire monitoring.

Objective 3: Minimise the risk of arson in the Reserve.

Indicator:

- Number and cause of ignitions

Objective 4: Minimise the spread of unplanned fires within, from or into the Reserve.

Indicators:

- Average area by tenure of individual unplanned fires affecting the Reserve.
- Number of unplanned fires affecting the Reserve with multiple tenures.

Objective 5: Protect the Reserve's Aboriginal sites, historic places and culturally significant features from damage by bush fires.

Indicator:

- Number of damaged Aboriginal sites, historic places and culturally significant features as a result of bush fires

Objective 6: Minimise the effect of bush fire management and control operations on the local economy.

Indicator:

- Number of park closure days.

These objectives are consistent with fire management policies within the Blue Mountains National Park, Plan of Management. In it, this Strategy is referred to as the Reserve Fire Management Plan.

2 DESCRIPTION OF THE RESERVE

2.1 Location

This plan applies to the Blue Mountains National Park (Fig 2 Location Map). The Reserve covers an area of approximately 267, 000 hectares and lies 60 – 100 kilometres to the west of the Sydney centre at a latitude of 33°40'.

It ranges in altitude from 50m to 1200m ASL (Above Sea Level).

The Reserve forms part of a very large and important conservation area created by the continuity of Kanangra Boyd NP, Yerranderie SRA, Nattai National Park and Wollemi National Park. As a result this plan also considers adjacent fuels, assets and fire control advantages.

The Reserve is bisected by two major east west transport and settlement corridors; the Great Western Highway (and railway) and the Bells Line of Road. These corridors are inhabited by in excess of 80,000 people. Catchments within the Reserve provide clean drinking water for Sydney and the Blue Mountains urban areas.

The Reserve falls within Blue Mountains City, Hawkesbury, Lithgow, Mulwaree, Oberon, Penrith, Wingecarribee and Wollondilly Bush fire Districts.

2.2 Bush fire Environment

2.2.1 Terrain

The terrain of the Reserve is characterised by a rugged sandstone plateau that is deeply dissected by gorges, canyons, escarpments and cliff lines. These contribute to high variations in weather conditions, wind patterns and fuel moisture.

Outside of the transport corridors the Reserve is largely remote with little or no vehicle access past cliff lines and canyons. The remote terrain necessitates a reliance on aircraft for fire suppression and the deployment of remote area fire fighting teams. It also provides varying radio communication and often results in delayed response times and larger fire events.

2.2.2 Climate and Fire Weather

The Reserve is located half way between the sub tropical and warm temperate latitudes of the globe. At different times of the year, fire weather is primarily influenced by temperate dry cool to hot westerly airstreams and warm humid easterly sub-tropical airstreams. Table 1 shows the typical pattern of the fire season in the reserve.

Weather Conditions Associated with Wild fires

Weather conditions associated with wild fires generally occur during the Declared Bush fire Danger Period generally from the 1st October to 31st March. The declared period is subject to revision by DBFM Committees according to prevailing and predicted conditions.

Weather Conditions Suitable for Prescribed Burns

Weather and fuel moisture conditions are only suitable for prescribed burning between 15- 30 days per year. These usually occur in autumn or early spring when fire behaviour can be controlled within natural or established perimeters. Generally suitable conditions coincide with short dry spells of 7 – 14 days that reduce fuel moisture levels with moisture recovery from over-night dews, and a low probability of dry, north-westerly winds.

Figure 2: Location Map

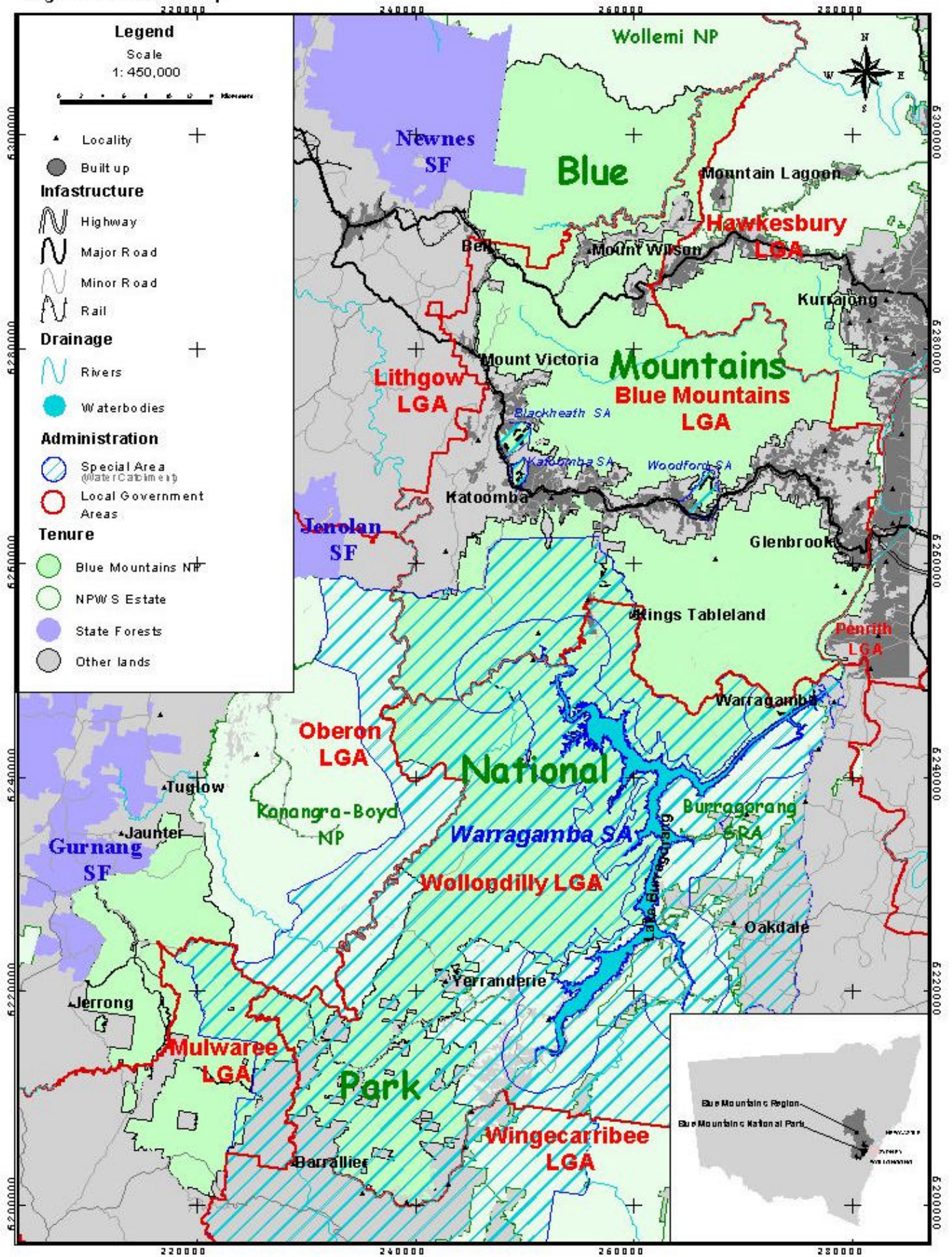


Table 1: Typical pattern of the yearly fire season in the Blue Mountains (adapted from Gellie 1994)

Period	Wildfire risk	General conditions
September – December	High	<ul style="list-style-type: none"> - Week long synoptic patterns bring cool dry and gusty westerly airstreams which are followed by cool to cold south to south westerly winds in mid to late spring and occasionally in December. - Extreme fire danger days occur when strong to gusty hot – north westerly winds precede cold fronts after prolonged spells of dry weather in November and December. - Multiple ignitions occur in remote areas of the Reserve after the passage of dry lightning storms during late spring and summer.
January – April	Moderate	<ul style="list-style-type: none"> - The summer period has warm to hot conditions at lower elevations. - Warm periods are interspersed with South Easterly or Easterly airstreams that bring drizzle or rain from the coast. - Thunderstorms are frequent producing heavy rainfall and lightning strikes. - Severe fires are likely to occur when January and February rains are below average. - Extreme fire danger days occur to a lesser extent in January.
May - June	Low	<ul style="list-style-type: none"> - Moist mild weather occurs during this part of the year. - Severe fires unlikely
July - August	Low	<ul style="list-style-type: none"> - A winter pattern of cold dry westerly airstreams dominate. - Weekly passage of cold fronts produces rain and occasional snow above 1000m. - Frosts are common at all elevations. - Severe fires are unlikely.

Climatic Zones

An altitudinal variation of approximately 1000 metres contributes to the formation of two distinct climatic zones within the Reserve. These have a significant impact on the weather and climatic variables effecting fire behaviour.

- a) The dry climatic zone - between 50 and 600 metres has an average annual rainfall of 700 – 800mm, higher average temperatures and lower average humidity levels. As a result, these areas experience a greater ignition risk, a larger window of opportunity for implementing prescribed burns and a prolonged fire season.
- b) The moist climatic zone – between 600 and 1200 metres experiences an average annual rainfall of 1200 – 1400mm, cooler temperatures and humidity levels that can be 5 – 20% lower than elevations below 600m. As a result, these areas experience difficulties in implementing prescribed burns and a shorter fire season.

Climate and Past Cycles of Fire Seasons

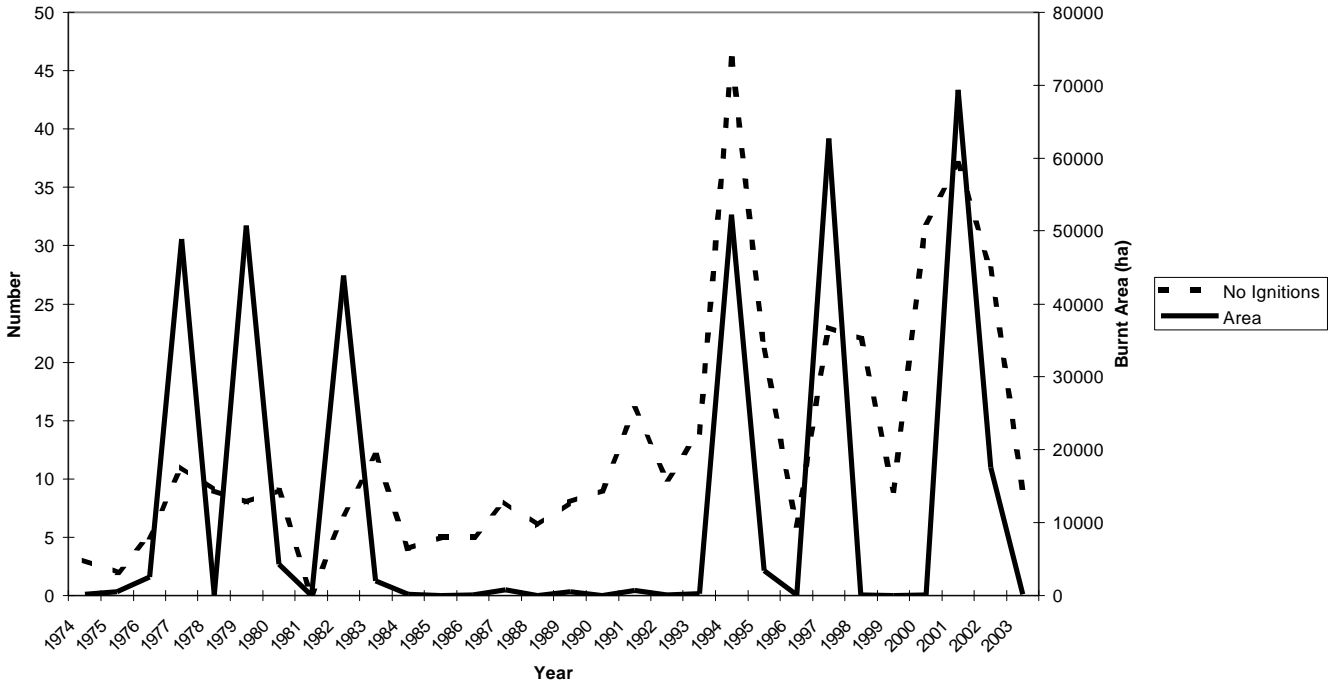
Historically, evidence from past cycles of fire seasons indicates that severe wildfire seasons are likely to occur every 5 - 11 years (Bureau of Meteorology, 2002). The occurrence of severe seasons generally correlates with ‘*El Nino*’ induced droughts that increase the availability of fine fuels to sustain wild fires (Cunningham 1984; Gellie 1994). Indicators such as the Southern Oscillation Index (SOI) and the Soil Dryness Index (SDI) are used to predict the onset of severe fire seasons. Between severe seasons minimal area is burnt and fuels are able to accumulate as a result of successive wet summers.

2.2.3 Fire History

Fire history records for Blue Mountains National Park date back to 1957. 385 records have been compiled from NPWS original maps and incident reports, NSW Rural Fire Service, State Forests of NSW, Sydney Catchment Authority (previously Sydney Water) and anecdotal evidence from service staff, local fire brigade members, and Reserve neighbours. Record

Blue Mountains National Park Fire Management Strategy
 keeping was standardised for NPWS in 1984. The 319 records from this date are therefore more concise. An average of 17 wild fires have affected the Reserve each year since 1984. The last fire including prescribed burns affecting the Reserve area are detailed in Fig 2b Fire History and 2c Fire Frequency.

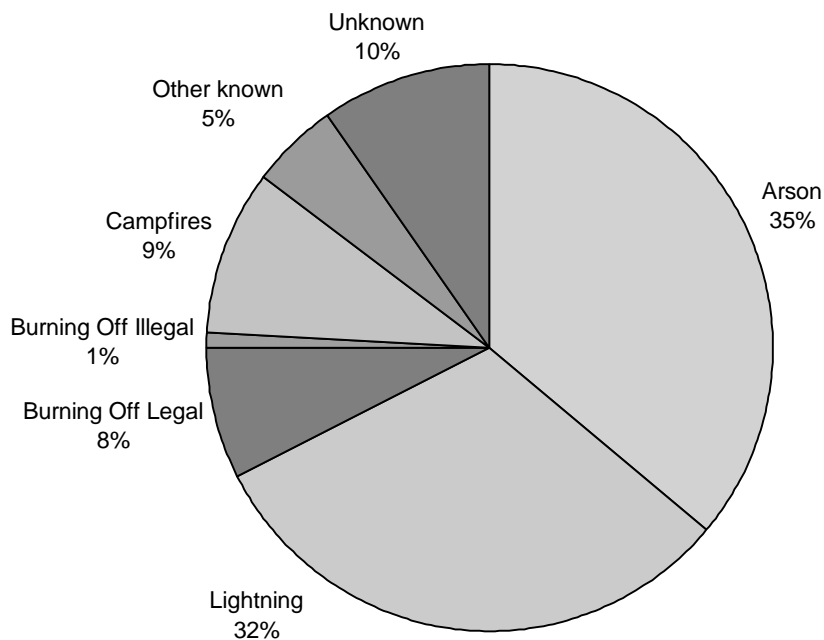
Blue Mountains National Park Number of Ignitions and Area Burnt by Year 1974-2003



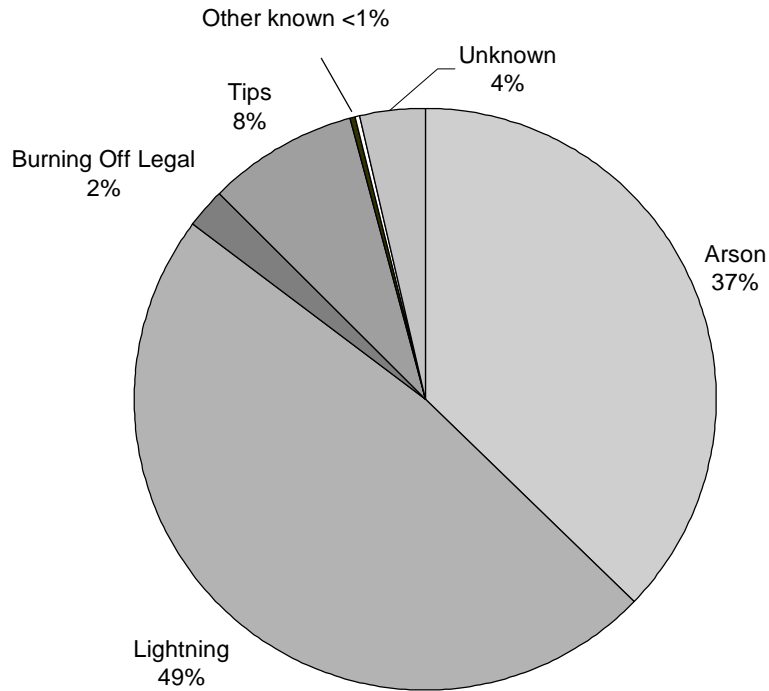
Causes of Fire

The following graphs below illustrate the historical fire frequency and cause of ignitions and the area affected.

Blue Mountains National Park Bush Fire Ignition Sources 1957-2003



Blue Mountains National Park Bush Fire Ignition Sources by Area Burnt 1957-2003



NB: The category ‘Arson’ includes ignitions where arson is suspected.

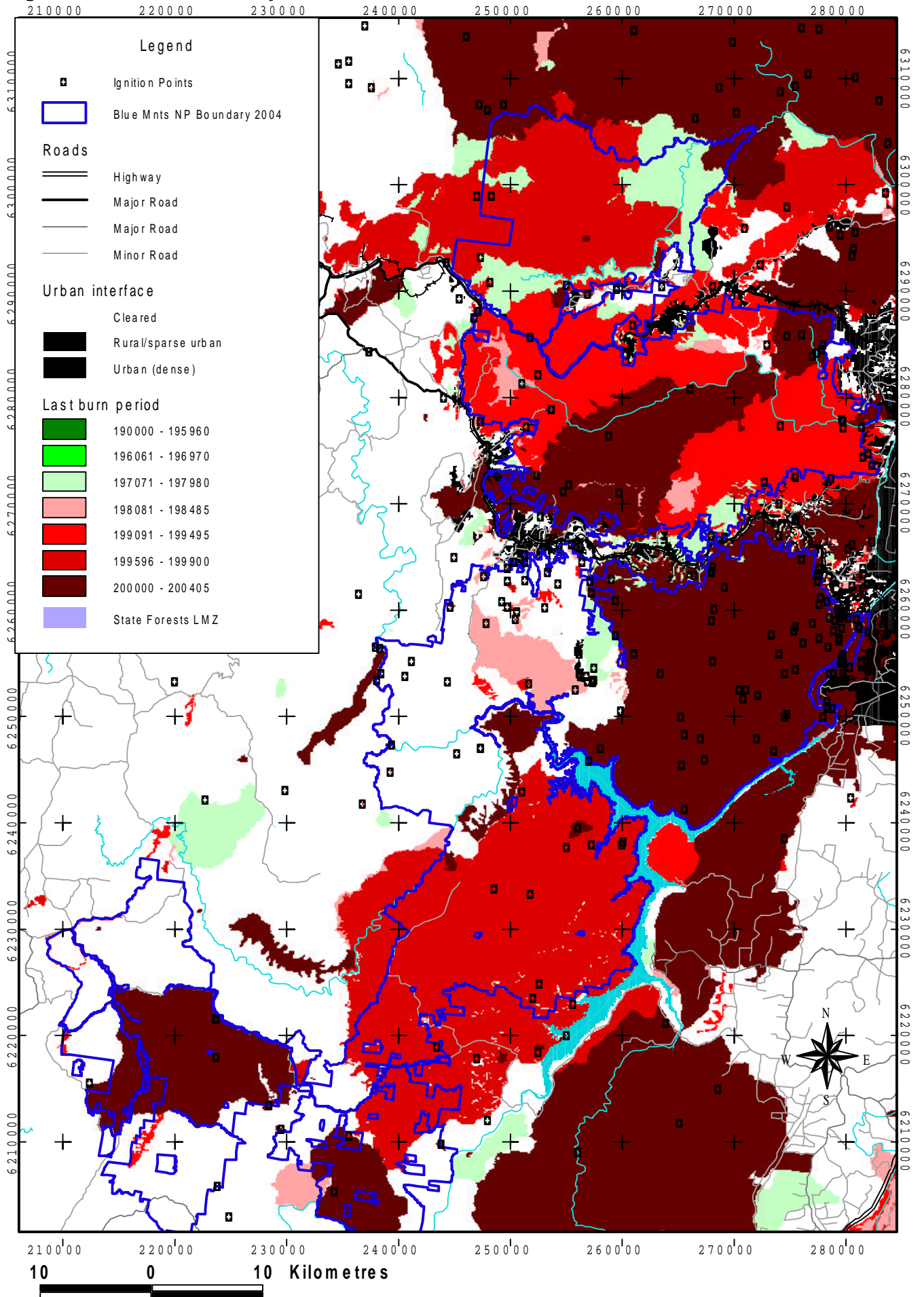
Wildfire History

Table 2 classifies historical wild fires by their proximity to urban areas, size and frequency. Databases indicate the scale of individual wild fires varies from less than one hectare to greater than 10,000ha.

Table 2: Summary of general wildfire types, size and frequency within the Reserve (adapted from Gellie 1994)

	Type of fire	Size (Ha)	Recurrence interval	Likelihood
Remote area	Large remote area	>1,000	1 in every 20 yrs (Lightning)	Moderate
	Medium size remote area	100 – 1,000	1 – 3 yrs (Lightning)	High
	Small size remote fire	1 - 100	Every season (Camping, Lightning)	High
Outer Urban	Very large outer urban (semi remote)	> 10, 000	1 in every 8-10 yrs (Arson/ Lightning)	High
	Medium size outer urban area (semi remote)	100 – 1,000	Every season (Arson, Lightning, visitors)	Moderate
	Small outer urban (semi remote)	1 - 100	Every season (Visitors, arson)	Very High
Urban	Large urban	>1, 000	1 in every 10 yrs (Arson/ Lightning)	Very High
	Medium size urban area	100 – 1,000	1 in every 2 – 3 yrs (Arson, Misc)	Moderate
	Small urban fire	1 - 100	Every season (Escaped burn off)	Very High

Fig 2b Fire History



Hazard Reduction Burning History

The graph below illustrates the hazard reduction burning history for the Reserve since 1980 (when records and maps have been maintained).

Table 3 (below) classifies the different motivations for historic prescribed burns operations. Databases indicate that a high number of prescribed burns are small burns to protect assets. These contribute to approximately one third of the area treated by prescribed fire. Approximately two thirds of the area treated has been implemented in strategic zones adjacent to the urban interface or on more remote ridges. A lesser number and proportion of area treated by prescribed burns have been implemented to maintain ecological processes within vegetation communities.

Area of Prescribed Burning in the Blue Mountains National Park 1980-2003

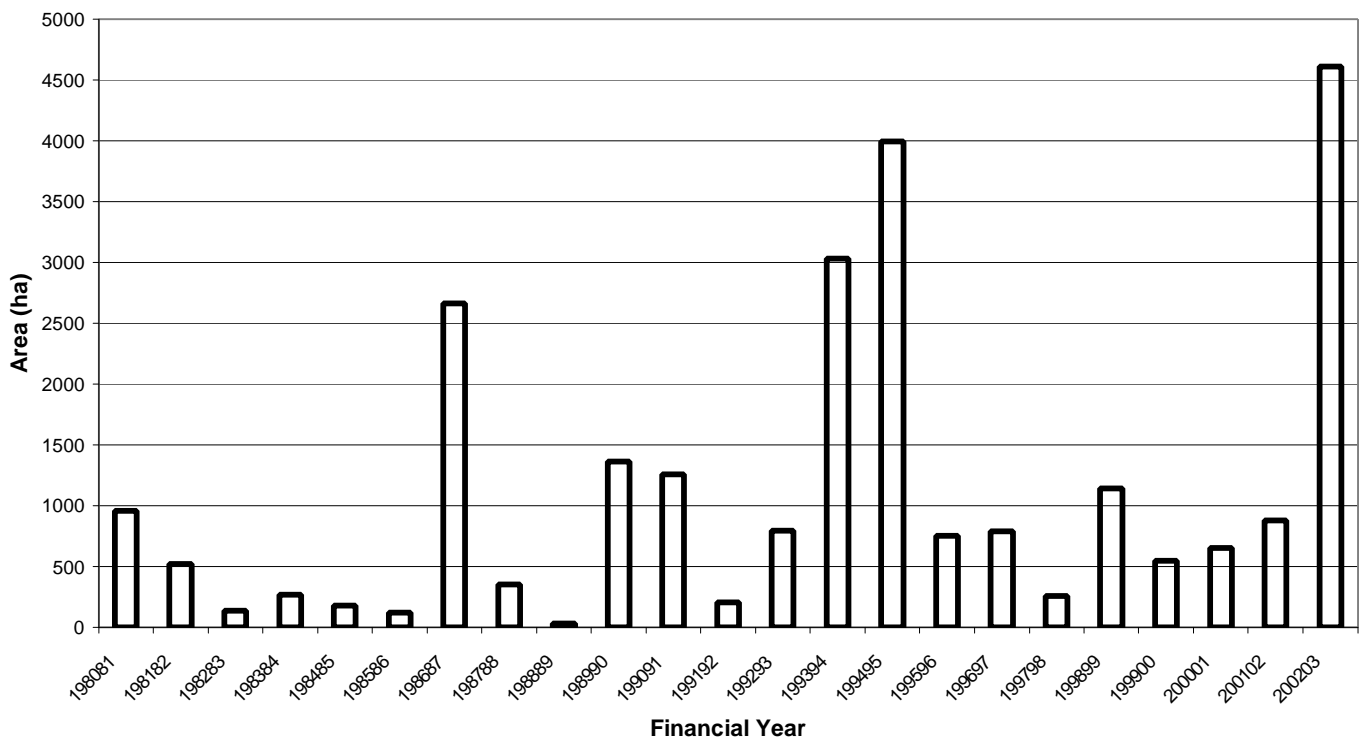
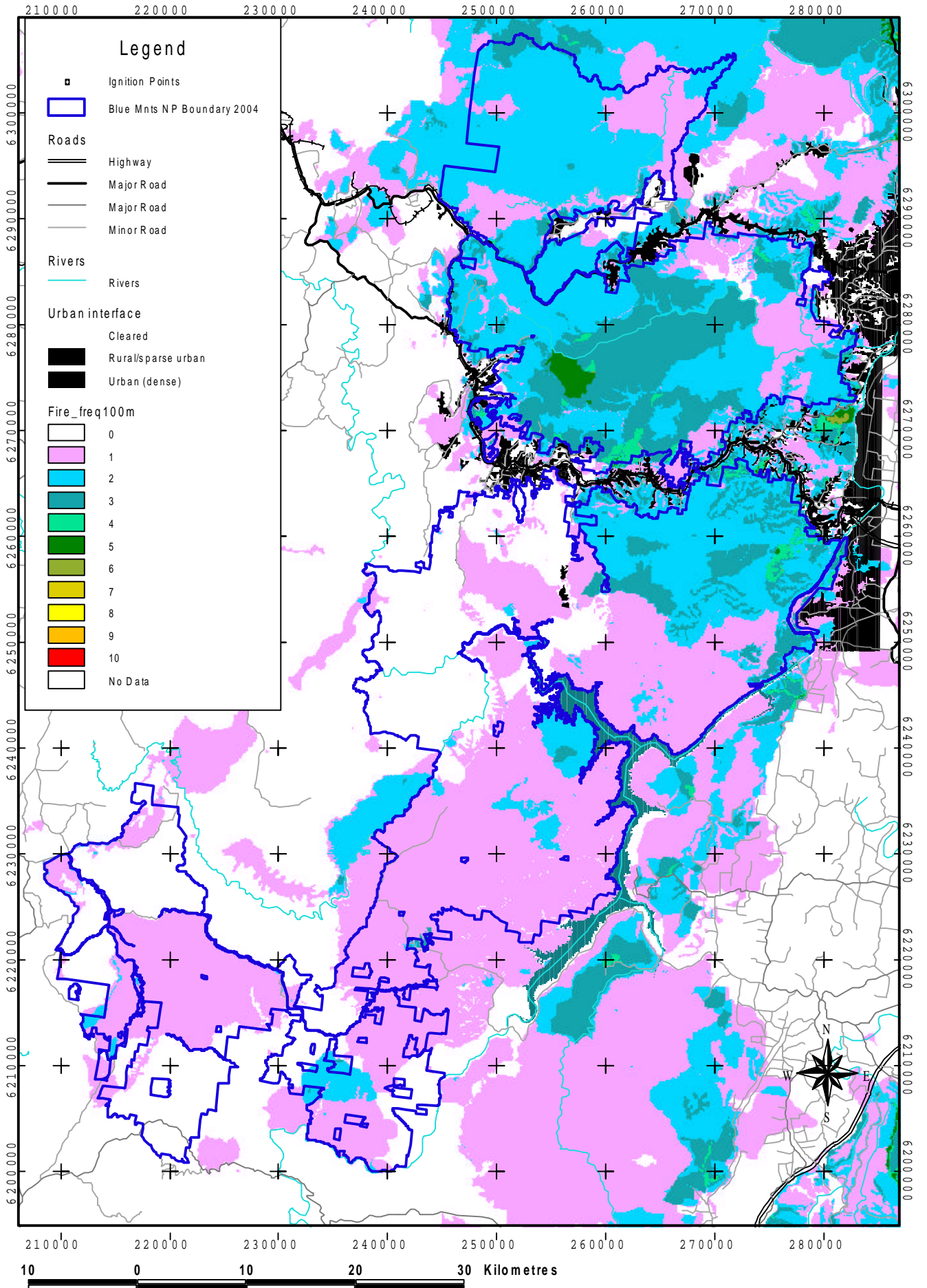


Table 3: Classification of prescribed burns historically implemented within the Reserve

Burn type	Priority	Block size (ha)	Broad Prescription
Asset Protection Burn	A	<100	Every 3- 7 years, moderate intensity, autumn or early spring
Strategic Burn	B	100 – 3000	Every 8- 15 years, moderate intensity, autumn or early spring
Ecological Burn	C	100 - 3000	Dependant of fire regime requirements of vegetation communities and habitat. Every 10 – 30 years, moderate to high intensity, autumn or early spring

Figure 2c: Fire Frequency Since 1943



2.2.4 Fire Behaviour Potential

Information on the fire behaviour potential has been gained from an analysis of historic records, field observations, GIS modelling and anecdotal accounts. The Reserve has large areas of extreme bush fire behaviour potential. Historically, wild fires have exhibited high rates of spread (1-2km/hr) and flame heights (50m) when drought, fuel and weather conditions combine to produce extreme fire behaviour. Significant factors contributing to bush fire behaviour potential within the reserve include;

- 97% of the vegetation fuels are dominated by Eucalypt woodland, forests and heath that will burn intensely in an average season. (Holme and Gellie 1989).
- The Reserve is characterised by extensive steep terrain (slopes greater than 15°) with short spotting distances between ridges. However, the rounded ridge tops that are exposed to the wind have more effect on fire behaviour than slope in general, as fires can spot easily from ridge to ridge.
- Aspect has a significant affect on fire behaviour. Under north westerly winds fires burn at right angles to the ridgelines between the Great Western Highway and the Grose River, which creates intense fire behaviour and heavy spotting over a large area. Under a south westerly pattern however, fires burn along these ridge lines. These fires may burn intensely however spotting is reduced as the convection column is more stable.
- Fuels tend to be available longer in the Dry climatic zone of the lower plateau resulting in increased fire behaviour potential for a longer period of time during the fire season.
- The most likely weather pattern associated with severe fire behaviour generates from fresh to strong north - westerly or south - westerly winds. Table 4 shows the potential for the spread of fires under each of the weather patterns in the dry and moist climatic zones. Estimates are based on observed rated of spread in the field.

Table 4: Potential for fire spread under common weather patterns (adapted from Gellie 1994)

Weather pattern	Climatic zone	Daily duration (hrs)	Length of travel per day (km)	Number of days	Total length of travel (km)
North Westerly	Dry	6-8	15-20	1-2	15-40
	Moist	5-7	10-14	1-2	10-28
South Westerly	Dry	5-7	10-14	0.5-1	5-14
	Moist	5-7	7.5-11	0.5-1	3.5-11

Note: the daily travel in each of the climatic zones is assumed to be;
 Dry Zone: 2.5 km/hr(NW) 2.0 km/hr(SW)
 Moist Zone: 2.0 km/hr(NW) 1.5 km/hr(SW)

2.3 Major Assets

Within and adjacent to the Reserve there are a large number of capital assets at a high risk from damage from bush fires. These are:

- Extensive urban and rural residential areas occur along the Great Western Highway, Bells Line of Road and in Western Sydney,
- A number of isolated in- holdings are located in remote areas,
- Numerous NPWS facilities are distributed throughout the Reserve often in areas of high fire behaviour potential,
- Commercial pine plantations (both State-owned and private)
- Rural Lands adjacent to the Reserve in the south east and west,
- State infrastructure and utilities such as power lines, sewerage, transmission and communications, water supply and monitoring equipment, gas and water pipelines.

2.4 Water Catchment Values

Uncontrolled intense wildfire can affect the hydrology of an area, and the quality and nutrient status of its drainage. The major metropolitan population of Sydney and the Blue Mountains are supplied clean water from the forested catchments within the Reserve. This includes water draining into Lake Burragorang (Warragamba Dam) and smaller supply pondages such as the Woodford Dam, the Katoomba Cascades Dams and the Blackheath Greaves Creek Dams.

2.5 Natural Heritage

The Reserve has significant natural heritage values including wilderness, wild rivers, world heritage areas, important vegetation communities, endangered flora and fauna populations, rugged geological landforms and sensitive soil landscapes. These values have evolved under a long history of varying intensity fires. These values are sometimes compromised by inappropriate fire regimes and related activities. Notable natural heritage values are stated below:

- The Reserve forms a significant part of the Greater Blue Mountains World Heritage Area (James 1994; and NPWS and Environment Australia 1998a).
- The Reserve incorporates significant areas of the Kanangra – Boyd (NPWS 1996), Wollemi (NPWS 1997) and Grose (NPWS 1998b) Wilderness Areas.
- Some rivers traversing the Reserve have the potential to be declared wild rivers. These include the Grose River, Coxs River, Erskine Creek, Wollangambe River and Bungleboori Creek (NPWS 2002b).
- The Reserve provides habitat for over 40 vegetation communities. Vegetation has been extensively mapped at 1:25, 000 (Holme, 1994), 1:100,000 (Holme, 1989, 1991; Benson 1992; Benson and Keith, 1985, 1990; Fisher, Ryan and Lembit 1995; and Fischer & Ryan, 2000) and also modelled (Thomas, Gellie, and Harrison, 2000 a & b). Other interpretations have also been undertaken by the NPWS (Gellie and McRae 1988). Several communities are of particular concern including two endangered ecological communities.
- Over 1000 species of flora have been recorded within the Reserve. Species of particular concern include 2 species that are now believed to be extinct, 24 endangered species, 31 vulnerable species, 40 Rare Or Threatened Australian Plants (Briggs and Leigh 1995), and other species at the geographic limit of their distribution, or of special conservation significance (James, 1994). The distribution of potential habitat of threatened vascular flora has been modelled for species within the Reserve (NPWS, 1999).
- The Reserve supports a high diversity of fauna including, 46 mammals (including 27 marsupials and 2 monotremes), over 200 birds, 58 reptiles, 32 amphibians, and numerous invertebrates. Species of particular concern include 2 species now believed extinct that may once have occurred, 5 endangered species, 20 vulnerable species, and other fauna species with restricted distributions and disjunct populations. The distribution of potential habitat of vertebrate fauna has been modelled for species within the Reserve (NPWS, 1999)
- Many of the soil landscapes are prone to erosion as a result of high intensity fires, track and trail maintenance and construction and other fire management works (Austin and Atkinson 1985; Hicks and Lynch 1989; Bannerman and Hazelton 1989).

2.6 Cultural Heritage

Culturally important places, sites and objects of both Aboriginal and non-Aboriginal origin occur throughout the Reserve. These provide a record of human interaction with the natural landscape. Significant cultural heritage values include;

- over 700 Aboriginal archaeological sites and other culturally significant areas, and,
- 62 historic sites including buildings, mines, quarries, lookouts, picnic areas and walking tracks have been identified. These latter sites reflect changing land use, phases of settlement, the development of tourism, outdoor recreation and conservation movements in the latter part of last century and early this century.

2.7 Recreational Use and Facilities

The Blue Mountains National Park provides a wide range of recreational opportunities in a natural setting. The Reserve is in close proximity to Sydney. The lookouts can be accessed easily on the transport corridors or by a number of railway stations. As a consequence it receives over three million visitors per year from local and international tourists. Significant recreational uses and facilities include;

- visitor information centres, lookouts, camping areas, picnic areas, natural heritage interpretation signage, shelters and toilets;
- a broad range of outdoor recreation activities including bushwalking, camping, picnicing, canyoning, cycling, abseiling and rock climbing.

There are also a significant number of tour and commercial recreation operators that are authorised to access and use these facilities.

2.8 Contribution to Local Economy

The Blue Mountains are extensively promoted as the city within a National Park. The local economy of the Blue Mountains is reliant on the tourism industry. The Reserve plays a key role by providing lookouts, landscape views and recreational opportunities. The passage of uncontrolled bush fires can make areas unsafe and affect aesthetic values. Following a risk assessment, areas are sometimes closed to the public after fires or in periods of high and extreme fire danger. This can impact on the local economy by limiting recreational opportunities, walking tracks and access to lookouts.

3 BUSH FIRE RISKS

3.1 Introduction

A bush fire risk analysis has been undertaken to identify the level of risk to assets within and immediately adjacent to the Reserve. These assets include life and property, natural heritage and cultural heritage values, water catchment values and the eco-tourism industry. For the purpose of this plan, bush fire risk is defined as the chance of a bush fire or inappropriate fire regime occurring and causing damage to assets. The bush fire risk analysis method is designed to compliment District Bush Fire Risk Management Plans and is further described in the NPWS Strategy for Fire Management Planning (NPWS, 2003). The results of the assessment form the basis for setting priorities for the selection of fire management strategies and the generation of works schedules.

3.2 Life and Property Risks

Since 1911, wild fires have destroyed over 600 houses and killed 14 people in the Blue Mountains (Cunningham 1989; NPWS 2001). The majority of property damage was caused by the 2% of fires which were burning on days of severe fire weather (Gellie, 1994). Table 5 and Figure 3 illustrate the potential damage scenarios within neighbouring communities.

3.2.1 Risks to Life

Fire Fighters

High risk situations for fire fighters include:

- Working in proximity to escarpments, cliffs and steep terrain;
- Property protection directly behind residences where no fire fighting access has been constructed and vegetation adjoins;
- Initial remote deployment of crews for direct attack
- Remote operations generally where there are a limited number of safety refuges and identified escape routes, and changing weather conditions may complicate crew extraction;
- Dead end tracks and trails where there is infrequent turn around bays and refuge areas;
- High fuel loads;
- Aircraft operations, and;
- Working near powerlines.

Neighbours

High risk situations for neighbours include:

- Property protection during wildfire's where neighbours do not have the appropriate asset protection zones, personal protective equipment or training, and;
- Single access 'in-holdings' or other facilities (as the opportunity of escape is limited and could be cut off by an approaching fire front).

Visitors

High risk situations for visitors include:

- Along single access tracks to NPWS facilities and lookouts because the opportunity of escape is limited and could be cut off by an approaching fire front;
- In remote areas where visitors may be unaware of Reserve closures, fire bans or approaching fire fronts, and;
- Within a burnt area where trees and branches are falling and there is a possibility of re-ignition.

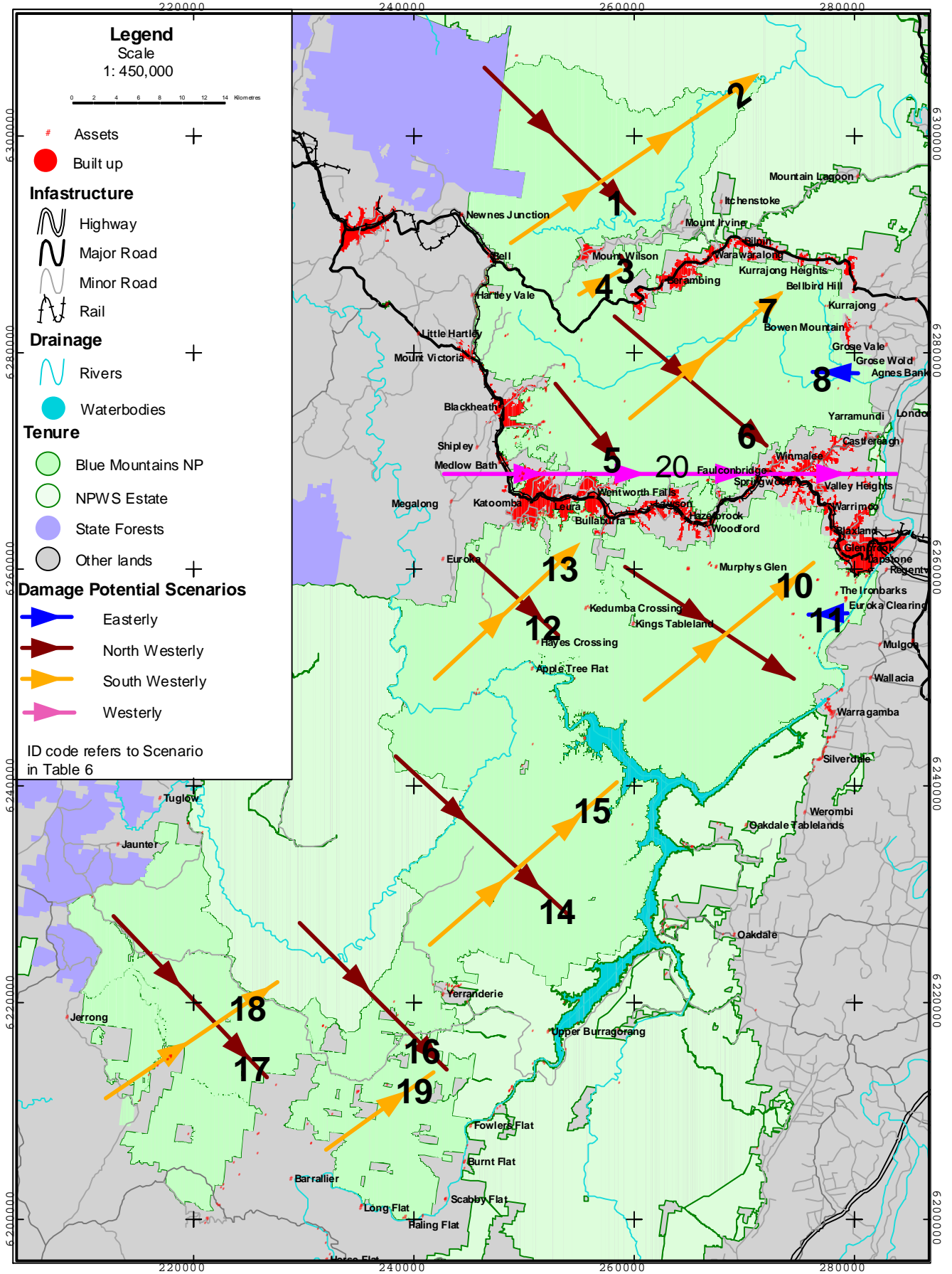
Table 5: Damage potential scenarios (Adapted from Gellie 1994)

Scn	Zone of impact	Source of ignition	Ignition risk ¹	Wind Dir.	Fire Potential ₃	Length of run (km) ⁴	Risk ⁵	Comments
1	The Mounts	Remote	High (lightning)	NW	Very High	Medium to long	Major	- Impacts directly as head or flank on Interface areas from Bell Mt Tomah, Mt Irvine and east to Itchenstoke
2	The Mounts to Itchenstoke	Bell	Moderate	SW	High	Short to Medium	Very High	- Impacts directly as head or flank on Interface areas from Mt Tomah to Mt Irvine - Potential for large remote area fire
3	Berambing Warawaralong	Mt Wilson - Irvine	Moderate	NW	Very High	Short	High	- Rural residential areas with vegetation close to houses,
4	Berambing Warawaralong	Bells line of road	Moderate	SW	High	Short to Medium	High	
5	Grose valley – Middle mountain towns	Upper Mountain towns	Very High (Arson)	NW – WNW	Very High	Short – Medium	Very High	- Impacts as a flank or fire front between Nth Leura, Wentworth Falls and Linden, - The further Nth the ignition point further east zone of impact, - Fire fingers can run into urban areas if wind tends N to NE
6	Grose valley - Lower Mountain towns	Bells Line of Road or Grose Valley	High	NW – WNW	Very High	Medium – long	High	- Impacts directly or as a flank on towns from Linden to Winnalee, Yarramundi and Hawkesbury heights - Also includes small to medium fires starting outside the urban area
7	Kurrajong,	Grose valley	High (lightning)	WSW, SW	High	Medium – long	High	• Impacts from Kurrajong to Bowen Mountain, Grose Vale & Grose Wold
8	Grose valley - Lower Mountain Towns	Castlereagh	Very High (Arson)	E	Moderate	Short	Moderate	- Small fires and usually rapidly suppressed
9	Glenbrook to Warragamba	Blue Labyrinth	High	W - NW	Very High	Moderate – Long	High	
10	Middle Mountain towns to Warragamba	Blue Labyrinth Within towns	Very High	WSW, SW	High	Medium – long	Very High	- Unlikely to be carried as a broad front into urban areas, - Rainforests and cliffs cause fire to break up into fingers, - Potential for a large fire to affect a large area of central and lower mountains
11	Blue Labyrinth	Glenbrook to Warragamba	High	E	Moderate	Short	Moderate	- Small fires and usually rapidly suppressed

Blue Mountains National Park Fire Management Strategy

Scn	Zone of impact	Source of ignition	Ignition risk ¹	Wind Dir.	Fire Potential ₃	Length of run (km) ⁴	Risk ⁵	Comments
12	Upper mountain towns, Apple tree flat to Kedumba Crossing	Megalong Valley	Moderate	W - NW	Very High	Short – Moderate	High	
13	Upper Mountains	Megalong Valley	Moderate	WSW, SW	High	Medium – long	High	- Cliff lines break fire run - Good standard of protection from services
14	Yerranderie - Lake Burragorang	Kanangra Boyd	Moderate Lightning	W - NW	Very High	Moderate – Long	High	- Large remote area fire west of Scott's main Range
15	Apple tree flat - Lake Burragorang	Yerranderie	Moderate	WSW, SW	High	Moderate – Long	High	- Large remote area fire west of Scott's main Range
16	Yerranderie to Barrallier	Yerranderie	Moderate Lightning	W - NW	Very High	Short - Moderate	High	- Large remote areas
17	Barrallier	Mt Werong	Moderate Lightning	W - NW	Very High	Short - Moderate	High	
18	Kanangra – Boyd NP	Jerrong	Low	WSW, SW	High	Moderate – Long	High	
19	Yerranderie	Barrallier	Low	WSW, SW	High	Moderate – Long	High	
20	Upper Mnts Towns	Megalong	High Arson	W	Very High	Short- Moderate	High	Impacts Katoomba to Linden under strong westerlys
<p>*1 Ignition risk: based on density of ignitions within 2km of asset; High: > 15, Moderate: 5 – 15, Low: <5. *2 Wind direction: Based on historical fires within the park boundary *3 Fire Potential: Based on the results of bush fire behaviour potential model within 100m of asset location *4 Length of run: Based on the run of fires in recorded fire history Short: <1km Medium: 1-5km Long: >5km *5 Risk: Based on the classification in Gellie (1994)</p>								

Figure 3: Damage Potential Scenarios



3.2.2 Risks to Property

The various property values at a high risk of bush fire damage are classified below. The relevant RFS District's Bush Fire Risk Management Plans detail the specific level of risk to community assets. The locations of assets are mapped in the NPWS geographic information system and on bush fire suppression maps.

Urban Interface Areas

The urban interface within the Blue Mountains generally faces the greatest threat to damage from bush fires. A 170km interface occurs adjacent to the Reserve or other contiguous bushland along the Great Western Highway, Bells line of Road and some Western Sydney suburbs. Factors influencing the risk of damage to property at the urban interface include:

- The aspect, wind exposure and position of buildings with respect to plateaus and spur lines that facilitate extreme fire behaviour;
- The proximity of contiguous flammable vegetation and fuels to buildings ;
- The availability, location and standard of fire fighting access and water services particularly between the asset and the approaching front;
- Single narrow access subdivisions where fire fighters and residents may be cut off from accessing the property by an approaching fire front;
- The age and safety design of housing. Some new developments incorporate protection mechanisms such as improved design, building materials and sprinkler systems;
- Availability of services (water) for fire fighting vehicles and aircraft;
- The depth and maintenance of asset protection zones, and;
- Where there is a history of damage under severe conditions.

Rural Residential Areas and Isolated 'In-holdings'

Within the Reserve there are a number of isolated private 'in-holdings'. Factors influencing the risk of damage to these include:

- Single access roads where fire fighters may be cut off from protecting the property by an approaching fire front;
- Availability of services (water) for fire fighting vehicles and aircraft;
- Presence and adequacy of cleared refuge areas;
- Depth and maintenance of asset protection zones, and;
- Training and equipment appropriate to residents.

NPWS Facilities

The Reserve hosts a large number of NPWS facilities including camping areas, car parks, picnic areas, shelters, toilets, information facilities and lookouts. Factors influencing the risk of damage to these include;

- Single access roads where fire fighters may be cut off from protecting the facility by an approaching fire front;
- Availability of services (water), and;
- Depth and maintenance of asset protection zones.

Rural lands

Rural lands similarly surround the Reserve. Assets that may be damaged from bush fires include houses, sheds, equipment, live stock, fences, crops and loss of pasture. Factors influencing the risk of damage include;

- Single access roads where fire fighters may be cut off from protecting the property by an approaching fire front;
- Availability of services (water);
- Presence and adequacy of cleared refuge areas, and;
- Depth and maintenance of asset protection zones.

Public Utilities and Infrastructure

A number of public utilities are located adjacent to or within the Reserve. In extreme conditions, these could be affected or damaged by fires. They include high voltage and domestic power lines, public access corridors by road and rail, water pipes, sewerage and pumping equipment, communication lines and towers, and important drinking water catchments and storages. Factors influencing the risk of damage to public utilities and infrastructure include;

- Single access roads where fire fighters may be cut off from accessing the facility by an approaching fire front;
- Availability of services (water) and or other appropriate fire fighting equipment
- Presence and adequacy of cleared refuge areas,
- Depth and maintenance of asset protection zones; and;
- The remote nature of some facilities where effective protection would be difficult and dangerous for crews under severe conditions.

Smoke Sensitive Areas

Fires can have a significant impact on air quality and visibility. Areas where smoke could affect services include;

- Schools, retirement villages and hospitals;
- Airfields ranging from remote and rural to major facilities at Richmond and Bankstown.
- Transport infrastructure including the Great Western Highway, Bells Line of Road, and the Western Railway , and;
- Where cumulative impacts of major bush fires within the Sydney basin affect suburban air quality and visibility.

3.3 Natural Heritage Risks

The natural heritage of the Blue Mountains include its unique ecology, biodiversity, scenic landscapes, wild rivers, wilderness and clean water catchments.

The ecology of the Blue Mountains National Park has evolved with regular bush fire events of varying intensity. Many natural ecological processes of regeneration are triggered by bush fires. Human interaction often seeks to control bush fire events by limiting the area burnt and the intensity, and managing the frequency, to minimise the risk to life and property. The frequency and intensity of bush fires affecting an area is known as a 'fire regime'. In some instances, fire regimes can be inappropriate for the long-term sustainability of ecological processes.

Figure 4 presents the natural heritage values at a high risk from inappropriate fire regimes. High risk locations are mapped in the NPWS geographic information system and on bush fire suppression maps.

High Risk Fire Regimes

While a single fire may have a significant affect on individual plants and animals, the long term survival of species populations is dependant on the interaction and dynamics between the frequency, intensity, season, and extent of successive fires. Table 6 summarises the components of fire regimes that may contribute to a high risk of extinction of flora and fauna species (Gill and Bradstock 1995; Keith, 1996).

Table 6: High risk fire regimes that may contribute to species extinction (adapted from Keith, 1996)

Fire Regime Characteristic	Mechanism of Extinction
High Fire Frequency	<ul style="list-style-type: none"> - Depletion of obligate seeders due to insufficient time between successive fires for these species to reach reproductive maturity. - Depletion of those species which are susceptible to mechanical damage or injuries caused by recurrent fires. - Depletion of those species which only develop mechanisms which enable them to survive fire when they are older. - Depletion of species due to exhaustion of dormant bud or soil seed pools. - Depletion of species due to physical changes in habitat. - Depletion of those species susceptible to competition from opportunistic exotics. - Low plant nutrient availability due to loss of nutrients through smoke and erosion.
Low Fire Frequency	<ul style="list-style-type: none"> - Depletion of those species which are dependent upon fire for their regeneration (eg: fire or smoke is required to reduce the competition from other species, to stimulate flowering or to stimulate seed release or germination). - Low plant nutrient availability due to nutrients being held in forms which cannot be used by plants. - Depletion of species due to physical changes in habitat.
High Intensity Fires	<ul style="list-style-type: none"> - Depletion of standing plants and animals through heat induced death of vital tissues. - Depletion of species due to destruction of soil seed banks and dormant bud pools. - Depletion of species due to physical changes in habitat.
Low Intensity Fires	<ul style="list-style-type: none"> - Depletion of those species in which higher intensity fire is required to stimulate the release or germination of seeds. - High post - fire seedling mortality due to predation. - Depletion of species due to physical changes in habitat.
Spring/ Summer Fires	<ul style="list-style-type: none"> - Depletion of species due to disruption to plant and animal breeding. - High post-fire seedling mortality due to desiccation. - Depletion of hollow – dwelling animals due to increased destruction of tree hollows and fallen logs. - Depletion of species due to physical changes in habitat.
Autumn Fires	<ul style="list-style-type: none"> - High post-fire seedling mortality due to frost. - Depletion of hollow – dwelling animals due to increased destruction of tree hollows and fallen logs. - Depletion of species due to physical changes in habitat.
Small or patchy Fires	<ul style="list-style-type: none"> - High post - fire seedling mortality due to predation. - Depletion of those plant species which are reliant upon fire to reduce competition.
Large Fires	<ul style="list-style-type: none"> - High post - fire animal mortality due to predation as a result of lack of cover. - High post - fire animal mortality due to competition for scarce resources. - Depletion of species due to poor dispersal of species into burnt area. - Depletion of species due to physical changes in habitat. - Depletion of those species susceptible to competition from opportunistic exotics.

High Risk Fire Management Activities

Fire management activities that may compromise natural heritage values include;

- Excessive use of earth moving machinery, slashing or herbicides
- Excessive use of fire suppression chemicals,
- Introduction of exotic species and water contamination through aircraft suppression operations, and;
- Hazard reduction burning without consideration of environmental impact.

3.3.1 Greater Blue Mountains World Heritage Area

The Reserve forms a significant part of the Greater Blue Mountains World Heritage Area (WHA) (James, 1994). The Blue Mountains WHA is of National Environmental Significance (NES) under the Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999. The primary risks to the Blue Mountains WHA values from fire include;

- The impact of altered or inappropriate fire regimes on the ecological, biological and evolutionary processes within the eucalypt dominated ecosystems, and
- The impact of inappropriate fire regimes on the quality of habitats for the in-situ conservation of the biological diversity of primitive species with Gondwana affinities and, of rare or threatened plants and animals.

3.3.2 Wilderness

The Reserve incorporates the Kanangra - Boyd, Wollemi and Grose declared Wilderness Areas. Ecologically inappropriate fire regimes and fire management activities can affect wilderness values. Activities that are incompatible with wilderness values include the construction of fire breaks and access tracks with earth moving equipment, the felling of trees for helipads and the intensive use of people and aircraft in remote fire fighting situations.

3.3.3 Habitat for Threatened species, Populations & Communities

The Reserve provides habitat for a number of threatened flora and fauna populations and communities that are at risk of extinction from ecologically inappropriate fire regimes and fire management activities.

- High Risk Flora Populations include: 2 species which are believed to be extinct, 5 endangered species, 16 vulnerable species, 44 species recorded as Rare Or Threatened Australian Plants (Briggs and Leigh 1995), species at the geographic limit of their distribution, and others of special conservation significance (James 1994).
- High Risk Fauna Populations include: 2 fauna species now believed extinct that may once have occurred in the Reserve, 5 endangered species, 20 vulnerable species, and others with restricted distribution and disjunct populations.
- High Risk Vegetation Communities: 2 endangered ecological communities (Shale sandstone transition forest and Sydney Turpentine – Ironbark forest), proposed endangered ecological communities such as Blue Mountains Shale Cap forest and Blue Mountains Sedge Swamps, and a number of vegetation communities that are considered to have a high ecological value.

3.3.4 Water Catchments, Soil Landscapes and Wild Rivers

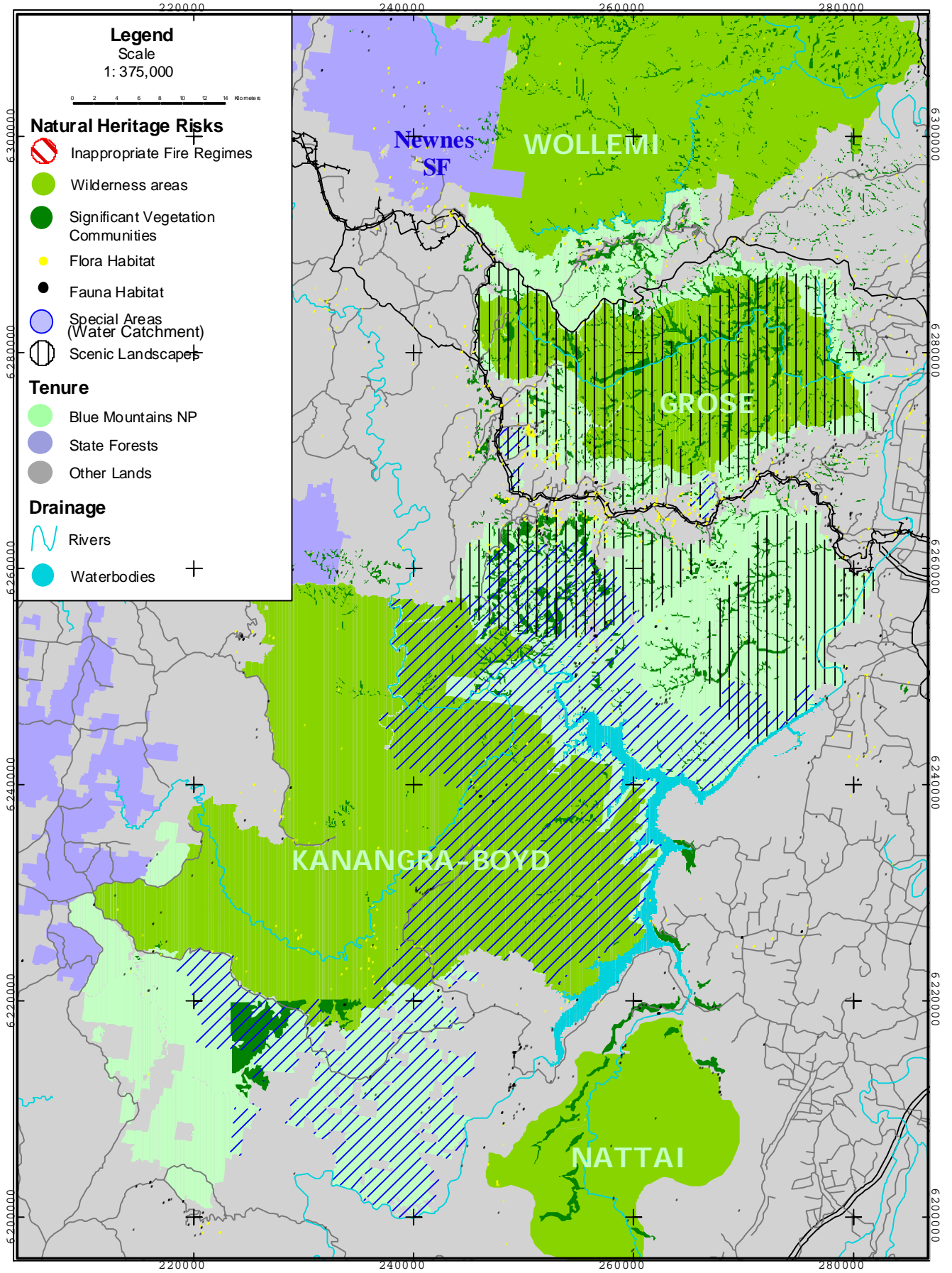
Bush fires have a significant effect on a landscape's hydrology. Intense bush fires remove cover vegetation, fine fuels and decomposing organic matter that cover soils. Water run off increases after fires due to the decrease in green foliage which intercepts rain and processes ground water. The soils are unprotected and are eroded by heavy rains. Later, run off decreases below pre fire levels as seed germination and natural regeneration occurs.

The catchments of the Reserve provide clean drinking water to the Blue Mountains and Sydney Metropolitan water storages including Lake Burragorang, Greaves Creek, Cascades and Woodford reservoirs. High Risk drinking water catchments within the Reserve include the Blackheath, Katoomba, Woodford and Warragamba Special Areas. Drinking water quality and yield can be significantly affected by high intensity bush fires which burn extensive areas. The major impacts include increased sediment, nutrient and organic matter loads in river systems and water storages with the erosion of soil and ash following post fire rains.

Within the Reserve there are a number of soil landscapes with a high erosion potential (Hairsine, Zierholz and Booker 1995; Austin and Atkinson 1985). These landscapes are Hawkesbury sandstone side slopes and colluvial slopes, Narrabeen side slopes and colluvial slopes and Permian sedimentary foot slopes. The impacts of erosion are; alteration of landforms, the smothering of vegetation, increased sedimentation of drainage lines and water bodies, and alteration of aquatic habitat. Increased nutrient loads can also assist in the invasion of weeds. Extreme erosion events can follow high intensity wild fires. These can produce massive sediment loads and reduce the regenerative capacity of ecosystems through the removal of seed banks and nutrients (Hairsine et al, 1995).

The Grose River, Coxs River, Erskine Creek, Wollangambe River and Bungleboori Creek are proposed for assessment as declared Wild Rivers. Wild River values could be similarly affected by bush fires.

Figure 4: High Risk Natural Heritage Values



3.3.5 Scenic Landscapes

The Blue Mountains is an area of national tourism significance and one of the State's major eco-tourist destinations. The extensive system of lookouts and walking tracks attracts approximately 2.8 million visitors per annum. Bush fires have the potential to affect the aesthetic quality of the landscape and deter visitors for safety reasons. Extreme fire danger conditions also trigger restrictions on Reserve access. The Blue Mountains economy is dependant on tourism and decreased visitation associated with bush fires has significant impacts.

Operations associated with bush fire suppression such as the construction of trails, fire breaks and helipads also have the risk of affecting scenic values by breaking landscape continuity.

General locations of high visitation include the Jamieson Valley escarpment from Wentworth Falls to the Three Sisters, Grose Valley (southern, eastern side and western sides), Mulgoa area, Glenbrook area, and the Mid Mountains.

3.3.6 Colonisation of Exotic Species

Following the passage of a bush fire, the burnt ground provides scarce resources for the remaining native animals and a nutrient rich seed bed for native plants. Many exotic species have the ability to colonise such disturbed environments by out-competing native species. The major issue affecting biodiversity values within the Reserve relates to colonising of gazetted noxious weeds and pests and other exotic species. This colonisation can be exacerbated by ecologically inappropriate fire regimes. Fire events and fire management activities can also impact by transporting exotic seeds on machinery, water and equipment

The higher risk locations for exotic species impacts include urban interface areas, adjacent to tracks and trails, drainage lines and power line easements.

3.3.7 Areas Under Rehabilitation

At any one time, there are sites within the Reserve subject to rehabilitation programs. This includes areas of historic disturbance such as temporary fire access trails and adjacent urban areas, and specific endangered species recovery programs. The desirability of fire in these areas depends on the program.

3.4 Cultural Heritage Risks

The Reserve has a range of Cultural Heritage values that are at high risk of damage from bush fires and fire management operations. Their locations are accurately mapped in the NPWS geographic information system (GIS) and on bush fire suppression maps. They are also illustrated in Figure 5.

3.4.1 Aboriginal Archaeological Sites

There are over 700 records of Aboriginal sites within the Reserve. Important examples that are open to the public include Red Hands Cave, Kinks Tableland, Lyre Bird Dell, and Asgard Swamp. Bush fires, foams and wetting agents, retardants, vehicles and earthmoving equipment can impact on these sites. Table 7 below summarises the potential impacts of fires and fire management activities on Aboriginal sites.

Table 7: High risk Aboriginal sites (adapted from English, 2000)

Risk	Site type	Impacts of bush fires and fire management operations
Very high	Scarred and carved trees	<ul style="list-style-type: none"> - High intensity fire may cause tree death, erode tree stability, or damage scars. Fire may also lead to a decline in tree health and promote rot. - Fires may destroy dead trees - Low intensity prescribed burn has a low impact if site is protected by a buffer zone. - Slashing, mowing and dozer lines construction could have a high impact if the site is not identified and struck.
High	Rock engravings	<ul style="list-style-type: none"> - High intensity wildfire may cause spalling of the sandstone and therefore damage engravings. A build up of soil due to post fire erosion may contribute to chemical weathering. - Low intensity prescribed burns have a low impact if the site is protected by buffer zone. - Slashing, mowing or dozer line construction could have a moderate to high impact if the site is driven over.
Moderate	Axe grinding grooves	<ul style="list-style-type: none"> - As above - Low intensity prescribed burning has a low impact if the site is protected by a buffer zone. - Slashing, mowing or dozer line construction could have a moderate to high impact if the site is driven over.
Moderate	Rock art Site	<ul style="list-style-type: none"> - High intensity fires may damage shelter surface and cause the loss of art. Smoke blackening will obscure or damage art motifs. The removal of protective vegetation at shelter entrance may promote weathering. - Low intensity prescribed burning has a low impact if the site is protected by a buffer zone. - Sites may be affected by smoke damage, and removal of protective vegetation - Slashing, mowing or dozer line construction will have a low to negligible impact except if protective vegetation is damaged or removed.
Moderate	stone arrangements	<ul style="list-style-type: none"> - High intensity wildfire may cause spalling of stones in an arrangement. Post fire soil erosion may lead to displacement of stones. - Low intensity Prescribed burn has a low impact if the site is protected by a buffer zone. - Slashing, mowing or dozer line construction could have a moderate to high impact if the site is driven over.
Low	Middens	<ul style="list-style-type: none"> - High intensity wildfire may remove protective vegetation and promote post fire erosion. There will be low impact if post fire soil erosion is not caused. - Low intensity prescribed burning has a low impact if the site is protected by a buffer zone.. - Slashing, mowing or dozer line construction could have a moderate to high impact if the site is driven over.
Low	Burial grounds	<ul style="list-style-type: none"> - High intensity wildfire may remove protective vegetation and promote post fire erosion. This can expose remains especially in sandy soils. - Low intensity prescribed burning has a low impact on the site if protective vegetation is not significantly altered. - Slashing, mowing or dozer line construction could have a high impact if the site is driven over.
Very Low	Quarry	<ul style="list-style-type: none"> - High intensity wildfire may remove protective vegetation and promote post fire erosion. - Slashing, mowing or dozer line construction could have a high impact if the site is driven over.

3.4.2 Aboriginal Culturally Significant Areas

Many landscapes within the Blue Mountains are important in Aboriginal culture. Bush fires can impact on valued landscape features such as story places (eg a mountain) by removing vegetation, promoting soil erosion and weed growth. The health of the environment associated with these types of places is often directly linked to their cultural significance. For the same

reasons, the construction of fire trails, helipads or other works can degrade the cultural environment. Bush fires can also reduce the availability of food and medicine plants or diminish the value for recreational, educational or ceremonial purposes. A number of Aboriginal groups and individuals maintain an active interest in the management of such areas.

3.4.3 Historic Cultural Heritage Sites

There are 64 historic sites within the Reserve that are listed on the NPWS Cultural Sites register. These include mining sites, walking tracks, stock and trade routes and other evidence of early European settlement. Several walking tracks have been identified as items of State heritage significance. Table 8 classifies the high risk cultural heritage sites and potential impacts of bush fires and fire management activities.

Figure 5: Cultural Heritage Risks

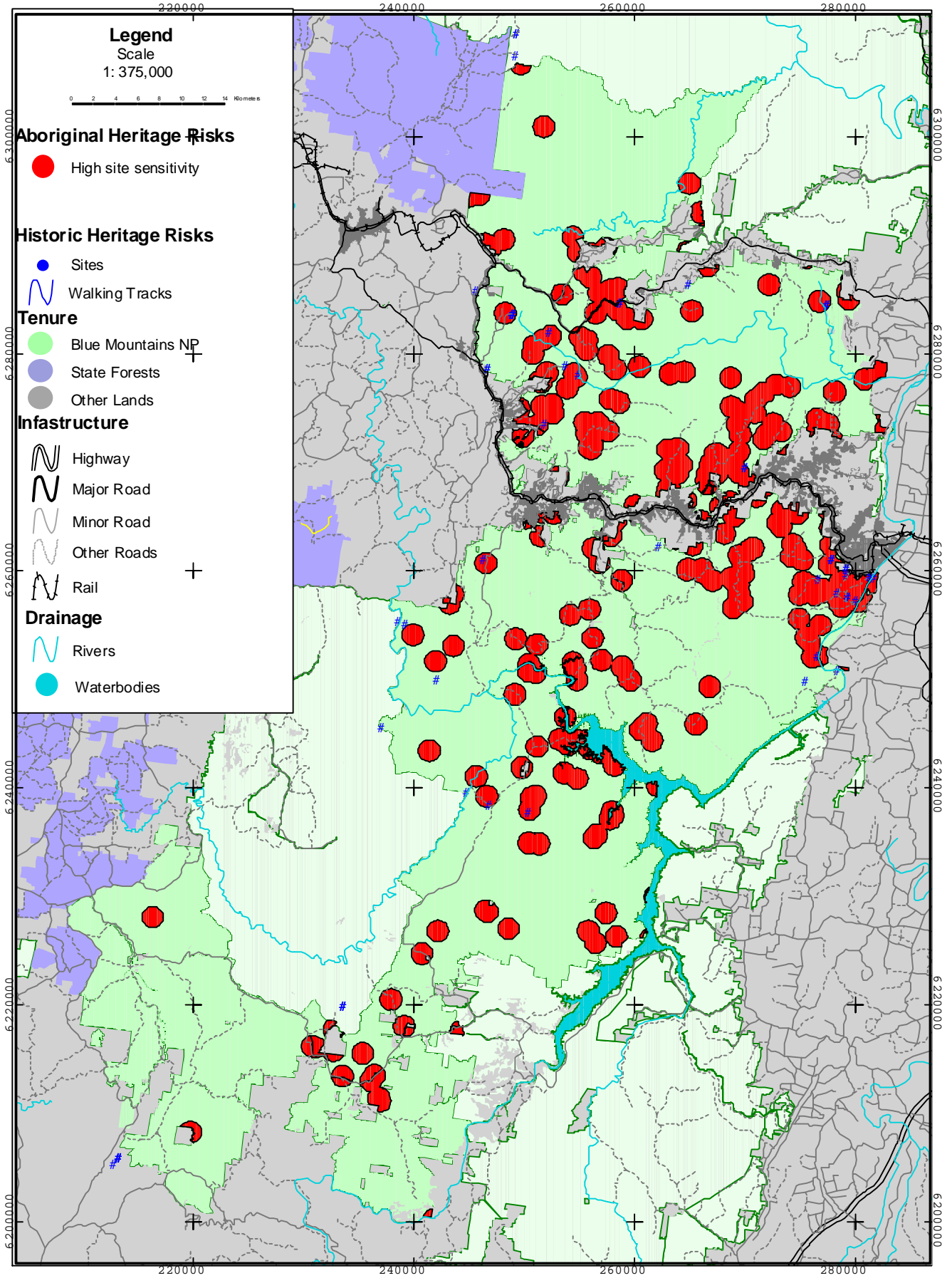


Table 8: High Risk Historic Cultural Heritage Sites

General location	Impacts of bush fires and fire management operations
Constructions, foundations, building remains	Fire may directly remove combustible material such as timber structures. Post fire soil erosion may lead to displacement of foundations. High impact could result if the site is struck by a vehicle.
Artefacts	Post fire soil erosion may lead to artefact movement and damage to archaeological deposits.
Wells, Mines and Quarries	Low impact except where post-fire erosion causes artefact movement or changes to site. High impact if driven over especially with earth moving equipment.
Earthworks, drainage lines, retaining walls etc	High intensity fires may cause spalling of rock constructions. Removal of protective vegetation may promote erosion especially along drainage lines. Earth moving equipment may alter historic earthworks.
Gardens and exotic vegetation	Depending on the intensity, fire may cause vegetation death and erode stability. This may also lead to decline in vegetation health.
Stone arrangements	May cause spalling of stones in an arrangement. Post fire soil erosion may lead to displacement of stones.

4 BUSH FIRE MANAGEMENT STRATEGIES

4.1 Introduction

The following section details the fire management strategies to achieve each of the Strategy objectives

4.2 Fire Management Zones

In order to manage the sometimes conflicting priorities between property protection and ecological sustainability, the NPWS has adopted a Fire Management Zoning (FMZ) system for its reserves. The Blue Mountains National Park has been divided into Fire Management Zones based on the similar approach within District Bush Fire Risk Management Plans (RMP's). The boundaries have been identified at a scale of 1:25, 000 using practical fire control advantages such as roads, water storage's, drainage lines and areas of low bush fire behaviour potential. In many areas the Reserve boundary does not align with practical fire control advantages. In these situations effective fire control can only be implemented in consultation and coordination with neighbours and District Bush Fire Management Committees for consistency. Figure 6 shows the zone boundaries for the Reserve area.

Fire Management Zone	Area	Proportion
Asset Protection	852	0.3%
Strategic Fire Management	57349	21.5%
Heritage Management	208658	78.2%
Total	266859	100%

The following sections provide an overview of the management rational for each zone type.

4.2.1 Asset Protection Zones (APZ)

Asset Protection Zones are localised areas (less than 100m wide) adjacent to valuable community assets, specific natural heritage or culturally important sites that have a risk of damage by bush fires or associated management activities. As the National Park boundary is usually some distance away from communities there are only a few asset protection zones applicable. Table 9 provides an overview of this zone.

Table 9: Overview of Asset Protection Zones (APZ)

Primary Fire Management Objectives:	- To protect human life, including permanent residents, visitors and fire fighters from bush fires. - To protect residential areas, crops, plantations, utilities, camping areas, day use areas, urban interface, cultural heritage assets and other built assets from bush fire.
Prevention & Mitigation Objectives:	- To cooperatively maintain and manage with neighbours and District Bush Fire Management Committees through community education and community fireguard type programs.
Application:	- In compliance with the Bush Fire Assessment Code for Asset Protection and Strategic Fire Management Zones (RFS 2003) - To be effective, operations must be integrated along with neighbours, Councils, other agencies and the RFS. - Remote utility assets (powerlines and communications towers) within the Reserve will be protected under MOU's with the relevant authority.
Locations:	- Areas adjacent to urban areas, high visitation areas, utilities or other built assets, which are exposed to a high level of bush fire Risk.
Standards:	- Unless specified otherwise, width and fuel guidelines will be as detailed in Planning for Bush fire Protection (RFS & Planning NSW, 2001). Generally these are 10-100m wide, immediately adjacent to assets and aim to keep fine fuels less than 8t/ha.
Strategies	- Prescribed burning. - Slashing/mowing. - Selective shrub/tree removal and under scrubbing.

	<ul style="list-style-type: none"> - Herbicide application. - Watering. - Trail maintenance and construction where necessary. - Radiation zone construction.
Management Intensity:	<ul style="list-style-type: none"> - Asset Protection Zones will be the most intensively managed fire management zone with more than 90% of each Asset Protection Zone treated per treatment cycle. - Treatment cycles will be short in length. As an indication, treatment cycles could vary from once every 2 months (e.g. slashing) to once every 3 - 7 years (e.g. prescribed burning) depending on the strategy implemented.
Impacts:	<ul style="list-style-type: none"> - Such intensive management may have significant negative impacts on a wide range of natural and cultural values. Strategies may be modified to protect natural and cultural values as long as it does not compromise the primary fire management objective in Asset Protection Zones.
Performance indicators:	<ul style="list-style-type: none"> - Value of property damaged or destroyed adjacent NPWS APZs. - Number, area and % of APZs where prescriptions meet standards. - Number and area of APZs treated to meet standards. - Number of cooperative arrangements with neighbours or community fireguard groups regarding APZ maintenance.

4.2.2 Strategic Fire Management Zones (SFMZ)

Strategic Fire Management Zones are assigned to larger areas usually adjacent to and complimenting the asset protection zone. They are managed to protect community assets and ecological sustainability. The intensity and location of assets, and the relative lack of practical fire control advantages requires significant areas to be classified in this zone. The broad scale of mapping does not account for moist forest and rain forest ecologies where these exist within the broader strategic zones (i.e. Jamison Valley). Prescribed burning will be planned within fuel moisture and weather conditions to minimise any damaging effects on these ecologies. Table 10 provides an overview of this zone.

Table 10: Overview of Strategic Fire Management Zones (SFMZ)

Primary Fire Management Objectives:	<ul style="list-style-type: none"> - To reduce fire intensity, spotting distance and therefore assist in the strategic control, containment of bush fires and the protection of fire fighters. - To reduce the probability of bush fires being ignited in areas of high bush fire risk. - To complement Asset Protection Zones and to strengthen existing fire control advantages. - To restrict the movement of bush fires between Fire Management Zones. - To restrict the movement of bush fires from other land onto NPWS estate and from NPWS estate onto neighbouring land. - To break up large continuous areas of high bush fire behaviour potential to reduce the probability of large 'landscape' scale bush fires.
Prevention & Mitigation Objectives:	<ul style="list-style-type: none"> - Promotion of the Service's fire and fuel management activities through community education programs. - To be effective, operations must be integrated and gain concurrence from neighbours and the RFS where Reserve boundaries do not follow logical fire advantages.
Application:	<ul style="list-style-type: none"> - In compliance with the Bush Fire Assessment Code for Asset Protection and Strategic Fire Management Zones (RFS 2003)
Locations:	<ul style="list-style-type: none"> - Within large continuous areas of high bush fire behaviour potential. - In areas with a proven history of bush fire ignitions. - In areas of high bush fire behaviour potential that occur along the boundaries of NPWS estate. - Adjacent to existing fire control advantages or to link existing fire control advantages together including the established northern and southern strategic lines. - Adjacent to Asset Protection Zones. - Other strategic areas for controlling the spread of bush fires.
Standards:	<ul style="list-style-type: none"> - Width will be 100 to 3000 metres. - To achieve objectives and in consultation with DBFMCs.
Strategies	<ul style="list-style-type: none"> - Generally prescribed burning supplemented with slashing/mowing, selective shrub/tree removal and under-scrubbing. - Trail maintenance or construction with regard to DBFMCs Fire Trail Registers.
Management Intensity:	<ul style="list-style-type: none"> - Management intensity will be moderate with generally less than 70% of each Strategic Fire Management Zone treated per treatment cycle. - Treatment cycles will be moderate in length. As an indication, treatment cycles could

		vary from once every 7 to 15 years depending on the strategy implemented.
Impacts:	-	The strategies implemented in Strategic Fire Management Zones are likely to have only a minor impact on most natural and cultural values but may have a significant negative impact on some sensitive natural and cultural values. Strategies may be modified to protect these values as long as they do not compromise achieving the primary objectives of the zone.
Performance Indicators:	-	Number, area and % of SFMZs where prescriptions meet standards.
	-	Number and area of SFMZs treated to meet standards.

4.2.3 Heritage Area Management Zones (HAMZ)

Heritage Management Zones are areas where the principle objective is to sustain heritage values. Table 11 provides an overview of this zone.

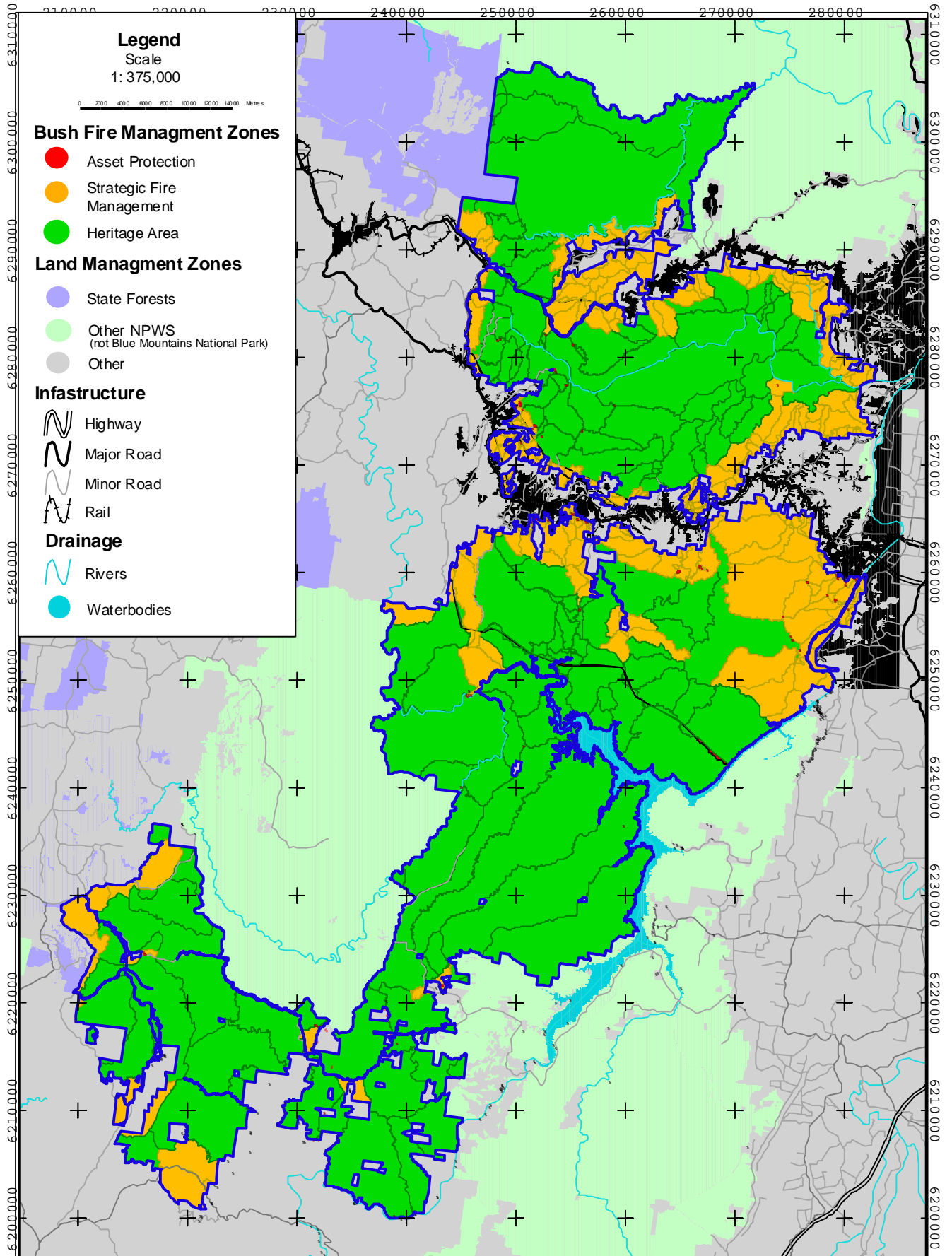
Table 11: Heritage Area Management Zones (HAMZ)

Primary Fire Management Objectives:	-	To prevent the extinction of all species which are known to occur naturally within the reserve (conserve biodiversity).
	-	To protect Aboriginal sites, Historic Heritage sites and other culturally significant features from fire.
Prevention & Mitigation Objectives:	-	Promotion and awareness of the values that may be threatened by bush fires or inappropriate fire regimes within the zone.
Application:	-	Where conflict exists between the strategies required to achieve the objectives of preventing the extinction of all species which are known to occur naturally within NPWS estate (conserving biodiversity) and protecting Aboriginal sites, Historic Heritage sites and other culturally significant features from fire (conserving cultural heritage) and the strategies required to achieve any other fire management objective, the former will be implemented.
Locations:	-	Areas not satisfying the criteria for inclusion in Asset Protection or Strategic Fire Management Zones. Core areas of the reserve including Wilderness areas and World Heritage areas.
Standards:	-	As far as possible, fire regimes maintained within the biodiversity fire regime thresholds for vegetation communities (identified within table) that occur within the zones.
	-	As far as possible, follow the threatened species management guidelines.
	-	As far as possible, follow the cultural heritage management guidelines.
Strategies	-	As appropriate to conserve biodiversity and cultural heritage (may involve suppressing bush fires, allowing bush fires to burn and prescribed burning).
	-	Suppressing bush fires and, where necessary, conducting prescribed burns to maintain fire regimes within the biodiversity thresholds specified in Table 22, and
	-	Implementing the threatened species and cultural heritage management guidelines in locations where threatened species and cultural heritage sites are known or likely to occur.
Management Intensity:	-	Will be determined by the requirements for the protection of vegetation communities, threatened species and cultural heritage sites present within the zone.
Impacts:	-	The strategies implemented in this zone will be designed to conserve natural and cultural heritage and will not have a negative impact on these values.
Performance Indicators	-	Number, area and % of HAMZs where prescriptions meet standards.
	-	Number and area of HAMZs treated to meet standards.
	-	Number of threatened species populations showing decline due to inappropriate fire regimes.

4.2.4 Land Management Zones (LMZ)

Land management zones cover land tenures not managed by NPWS. They include privately owned land, State forests, Council reserves and other Crown lands.

Figure 6: Bush Fire Management Zones



4.3 Strategies to Reduce the Occurrence of Human Caused Unplanned Fires

Approximately 75% of all fires are attributed to human causes. The strategies to reduce the occurrence of human caused unplanned fires in the Reserve are detailed below.

4.3.1 Deliberate Arson

The Service will implement the following strategies to minimise arson ignitions:

- Promoting cooperative surveillance programs through DBFMC's including neighbourhood watch programs and patrols in high risk areas during severe fire weather conditions;
- Promoting community education and awareness programs through DBFMC's, including providing information for interpretations, signage and the media to highlight the consequences for arson;
- Assisting in fire prevention programs at local schools;
- Limiting public access by closing all or part of the Reserve during severe fire weather conditions, implementing Reserve fire bans during severe fire weather conditions or dry conditions, maintaining and installing strategic signage and gates, reviewing access trails for management effectiveness and rehabilitating non-essential trails, and minimising the construction of trails in locations that will increase the ignition risk, and;
- Cooperatively assist NSW Police and the Rural Fire Service to investigate all fires believed to have been deliberately lit.

4.3.2 Campers and Reserve Visitors

The Service will implement the following strategies to minimise ignitions started by visitors and campers:

- Increased preparedness for increased probability of bush fire ignitions during wildfire weather conditions, long weekends and areas with wood camping fires;
- Providing advice, information and interpretations at NPWS visitors centres and facilities, NPWS web site and liaising with external tourism information centres highlighting the conditions for the safe use of fire and unsafe activities that lead to the ignition of bush fires, and;
- Prohibiting the lighting of fires during total fire bans or conditions associated with severe fire weather to minimise the chance of fires being started by visitors.

4.3.3 Illegal Hazard Reduction Burns

As a statutory member of local DBFMCs, the Service will cooperatively encourage Committees to ensure neighbours obtain appropriate permits to implement prescribed burns.

4.3.4 Escaped Prescribed Burns

As a statutory member of local DBFMCs, the Service will cooperatively encourage Committees to ensure neighbours have access to the appropriate equipment, training and resources to adequately contain burns on their property.

4.3.5 Trains

The Service will cooperatively liaise with NSW State rail authorities to ensure adequate fuel free areas are adjacent to railway lines to prevent ignition started by trains.

4.3.6 Powerlines

The Service will cooperatively liaise with energy providers to ensure measures are taken to minimise the potential for ignitions started by power line arcing and falling trees.

4.3.7 Unknown ignition sources

The Service will investigate and report on all fires in the Reserve to minimise the number with unknown ignition sources.

4.4 Strategies to Suppress Unplanned Bush fires

Fire suppression actions start from the time the fire is detected until it is extinguished. NPWS priorities in bush fire suppression operations are;

- The safety of all incident personnel,
- The effective protection of human life and community assets,
- The conservation of natural and cultural heritage,
- The cost effectiveness of strategies, and
- The achievement of community support.

The NPWS will cooperatively implement the following strategies to suppress unplanned bush fires within the Reserve.

4.4.1 Preparedness for Ignitions

Based on the average annual ignition rate, between 10 and 30 wild fires will be suppressed within the Reserve each year. NPWS will be prepared for bush fire suppression by:

- Participating in pre-season preparedness days to test equipment, fire detection, response and suppression capability;
- Preparation of annual 'Regional incident procedures' and 'contacts list' documents to ensure an efficient and timely response to incidents;
- Minimising the response time to ignitions by;
 1. assessing the required level of day to day preparedness by monitoring Fire Danger indexes and synoptic conditions on a continuous basis throughout the fire season,
 2. ensuring all staff have their complete personal fire fighting equipment on-hand and in operational condition,
 3. identifying pre-emptive incident management and fire-fighting teams to enable a rapid response to ignitions during severe fire weather conditions.
 4. maintaining a remote fire fighting response capability on standby for the prompt control of fires specifically for the Sydney Water Catchments in association with the SCA and Sydney South Region.
- Maintaining surveillance through neighbours, aircraft, towers and other vantage points within the Reserve to detect the location of bush fires and initiate a coordinated response, and;
- Rostering Duty Officers throughout the fire season to activate and coordinate responses to fires on holidays and outside office hours.

4.4.2 Response to Ignitions

Coordinated Fire Management

NPWS has negotiated Co-operative Inter-Agency Bush Fire Suppression Agreements for the first response to ignitions and the suppression of bush fires for up to 8km from the Reserve boundary. These agreements are based on the Policy Statement of the Bush Fire Coordinating Committee and the Manual of Procedures for Coordinated Fire Fighting. The agreements are detailed in relevant District Bush Fire Operations Plans, and the policies or regulations of other involved organisations.

The Service will classify fires as follows:

Table 12: Summary of incident control under different bush fire classes

Class	Description
Class 1	Managed by NPWS which may or may not involve incidental or low level assistance from other authorities
Class 2	A fire that involves more than one agency in accordance with District Bush fire Operations Plans
Class 3	Multi agency bush fire emergency Incident Controller appointed by the Commissioner of the Rural Fire Service under Section 44 RFA (1997)

Incident Control System (ICS)

All fire suppression operations within the Reserve are managed using a formal Incident Control System (ICS). Under the ICS, an incident management team (IMT) will be established to manage the control, operations, planning and logistics of the bush fire suppression operation. The IMT will prepare an incident action plan detailing suppression operations. The type of plan will be in accordance with the size and complexity of the incident and will include suppression objectives, strategies, tactics, tasks, an incident map, list of resources and organisational structure.

Steps in the Evaluation of Appropriate Strategies

The evaluation of alternative strategies is critical to manage a particular a fire situation. Table 13 below shows the steps taken.

Table 13: Steps in the evaluation of fire suppression strategies (adapted form Gellie 1990)

Step		Factors to consider
1	Assess fire Potential	<ul style="list-style-type: none"> - Fire weather (including temperature, humidity, wind speed/ direction, synoptic pattern, outlook, and local influences), - Undertake simulations of fire behaviour potential and establish likely perimeters (i.e.- rate of spread (ROS), flame height and intensity), and - Confirm fire behaviour with reconnaissance.
2	Determine the risk to assets	<ul style="list-style-type: none"> - Identify any assets at risk in the path of the fire by referring to GIS assets register and consulting locals, and - Determine the distance, arrival time, fire intensity and damage potential to assets.
3	Assess the suitability of control advantages	<p>Establish what fire control advantages can be linked to form a continuous containment of the fire including;</p> <ul style="list-style-type: none"> - permanent tracks and trails, - natural advantages, - the location of resource requirements required to construct temporary control advantages such as hand-tool lines, dozer lines, wet lines, or retardant lines, and - the proximity of water points both helicopter and vehicle accessible, helipads, radio towers, airbases, base camps and safe areas. <p>Assess the risks associated with each option including the safety of crews, the risk of damage to assets and the likelihood of escape.</p>
4	Assess Environmental Impact	Assess the environmental impact of control strategies on high risk natural and cultural heritage values.
5	Assess the cost effectiveness of strategies	<p>Evaluate the cost of initial attack against the consequences of a prolonged campaign if attack is delayed, including,</p> <ul style="list-style-type: none"> - The cost of resourcing for different tactics, and - The cost of rehabilitation of temporary advantages.
6	Selection of preferred strategy	<p>The selection of the preferred criteria will meet the following criteria</p> <ul style="list-style-type: none"> - The safety of all incident personnel - The effective protection of human life and community assets - The conservation of biodiversity - The conservation of cultural heritage - The cost effectiveness of strategies - The achievement of community support

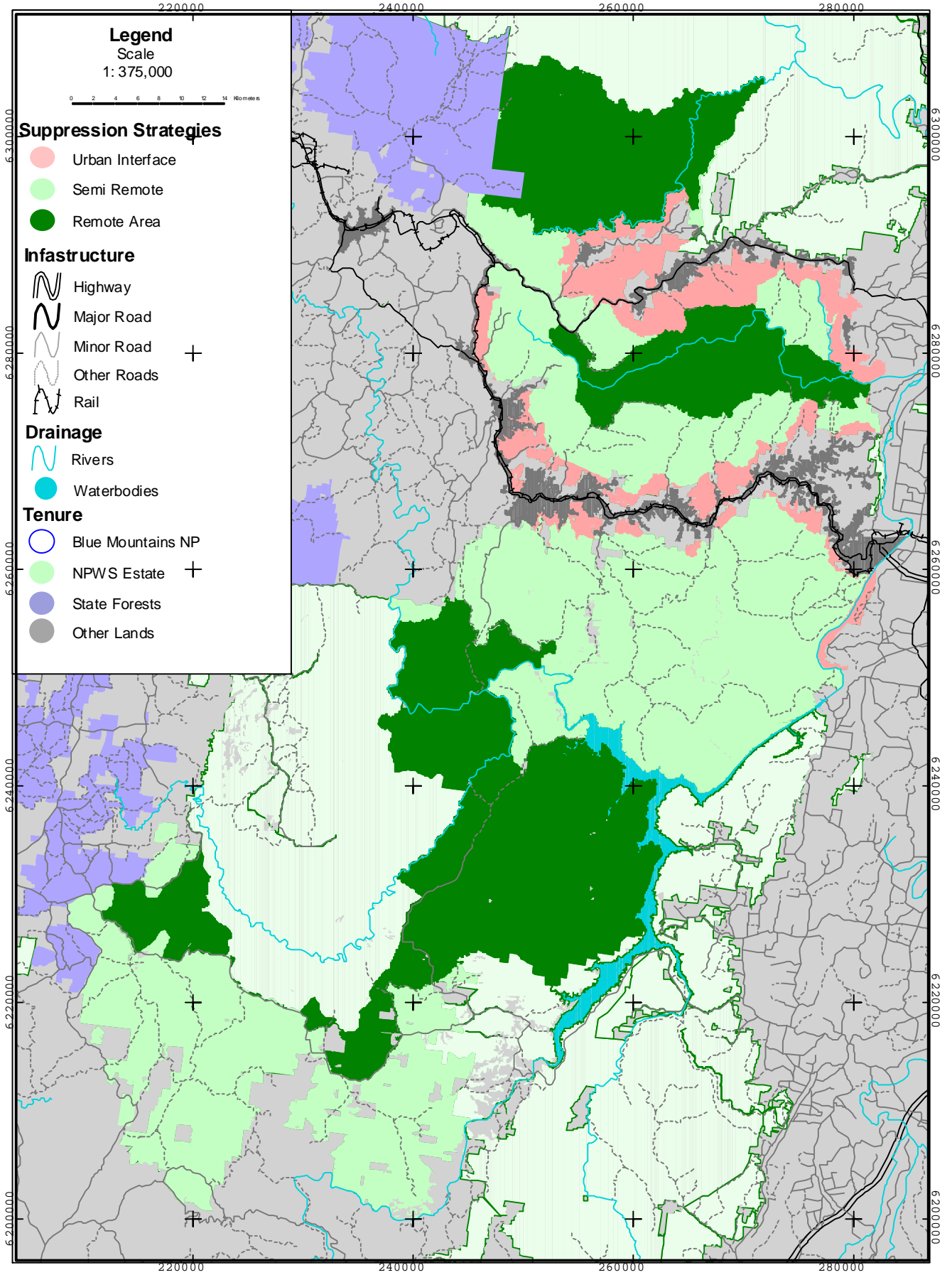
Major Suppression Strategies

NPWS in cooperation with other authorities may implement a wide range of strategies often in combination to suppress bush fires. These include reconnaissance, direct/ parallel or indirect attack, defensive, mop up and patrol. The appropriateness of the strategies depends highly on the remoteness of ignitions and their proximity to vehicle access. The strategies are detailed below while the general area of application is illustrated in Figure 7.

Table 14: Major strategies and tactics to suppress unplanned bush fires within the Reserve

Type of fire	Risk	Fire danger	Strategies	Tactics	Factors affecting the choice of tactics
Remote (Wilderness)	Fire escalation of remote area fires generally results in campaign fires and significant areas of the Reserve being burnt.	Very High to Extreme	<ul style="list-style-type: none"> - Aerial Reconnaissance - Direct Aerial attack and knockdown followed by helicopter insertion of Remote Area Fire Fighting Teams (RAFT). 	<ul style="list-style-type: none"> - Aircraft water bombing to reduce fire intensity with ground crew insertion when safe, - Backburning from existing roads/tracks 	<ul style="list-style-type: none"> - Level of remote access, steep terrain and proximity of fire to public assets - Travel time for aircraft and turn around times to water - Resource availability - Preservation of water quality - Communications - Cost
		Low to High	<ul style="list-style-type: none"> - As above and, - Monitor fire progress and conditions and suppress if public assets are likely to be threatened. 	<ul style="list-style-type: none"> - As above 	
Semi Remote (outer urban)	Fire escalation may have imminent impacts on life and property values	Very High to Extreme	<ul style="list-style-type: none"> - Aerial Reconnaissance - Direct Aerial attack - Direct attack with vehicle based ground crews, and indirect attack 	<ul style="list-style-type: none"> - Backburning from fire trails - Water retardant bombing with ground crew support - Aerial incendiary in appropriate conditions along natural containments such as creeks or to deepen backburns. 	<ul style="list-style-type: none"> - Vehicular access - Communications - Cost - Resource availability
		Low to High	<ul style="list-style-type: none"> - As above 	<ul style="list-style-type: none"> - Backburning from existing roads/tracks - Aerial incendiary in appropriate conditions along natural containments such as creeks or to deepen backburns. 	
Urban/ Residential interface	Fire has immediate impacts on life and property values	Very High to Extreme	<ul style="list-style-type: none"> - Defensive fire fighting behind or adjacent to properties, - Direct air attack 	<ul style="list-style-type: none"> - Backburning from control line - Direct attack by ground crews, - Water/ retardant bombing 	<ul style="list-style-type: none"> - Individual Property preparedness - Communications - Cost - Resource availability
		Low to High	<ul style="list-style-type: none"> - Direct attack with ground crews 	<ul style="list-style-type: none"> - Backburning from control lines - Direct attack by ground crews. 	

Figure 7: Wildfire Suppression Strategies



Summary of Operational Guidelines

The NPWS Fire Management Manual, 2003 details the comprehensive operational framework for managing fires on NPWS estate. This Manual must be consulted as part of operational planning for all fires. Table 15 provides a brief summary of important policies with respect to the Reserve.

Table 15: Summary of operational guidelines & policy

Fire Management Control lines and Tactics	
Handline construction	<ul style="list-style-type: none"> - Handline construction with hand tools, air blowers or slashers will be the preferred method of constructing control lines during bush fire suppression operations on NPWS estate, particularly within wilderness areas, water catchment areas and other Heritage Area Management Zones. - Where practical, handline construction will avoid threatened species locations, cultural heritage sites and areas prone to erosion. - As far as possible, handlines will be constructed in previously disturbed areas and will take advantage of existing fire control advantages.
Control line construction using earth moving machinery	<ul style="list-style-type: none"> - Approval must be gained from the NPWS Regional Manager or other senior officer before earthmoving equipment is deployed on NPWS lands or where formal arrangements have been made such as the Standard Operating Procedures for use of heavy plant for fire suppression operations with the Lithgow Bushfire District. - Earthmoving machinery will be used to construct control lines where it is not considered practical to use a handline and only when the probability of fire contained is high. - The threatened species and cultural heritage databases will be reviewed before implementation. - Earthmoving machinery will avoid declared wilderness areas, threatened species locations, cultural heritage sites, areas prone to erosion, heaths, swamps, or rainforests. Either a slashed line or a wet-line, using pumps and hoses, should be used to go through these areas - Construction work must be supervised by a NPWS officer or NPWS approved operator at all times - As far as possible, earthmoving machinery will be used in previously disturbed areas and will take advantage of existing fire control advantages. - Works must incorporate appropriate erosion control measures. - Constructed tracks will be evaluated for long term inclusion into the Reserve infrastructure or appropriately rehabilitated immediately after the fire.
Back burning	<ul style="list-style-type: none"> - NPWS will use backburning as a bush fire suppression strategy where required.. - Backburns may either be lit from the ground or from the air. - All backburning operations on NPWS lands should be supervised by NPWS personnel with the appropriate experience, qualifications, skills and local knowledge. - The area burnt must be the minimum necessary to achieve wildfire suppression objectives. - Back burning will be conducted in such a way that the danger of the fire escaping pre-determined boundaries is minimised, and the safety of firefighters is not compromised. - The length of back-burns must be minimised to avoid burning large areas at one time. This will help to ensure minimal disruption to fauna populations within the proposed area of the fire. - Backburning operations must take into consideration threatened species and cultural heritage management guidelines.
Fire fighting chemicals	<ul style="list-style-type: none"> - NPWS will use Retardant or Foam to slow fire progress or otherwise support control line implementation where it is practical. - Retardant and Foam will be considered impractical for stopping high intensity wild fires in thick canopy and where there is a high probability of spot fires. - As far as possible, NPWS will avoid the use of fire suppression chemicals in areas close to water storage's, in and surrounding wetlands, waterways and sensitive areas (eg. 30m of creek lines)and locations of threatened species, populations, vegetation communities growing on low nutrient soils will be avoided.

Fire Management Control lines and Tactics		
	<ul style="list-style-type: none"> - Foam/ Retardants must not be used if water is being sourced from scheduled catchments and private water supplies (ie. contamination of dams). - Locations of chemical treatments must be mapped during incident operations. 	
Aerial operations	<ul style="list-style-type: none"> - NPWS will use aircraft for aerial water bombing, laying suppression chemicals, deploying remote area fire fighting crews, reconnaissance and fire mapping, particularly in areas remote from vehicular access. - Water bombing will be avoided directly over cultural heritage sites. - Aerial ignition will be used to deepen backburning operations or to facilitate appropriate fire behaviour near proposed natural containments such as creeks. This will generally be carried out in late afternoon as dew point and humidity increase, and wind speed and temp decrease. 	
Power lines	<ul style="list-style-type: none"> - Where alternatives exist, NPWS will avoid using power line easements as control lines during suppression operations. - NPWS will ensure that Standard Operating Procedures (SOP) for fire management operations under powerlines are followed. 	
Remote area operations	<ul style="list-style-type: none"> - Where practical, aircraft will be used for transport and support into remote areas, in preference to new fire trail construction - RAFT insertion to remote area operations must be reviewed when extreme fire weather or storm conditions are predicted. 	
High Risk Areas to Natural Heritage		
Threatened Species	<ul style="list-style-type: none"> - All affected species must be identified through database searches, located and the affect of operations assessed prior to planning activities. - All fire fighting personnel involved in control line construction must be briefed on the species, its location, and methods to minimise impact. - Where possible, manage operations within appropriate fire free interval thresholds for the species. - Where possible, identified hollow and habitat trees will be retained. - The species must be considered in post fire rehabilitation planning to ensure sufficient food and resources are available and, colonisation of exotics and predation is minimised. 	
Vegetation communities sensitive to high frequency fire	<ul style="list-style-type: none"> - Where possible, fire suppression operations will be managed to minimise any negative affect on these ecologies. This includes rainforests, riparian communities, refuges for animals during bush fires, and areas with complex rocky topography. - Fire suppression and containment operations must specifically minimise attrition of the rainforest edges. 	
Natural heritage & vegetation communities affected by low fire frequency	<ul style="list-style-type: none"> - Where possible, fire suppression operations will be managed to minimise any negative affect on these ecologies and maintain a mosaic of affected and unaffected communities. - Where possible, manage operations within appropriate fire free interval thresholds for the age class distribution within communities. 	
Scheduled Water Catchment Areas	<ul style="list-style-type: none"> - Fire suppression operations will be planned to minimise high intensity fire within 500m of water storages and major drainage lines. Operations may include aerial incendiary under milder conditions to reduce the intensity of a major fire front. 	
World heritage & Wilderness values	<ul style="list-style-type: none"> - These values will be protected by employing minimal impact suppression techniques. - Constructed tracks will be evaluated for long term inclusion into the Reserve infrastructure or appropriately rehabilitated immediately after the fire. 	
Scenic areas and tourism	<ul style="list-style-type: none"> - Operations will aim to minimise the potential for high intensity fire in scenic landscapes. - Operations will be managed to minimise the affect on the local tourism industry. 	
High Risk Areas to Cultural Heritage Values		
Aboriginal sites	<ul style="list-style-type: none"> - The Aboriginal sites register should be consulted during fire suppression operations - NPWS will employ minimal impact suppression techniques and prepare site specific protection measures around known places before fire management activities and works. 	
	Site type	Guideline
	Scarred and Carved Trees	- As far as possible protect sites from fire.

Fire Management Control lines and Tactics		
	Stone arrangements, ceremonial rings, rock engravings, rock art, grinding grooves	<ul style="list-style-type: none"> - As far as possible protect sites from fire. - Avoid all ground disturbances including the use of earthmoving machinery, handline construction and driving over sites. - Avoid water bombing which may cause ground disturbance.
	Burials, artefact scatters, middens	<ul style="list-style-type: none"> - Avoid all ground disturbances including the use of earthmoving machinery, handline construction and driving over sites. - Avoid water bombing which may cause ground disturbance. - Site may be burnt by bush fire
	Other	<ul style="list-style-type: none"> - In the event of an unknown site being found during operations, action should be take to avoid damage, and report to appropriate officers.
Culturally important areas	These areas will be protected by using various suppression techniques including the removal of fine fuel, and thoroughly briefing plant operators on the site locations and sensitivity.	

Equipment

Appropriate equipment is required to effectively suppress fires in the Reserve. NPWS fire management equipment is a resource shared across New South Wales depending on the location of major fire campaigns. The plant and equipment presently available for quick response from the Blue Mountains Region has been summarised in Table 16. This list is updated and included in the annual Regional Incident Procedures document.

Table 16: Summary of fire management equipment

Utility/ equipment	Location
Vehicles	<ul style="list-style-type: none"> - 4000 Hino Tanker - 10000 litre mobile bulk water tank - 9 Slip-on units - 7 Command vehicles - 4WD motor cycles
Aviation equipment	<p>NPWS will use a variety of aircraft to access areas remote from vehicular access for aerial water bombing, laying suppression chemicals, deploying remote area fire fighting crews, reconnaissance and fire mapping where considered appropriate during suppression operations. Other aviation equipment include;</p> <ul style="list-style-type: none"> - Aviation radio - Remote area fire fighting equipment including pumps, hoses, buoy walls and bladders. - ARMS software
Communications	<p>Radio networks including;</p> <ul style="list-style-type: none"> - VHF Radio system with relay boxes and a mast trailer - Mobile radios in all NPWS vehicles - 9 GRN radios in various command vehicles - 45 Midland hand held radios <p>Telephone</p> <ul style="list-style-type: none"> - Including: Mobile and satellite phones <p>Computer network</p> <ul style="list-style-type: none"> - All NPWS offices are connected to a wide area network (WAN)
Heavy plant equipment	<ul style="list-style-type: none"> - D4 size and Caterpilla traxcavator bulldozers with float capability - 2 graders - Boggie tipper - 1.5 tonne tipper with hiab crane - Skid steer loader with backhoe attachment - 4WD tractors/slathers
Weather Systems	<ul style="list-style-type: none"> - Innovative Research Remote Weather Stations - Manual Weather Stations - Internet Weather Details - MetFax
Other Fire Equipment	<ul style="list-style-type: none"> - Incendiary shot gun, and injection equipment and ancillary equipment - Catering unit

Resources

The Blue Mountains Region has approximately 70 trained staff in fire fighting or fire incident management. Strategies to ensure adequate resourcing for bush fire suppression operations include;

- Leave management: The Region will maintain a level of resourcing that is appropriate to the level of bush fire risk by managing recreation leave.
- Out of area support: When local resources are exhausted, the Region will seek out of area support to carry out firefighting operations and associated logistics, planning and administrative functions.
- Seasonal fire fighting crews: In cooperation with the Sydney Catchment Authority the Region will maintain a rapid response fire fighting team to protect the Sydney and Blue Mountains drinking water catchments.
- Remote area fire fighting teams: The Region will maintain a rapid response remote area capability to suppress fires quickly and prevent escalation.

4.4.3 Rehabilitation

The rehabilitation of helipads, tracks and hand tool lines is an integral part of fire operations. Actions undertaken as part of the fire suppression operation may have significant long- term impacts on the values of the Reserve. Table 17 details the major rehabilitation strategies for likely impacts caused as part of a suppression operation. Urgent works must be undertaken as part of the operation de-escalation. Longer term works require a detailed rehabilitation plan to be prepared.

Table 17: Rehabilitation strategies for fire suppression impacts

Cause	Impacts	Rehabilitation strategies
Trails	- Bulldust present, poorly drained and no erosion controls,	- Review future strategic value. Install drainage and erosion controls. If not strategic, close access with debris and top soil. Allow to regenerate.
Retardant/ Foam	- Unknown impacts	- Map sites where foam or retardant was used. - Monitor vegetation impact and recovery.
Remote Helipads	- Area cleared, equipment and consumables remaining (i.e. fuel), rubbish on site	- Close and rehabilitate, and clean up.
Staging areas and refuge areas	- Area cleared, equipment and consumables remaining (i.e. fuel), rubbish on site	- Close and rehabilitate, and clean up
Cleared vegetation	- Threatened species, populations communities, weeds and pest invasion, soil erosion	- Survey vegetation, - Implement pest control programs - Implement revegetation programs - Monitor recovery
Injured wildlife	- Decline in threatened fauna populations	- Organise rescue crews to enter fire ground - Liaise with NSW Agriculture for large scale rescue of injured wildlife
Cultural sites	- Sites damaged by operations	- Survey and document impacts, - Contact sites officer and Land Councils
Damage to neighbouring properties	- Structures destroyed, water supply depleted, roads damaged.	- Survey and document damages - Organise meetings with neighbours - Activate sub-units of DISPLAN

4.4.4 Public and Media Relations

NPWS will seek community support when determining objectives, strategies and actions for suppression operations. Strategies to foster positive public and media relations for major incidents include;

- The preparation of a specific media and public relations communications plan,
- The appointment of a media officer to coordinate public and media relations activities including liaison with relevant tourism authorities as well as traditional media, and
- Development of media protocols between agencies to ensure coordinated and accurate reporting.

4.5 Strategies to Minimise the Potential for the Spread of Bush Fires

Within the Reserve, a range of permanent, natural and temporary fire control advantages exist to minimise the potential for the spread of bush fires from or into the Reserve. Fire control advantages have been mapped at 1:25,000 on topographic maps and are maintained in the NPWS geographic information system (Macdonald Wagner 1987; Gellie, Manson and Tolhurst, 1992; Bush fire and Environmental Services 2002 a and b; NPWS, unpublished; RFS, unpublished). A large scale map is presented in Figure 8. The following sections define the different advantages, their characteristics and considerations.

4.5.1 Permanent Advantages

Table 18 summarises the permanent control advantages within the Reserve. NPWS works cooperatively with DBFMC's to ensure that an effective permanent fire control advantage infrastructure is in place to minimise the potential for the spread of fires from or into the Reserve. In general, the density of permanent advantages and priorities for maintenance are highest in Asset Protection and Strategic Zones and lowest in Heritage Management Zones. Permanent control lines will generally be linked with natural or temporary control advantages to provide complete containment of a fire.

Table 18: Summary of permanent fire control advantages

Control advantage	Characteristics & Considerations
Fire Management Tracks and Trails	<ul style="list-style-type: none"> - Appendix 1 lists the permanent fire management trails within the Reserve that will be maintained to enable containment of a moderate intensity fire. These have been taken from DBFMCs Fire Trail Registers which are subject to review currently. - Walking tracks may be used as control lines for containing a low intensity fire. - Prior to operations commencing, crew safety and probability of success must be assessed against track characteristics such as width, overhanging limbs, passing bays, bridges, turn-around areas and the remote nature of walking tracks.
Interface Control line (ICL)	<ul style="list-style-type: none"> - Where practical, ICL's will be maintained adjacent to assets to prevent the spread of fire into residential areas and enable effective property protection. - ICL's will utilise a combination of features including, fire trails, cleared areas, other previously disturbed areas or rock outcrops.
Power-line easements	<ul style="list-style-type: none"> - Power-line easements and associated cleared areas traverse through the Reserve over major ridges and can be used as permanent advantages where no alternatives exist - Easements will be linked into natural advantages such as creek lines, rock outcrop or rainforest vegetation by hand tool lines, wet lines, or retardant lines. - Crew safety must be assessed in dense smoke due to the possibility of arcing.
Other cleared areas	<ul style="list-style-type: none"> - Other cleared areas that act as advantages include sporting ovals, quarries, or fields that will impede the progress of a fire.

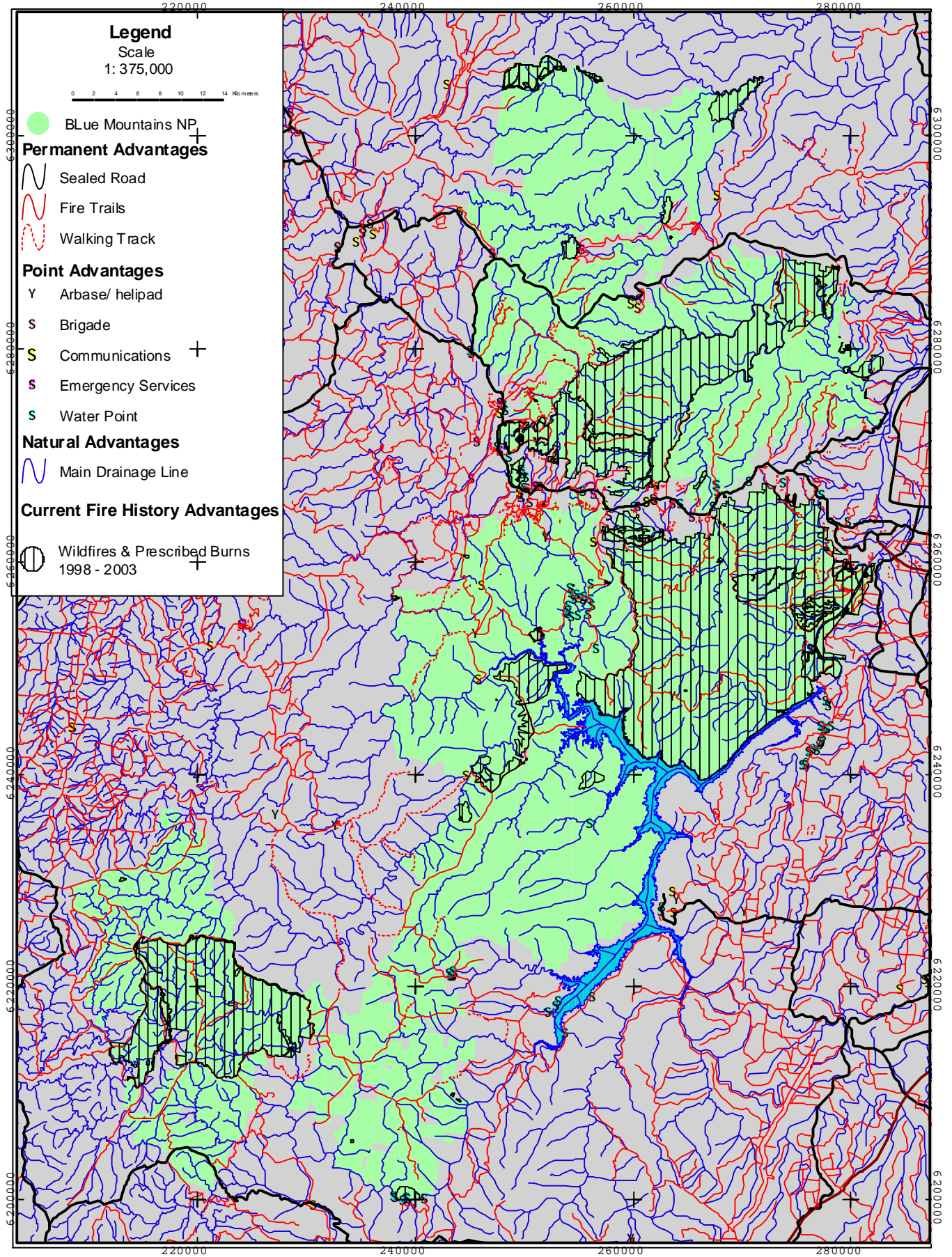
4.5.2 Natural Advantages

In general, natural fire advantages are associated with contiguous areas of low bush fire behaviour potential. These result from either low fuel loads or high moisture levels that will largely contain a moderate intensity fire with minimal effort under appropriate conditions. A description of such advantages and their limitations are outlined in Table 19 below:

Table 19: Summary of natural fire control advantages

Control advantages	Characteristics & Considerations
Drainage lines and rivers	<ul style="list-style-type: none"> - The effectiveness of drainage lines depends upon whether it is saturated or has a bed of sand or stones that will impede fire crossing rather than vegetation litter. - Drainage lines are unlikely to contain high intensity fires under severe conditions due to the likelihood of ridge top spotting. - Drainage lines are most effectively used with aerial incendiary operations in milder conditions
Water bodies	<ul style="list-style-type: none"> - A number of permanent water bodies can be found within the Reserve including Lake Burragorang, Woodfood Dam, and Cascades and Greaves Creek storages. Water bodies are generally associated with drinking water catchments where operations are restricted. - Major water bodies may be used as control lines when the spotting distance is less than the width of the water body. -
Cliff lines & escarpments	<ul style="list-style-type: none"> - Within the Reserve there are extensive cliffs and escarpments that sometimes provide natural barriers to the spread of bush fires under moderate conditions. - Cliffs often have vegetated ledges that reduce their effectiveness for bush fire containment. - The dangerous nature of cliffs makes them difficult to mop up and patrol.
Moist vegetation & rainforests	<ul style="list-style-type: none"> - Vegetation maps have been used to identify rainforests and moist gully forest communities. - The effectiveness of vegetation communities depends greatly on their ground fuel moisture. - Fire suppression should aim to minimise the effect on the vegetation by planning backburns or aerial ignitions to impact at night when fuel moisture levels are highest.
Rocky outcrops	<ul style="list-style-type: none"> - Within the Reserve there are extensive areas of surface rock that can be used to link other temporary control lines such as hand tool lines, wet lines or dozer lines. - Out-crops are generally located along ridge tops and escarpments.
Recent fire history	<ul style="list-style-type: none"> - Recently burnt areas can be used for containment. Their effectiveness is limited by their depth, the level of fuel reduction, the vegetation type, the recovery time for fuel loads, and the spotting distance of approaching fire. - In the Blue Mountains, most forest fuel levels will completely recover in 5-15 years. Under severe fire weather conditions, there is a short period of 1 – 3 years when fuel levels are low enough to provide an advantage (Cherny 1994; and James 1999).

Figure 8: Fire Control Advantages



4.5.3 Point Advantages

Point advantages include water availability points (both helicopter and vehicle accessible), fire detection viewing points, helipads, radio towers, airbases, control centres, staging areas and safe areas. Generally the density of point advantages is highest in Asset Protection and Strategic Zones and lowest in Heritage Management Zones. Table 20 describes the different types of control advantages within the Reserve.

Table 20: Summary of other point advantages

Control advantages	Characteristics & Considerations
Fire detection lookouts	<ul style="list-style-type: none"> - These include the primary viewing vantages of Narrowneck, Sunny Corner, Mt Bindo and Shooters Hill fire towers, Mt Tomah, and Wentworth Falls and Woodford Water storage tanks. - Detection can also be gained from the majority of public viewing lookouts within and overlooking the Reserve
Vehicle Water Points	<ul style="list-style-type: none"> - Vehicle based fire fighting can draw water from a number of natural features such as rivers and creeks and from numerous hydrants or dams within urban and semi urban areas.
Helicopter water points	<ul style="list-style-type: none"> - Helicopters can also source water from natural features such as rivers and water bodies when retardant or foam is not being used or constructed features such as dams or temporary bouy walls. - Helicopter water access points are seldom in remote areas and may require prolonged turn around times.
Airbases and Helipads	<ul style="list-style-type: none"> - NPWS manages specific helipads at the Blackheath & Glenbrook NPWS Depot. There are also numerous sports ovals, grasslands and air-strips that are suitable for temporary operations. - Remote helipad locations include natural openings such as rock outcrops supplemented with minor tree removal or already cleared camping areas.
Radio Towers	<ul style="list-style-type: none"> - Radio towers provide coverage over the Reserve and are situated at Narrowneck, Shooters Hill, and Mt Tomah.

4.5.4 Temporary Advantages

Temporary control advantages may be constructed where permanent advantages or natural advantages are not considered suitable for containment of a fire or prescribed burn. Table 21 summarises the temporary fire control advantages that may be implemented.

Table 21: Summary of temporary fire control advantages

Control advantages	Characteristics & Considerations
Dozer lines	<ul style="list-style-type: none"> - Temporary dozer lines can be created within the Reserve after appropriate consideration of the impacts on heritage values. Please see Table 17: Summary of operational guidelines for more information.
Hand-tool lines	<ul style="list-style-type: none"> - Temporary hand tool lines can be constructed with rake hoes, air blowers or slashers. This is the preferred method of constructing control lines particularly within wilderness areas, water catchment areas, environmentally sensitive areas and Heritage Area Management Zones. - Where practical, hand tool lines will avoid threatened species locations, cultural heritage sites and areas prone to erosion. Please see Table 16: Summary of operational guidelines for more information.
Wet lines	<ul style="list-style-type: none"> - Wet-lines can be used as temporary advantages and are the preferred method of control lines through threatened species locations, cultural heritage sites and areas prone to erosion in mild fire weather conditions.
Retardant lines	<ul style="list-style-type: none"> - Retardant and foam can be used to construct temporary advantages where it avoids water storage's, wetlands, waterways (eg. 30m of creek lines), locations of threatened species, and specifically identified vegetation communities that may be adversely affected by

Control advantages	Characteristics & Considerations
	nutrient changes. - Retardant lines are most effective where there is no canopy (i.e. heath or grasslands) or where there is no likelihood of fire spotting. - Foam/ retardants must not be used if water is being sourced from scheduled Sydney, Blue Mountains or private water supply catchments where there is risk of contamination of storages.

4.6 Strategies to Protect Life and Property

Due to its urban proximity, the Reserve poses a significant risk of damage to life and property from bush fires. The protection of life and property is dependent on a wide range of strategies and cooperation between agencies, local government, the community and neighbours. The NPWS Fire Management Manual, 2003 details the comprehensive NPWS policies to protect life & property from fires on NPWS estate.

4.6.1 Strategies to Protect Life

Protection of Firefighters

Major strategies to protect fire fighters include:

- Undertaking a thorough evaluation of the possible risks to fire fighters and support personnel before deploying crews onto the fire ground;
- Ensuring all personnel are provided with fire fighting equipment that complies with Service standards, and Australian and international Occupational Health and Safety Standards;
- Annual review of staff competency levels and facilitating additional training where necessary,
- Considering the presence of safety advisers on the fire ground for large incidents;
- Preparation of a medical evacuation plan detailing first aid procedures, evacuation procedures, hospital and ambulance locations within the Incident Action Plan;
- Ensuring fire fighters are assigned to duties that are within their physical capabilities;
- Providing critical incident stress support services including counsellors and peer support, and;
- Ensuring other persons (including wildlife carers, non-firefighting volunteers, and the media) have gained the permission of the incident controller, are accompanied by a fire trained officer, and have the minimum basic personal protective equipment prior to entering the fire ground.

Protection of Neighbours

Major strategies to protect neighbours include;

- Developing databases of contact details and asset locations to ensure timely contact and warning,
- Cooperating with neighbours, other fire fighting agencies and land managers in fire suppression and assisting DBFMCs in community fire prevention planning ,
- Assisting evacuation planning for in-holdings in remote areas,
- Providing community education and awareness material for displays, media, signs, posters, school resource kits and newsletters,
- Providing face to face contact at visitor information centres and make publications available to the public, and
- Advising neighbours and visitors of the actions required during fire bans, reserve closures and other fire management operations through appropriate community education, signage, media and liaison with tour operators.

Protection of Visitors

Major strategies to protect visitors include;

- Closure of all or part of the Reserve during total fire bans, periods of forecast very high to extreme fire danger, or during bush fire management or suppression operations,
- Instigating reserve fire bans over part or all of the Reserve during prolonged periods of dry conditions,
- Liaising and information dissemination with tour operators and tourism authorities regarding, park closures, access closures, total fire bans, reserve fire bans and DISPLAN evacuation procedures,
- Providing interpretation signage at major camping and picnic areas advising visitors of the actions they should undertake in the event of bush fire, and
- Cooperatively assisting in DISPLAN procedures for the evacuation of visitors from the Reserve in conjunction with other emergency services.

4.6.2 Strategies to Protect Property

The Reserve largely surrounds the population centres from Lithgow to Penrith. Within and close to the Reserve, there are a number of residential subdivisions in high risk bush fire areas. Without adequate protection, there is a significant probability of damage to assets from bush fires. NPWS will coordinate fuel management operations with neighbours and the RFS and facilitate preparation for bush fire events through respective District Bush Fire Management Committees. In recognition of its responsibilities for property and asset protection, NPWS will manage the Reserve area according to appropriately classified controls. These are:

Interface Control Line (ICL)

An interface control line (ICL) is a fire control line at the rear of properties that will often form part of the APZ. An ICL may consist of range of features including, fire trails, cleared areas, other previously disturbed areas or rock outcrops that can be linked together. It is the final line where fire fighters can either directly attack or back burn from to protect assets. NPWS will coordinate with RFS regarding the identification and maintenance of ICLs where they occur on the Reserve. A large proportion of ICL's occur on private property or land other than National Park. Land holders and other authorities must also contribute to the implementation of the strategy for it to be effective.

Asset Protection Zones (APZ's)

The establishment of specific APZs is the single most successful strategy for the protection of buildings against bush fires. The required width and fuel loading for new APZs is detailed in '*Planning for Bush Fire Protection*' (RFS 2001). The construction and maintenance of Asset Protection Zones (APZ) is more usually the responsibility of land owner or authority since it is most effective when it is maintained adjacent to the asset. Also as part of the APZ, a fuel reduced zone will be maintained between the interface control line and an outer management line. NPWS will intensively manage fuels where APZs fall within the Reserve in cooperation with neighbours. Fuel reduction procedures include prescribed burning, slashing, selective shrub removal, vegetation replacement, watering and irrigation, and herbicide treatments.

Building Standards and Development Control

Buildings need to be protected against burning debris by applying appropriate components of Australian standards AS 3959 (Standards Australia 1999). This includes building materials, building design, and sprinkler systems. NPWS will ensure new developments in the Reserve incorporate appropriate APZs as outlined in *Planning for Bush Fire Protection* (RFS 2001) and building standards specified in the Australian Standards AS 3959 (Standards Australia, 1999). NPWS will also encourage local government to implement and monitor these standards with neighbours.

Auxiliary Management Lines

Auxiliary management lines include roads, fire trails, walking tracks or temporary hand tool lines which link the interface control lines and the outer management lines. These are generally located along major ridge lines and are useful in bounding prescribed burning blocks and as a hard edge for back burning

Outer Management Line

Outer management lines include various fire trails, roads, walking tracks, power line easements and temporary hand tool lines and dozer lines. They delineate the outer limit of some fire management zones. The outer management lines may be used to control flank or backing fires, or as a platform for implementing backburns under moderating conditions. Outer management lines include the Northern (black-line) and Southern Strategic Lines (Bush fire & Environmental Services Pty Ltd, Bush Fire Protection Strategy for the Southern Perimeter of Townships within the City of Blue Mountains, 2001). These two outer management lines have been researched and planned in order to minimise preparation prior to a fire event. While NPWS will not necessarily prepare the lines each year, NPWS will coordinate preparation operations with the DBFMCs.

4.6.3 Protection of Smoke Sensitive Areas

Strategies to minimise the impact of smoke generated from prescribed burns and wild fires within the Reserve include;

- Implementing the NPWS Smoke Management Guidelines (Conroy 1996) and Environmental Protection Authority (EPA) guidelines for managing the impacts of smoke on the air quality in the Sydney basin,
- Advising neighbours of potential smoke impacts from prescribed burning operations,
- Coordinating with Police regarding visibility and closing roads, and
- Installing smoke signs to give motorists warning of potential hazards
- Provide media with information on remote operations where smoke could cause concern for visitors and community.

4.7 Strategies for Natural Heritage Conservation

Within the Reserve there are significant natural heritage values that could be damaged by inappropriate fire regimes and fire management activities.

For planned hazard reduction works, the NPWS will comply with the Bush Fire Environmental Assessment Code for Asset Protection and Strategic Fire Advantage Zones (RFS 2003). For other zones NPWS will prepare a Review of Environmental Factors that considers the full range of heritage values.

4.7.1 Biodiversity Fire Regime Thresholds

Table 22 details the biodiversity fire regime thresholds for vegetation communities within the Reserve. Figure 9 illustrates the regime thresholds across the Reserve. The threshold is a range of appropriate fire frequency intervals, intensities and seasons to sustain the ecology of each vegetation community. Where fire regimes are outside the threshold, significant declines in species populations can be expected, particularly if the fire regime prevails over greater than 50% of the community area. An annual evaluation of fire regimes and biodiversity thresholds will identify high risks to biodiversity.

Communities affected by high fire frequency

In communities that are either sensitive to or are already affected by *high* frequency fire, a range of strategies will be implemented to facilitate recovery, including:

- Prescribed burning to develop a mosaic of fire ages and minimise the risk of successive severe fires ;

- preparation of a specific Threat Abatement Plan or implement the provisions of any relevant Threat Abatement Plan;
- Immediate response and rapid suppression of wild fires, and;
- Alternative fuel management in APZs.

Communities affected by low fire frequency

In areas where past fire frequency has been less than the specified fire regime threshold (Table 22) strategies will be implemented including:

- The instigation of appropriate fire into the vegetation communities to maintain ecological processes and an appropriate age distribution, and;
- Where an ecological burn cannot be introduced at the threshold intensity safely, then waiting for one to occur naturally.

4.7.2 Greater Blue Mountains World Heritage Values

Strategies to protect the greater Blue Mountains World Heritage Area (WHA) values include;

- Consulting with Environment Australia regarding significant impact fire management proposals or policies;
- Employing minimal impact suppression techniques where possible, and;
- Maintaining fire regimes within the biodiversity fire regime thresholds (Table 22) and threatened species guidelines (Table 23 to Table 28)

4.7.3 Wilderness Area Values

Major strategies to protect Wilderness values include;

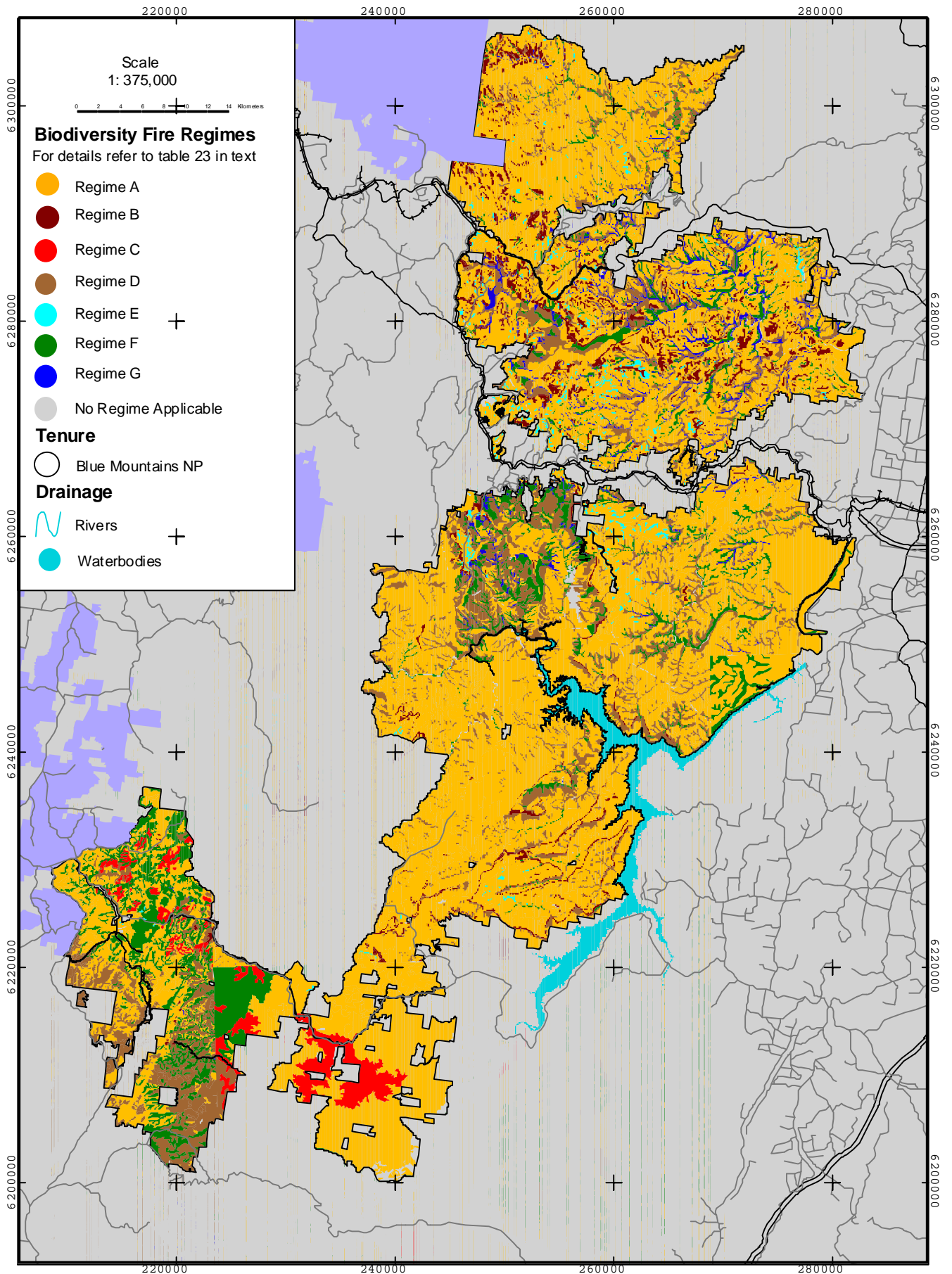
- All fire management activities within declared Wilderness Areas will be carried out with minimal environmental impact and major disturbance, where possible;
- Helipads, temporary trails and control lines will be rehabilitated;
- Prescribed fire will be utilised within Wilderness Areas where essential for hazard reduction, wildfire suppression or to maintain specific heritage values ;
- Fire trail networks will be reviewed systematically to ensure adequate access for fire fighting and property protection while maintaining the integrity of the Wilderness Areas. These reviews will be done in consultation with Bush Fire District Management Committees.
- Maintaining fire regimes within the biodiversity fire regime thresholds (Table 22) and threatened species guidelines (Table 23 to Table 28).

Table 22: Biodiversity fire regime thresholds for broad vegetation types

For detailed guidelines for specific communities see Gellie (1990)

Regime	Broad Vegetation	A decline in biodiversity is predicted if...	Additional Guidelines
A	Low Woodland/ Shrubland	<ul style="list-style-type: none"> - 3 or more consecutive fires with each inter -fire interval < 7yrs apart - no fires for > 30yrs - 3 or more consecutive fires of low intensity (i.e. needs some medium high intensity burns) . 	<ul style="list-style-type: none"> - Includes a diverse range of communities - Requires high to very high intensity fires - Up to 12 year fire intervals at high altitudes
B	Heathland	<ul style="list-style-type: none"> - 3 or more consecutive fires with each inter -fire interval < 7yrs apart; - 3 or more consecutive fires with each of the fires > 15yrs apart; - no fire for > 30yrs; - 3 or more consecutive fires of low intensity (i.e. needs some medium high intensity burns). 	<ul style="list-style-type: none"> - Requires high to very high intensity fires
C	Exposed Woodland	<ul style="list-style-type: none"> - 3 or more consecutive fires with each inter -fire interval < 7 yrs apart - 3 or more consecutive fires with each inter -fire interval >15yrs apart - no fire for > 30yrs - Avoid 3 or more consecutive fires of low intensity (i.e. needs some medium high intensity burns) . 	<ul style="list-style-type: none"> - Requires moderate - very high intensity fires
D	Dry Sheltered Forest	<ul style="list-style-type: none"> - 3 or more consecutive fires, with each inter -fire interval < 7yrs apart; - No fire for > 30 years - Avoid 3 or more consecutive fires of low intensity (i.e. needs some medium high intensity burns) . 	<ul style="list-style-type: none"> - Requires moderate - very high intensity fires
E	Swampland	<ul style="list-style-type: none"> - 3 or more consecutive fires with each inter -fire interval < 7 yrs apart; - 3 or more consecutive fires with each inter -fire interval > 15 - No fire for > 30 yrs - Avoid 3 or more consecutive fires of low intensity (i.e. needs some medium high intensity burns) . 	<ul style="list-style-type: none"> - Requires moderate - high intensity fires - Avoid frequently burning hanging swamp communities
F	Moist Sheltered Forest	<ul style="list-style-type: none"> - 3 or more consecutive fires with inter – fires intervals of < 20yrs; - Two or more canopy consuming fires within 100 yrs - no high intensity fire within 200 yrs 	<ul style="list-style-type: none"> - Includes riparian vegetation - Requires moderate - high intensity - Some drier part of these communities may tolerate lower fire intervals
G	Rainforest	<ul style="list-style-type: none"> - Any fire occurrence (a limited recovery ability exists). 	
F	Cleared disturbed	<ul style="list-style-type: none"> - No Fire regime applicable 	<ul style="list-style-type: none"> - Includes urban areas, agriculture, and cleared or disturbed sites that may contain pockets of undisturbed bushland

Figure 9: Biodiversity Fire Regime Thresholds



4.7.4 Threatened Species, Populations and Community Guidelines

The biodiversity fire regime thresholds specified for vegetation communities within the Reserve (Table 22) or the Bush Fire Environmental Assessment Code (RFS, 2003) may not take account of the specific requirements of threatened species. The NPWS will comply with this Code for Asset Protection and Strategic Fire Advantage Zones. In other areas, the following tables state the specific fire management guidelines and recommended Inter-fire Intervals (IFI) for threatened species populations and ecological communities identified within the Reserve. Accurate information is not known for all species. The precautionary approach will generally be applied in the absence of specific information. This may include maintaining the broader communities existing fire regime.

Flora Species Guidelines

Table 23: Endangered Plant Species (EP) Fire Management Guidelines

Map ID	Species	Fire Management Guidelines
EP1	<i>Acacia bynoeana</i>	Sensitive to high fire frequency; Identify fire regime requirements
EP2	<i>Acacia gordonii</i>	Requires high intensity fire; tag plants for fire response monitoring;
EP3	<i>Allocasuarina glareicola</i>	Min. IFI : >4yrs establish seed bank; Max IFI: 20 – 30
EP4	<i>Carex klaphakei</i>	Identify fire regime requirements;
EP5	<i>Cynanchum elegans</i>	Sensitive to high fire frequency; Identify fire regime requirements
EP6	<i>Diuris pendunculata</i>	Identify fire regime requirements
EP7	<i>Epacris hamiltonii</i>	Sensitive to high fire frequency; Min. IFI 15-20 to establish adequate soil seed stocks; Intense fire will destroy seed bank and root stock.
EP8	<i>Grevillea kedumbensis</i>	Identify fire regime requirement
EP9	<i>Grevillea obtusiflora subsp. obtusiflora</i>	Min. IFI 10-15; Max IFI: 20 - 30
EP10	<i>Hakea dohertyi</i>	Low intensity (<300°C) fast fire (<3min) to ensure seed survival; Min. IFI: >8yrs to establish seed bank; Max IFI: 20 – 30yrs;
EP11	<i>Haloragodendron lucasii</i>	Sensitive to high fire frequency; Identify fire regime requirements
EP12	<i>Lastreopsis hispida</i>	Exclude fire from vegetation type
EP13	<i>Leionema lachnaeoides</i>	Identify fire regime requirements. (Exclude fire in meantime. No regeneration after 2002/3 fires)
EP14	<i>Microstrobos fitzgeraldii</i>	Sensitive to high fire frequency; Generally exclude fire from waterfall habitat
EP15	<i>Persoonia hindii</i>	Identify fire regime requirements
EP16	<i>Persoonia hirsta subsp. evoluta</i>	Identify fire regime requirement
EP17	<i>Persoonia nutans</i>	Fire intensity frequency
EP18	<i>Pimelea spicata</i>	Sensitive to high fire frequency; 3 yrs to develop tap root, low intensity fire (<90°C) for seed survival;
EP19	<i>Pomaderris cotoneaster</i>	Min IFI unknown; Max IFI 20 yrs
EP20	<i>Pterostylis saxicola</i>	Identify fire regime requirements
EP21	<i>Pultenaea parviflora</i>	Min IFI 5yrs; Max IFI unknown
EP22	<i>Trachymene saniculifolia</i>	Identify fire regime requirements;
EP23	<i>Zieria covenyi</i>	Avoid frequent high intensity burns;

Map ID	Species	Fire Management Guidelines
EP24	<i>Xiphocalada var pedicellata</i>	Identify fire regime requirements

Table 24: Vulnerable Plant Species (VP) fire management Guidelines

Map ID	Species	Fire management guidelines
VP1	<i>Acacia blakei</i>	Identify fire regime requirements;
VP2	<i>Acacia baueri ssp aspera</i>	Identify fire regime requirements;
VP3	<i>Acacia clunies-rossiae</i>	Identify fire regime requirements;
VP4	<i>Acacia flocktoniae</i>	Identify fire regime requirements;
VP5	<i>Acacia pubescens</i>	Recommend limited fires in area until seed viability known; Intervals of 20-25y, mod-high intensity;
VP6	<i>Acrophyllum australe</i>	Sensitive to high fire frequency; Min. IFI 12yrs; Max IFI unknown;
VP7	<i>Baloskion longipes</i>	Identify fire regime requirements
VP8	<i>Boronia deneai</i>	Identify fire regime requirements
VP9	<i>Bossiaea oligosperma</i>	Identify fire regime requirements
VP10	<i>Darwinia biflora</i>	Sensitive to high fire frequency; Min. IFI 5-10; Max IFI 10yrs
VP11	<i>Darwinia peduncularis</i>	Identify fire regime requirements
VP12	<i>Derwentia blakelyi</i>	Identify fire regime requirements
VP13	<i>Dillwynia tenuifolia</i>	Min. IFI 5-10; Max IFI 40yrs
VP14	<i>Diuris aequalis</i>	Identify fire regime requirements
VP15	<i>Epacris sparsa</i>	Identify fire regime requirements
VP16	<i>Eucalyptus benthamii</i>	Sensitive to high fire frequency; Avoid high intensity fire (may kill individuals); Min IFI > 10yrs; Max IFI @ 200 yrs;
VP17	<i>Eucalyptus camfieldii</i>	Min IFI ; Max IFI may be disadvantaged by competition with absence of fire for 30 yrs
VP18	<i>Euphrasia bowdeniae</i>	Occurrence of wildfire in drier sites could potentially eliminate populations. Fire exclusion.
VP19	<i>Isopogon fletcheri</i>	Identify fire regime requirements
VP20	<i>Kunzea cambagei</i>	Infrequent low intensity fire events may be contributing to low recruitment; Timing of burns should be autumn - winter after seed release;
VP21	<i>Lepidosperma evansianum</i>	Identify fire regime requirements
VP22	<i>Melaleuca deanei</i>	May require fire to stimulate flowering Min. IFI 8yrs; Max IFI 100yrs;
VP23	<i>Micromyrtus minutiflora</i>	Identify fire regime requirements;
VP24	<i>Persoonia acerosa</i>	Specimens should be protected from hazard reduction burns and trail maintenance activities;
VP25	<i>Phyllota humifusa</i>	Identify fire regime requirements;
VP26	<i>Prasophyllum fuscum</i>	Identify fire regime requirements;
VP27	<i>Pultenaea glabra</i>	Identify fire regime requirements
VP28	<i>Tetradheca glandulosa</i>	Min. IFI 6-8; Max IFI unknown;
VP29	<i>Velleia perfoliata</i>	Sensitive to high fire frequency; Min. IFI 2-5; Max IFI 10yrs;
VP30	<i>Zieria involucrata</i>	Sensitive to high fire frequency; Min. IFI 10yrs; Max IFI 20 yrs;
VP31	<i>Zieria murphyi</i>	Identify fire regime requirements;

Table 25: Rare Or Threatened Australian Plant (RP) fire management Guidelines

Map ID	Species	Fire management guidelines
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Map ID	Species	Fire management guidelines
RP1	<i>Almaleea incurvata</i>	Min IFI >5yrs; Max IFI @ 10yrs
RP2	<i>Atkinsonia ligustrina</i>	Min. IFI 8 yrs; Max IFI 20yr
RP3	<i>Blandfordia cunninghamii</i>	Identify fire regime requirements;
RP4	<i>Blechnum gregsonii</i>	Identify fire regime requirements
RP5	<i>Cyphanthera scabrella</i>	Identify fire regime requirements
RP6	<i>Deyeuxia microseta</i>	Identify fire regime requirements
RP7	<i>Epacris muelleri</i>	Avoid fire on cliff lines; Identify fire regime requirements;
RP8	<i>Eriostemon obovalis</i>	identify fire regime requirements;
RP9	<i>Eucalyptus apiculata</i>	Identify fire regime requirements;
RP10	<i>Eucalyptus burgessiana</i>	Identify fire regime requirements
RP11	<i>Eucalyptus cunninghamii</i>	Min IFI unknown; Max IFI 100 yrs; Identify minimum fire regime requirements,
RP12	<i>Eucalyptus gregsoniana</i>	Identify fire regime requirements;
RP13	<i>Geranium graniticola</i>	Identify fire regime requirements ;
RP14	<i>Goodenia rostrivalvis</i>	Identify fire regime requirements;
RP15	<i>Hakea constablei</i>	Min IFI 4yrs; Max IFI unknown;
RP16	<i>Hymenophyllum pumilum</i>	Identify fire regime requirements;
RP17	<i>Leptospermum rupicola</i>	May require fire for seed release;
RP18	<i>Leucopogon fletcheri subsp. A</i>	Identify fire regime requirements;
RP19	<i>Lissanthe sapida</i>	Identify fire regime requirements;
RP20	<i>Lomandra fluviatilis</i>	Identify fire regime requirements;
RP21	<i>Notochloe microdon</i>	Identify fire regime requirements;
RP22	<i>Olearia quercifolia</i>	Identify fire regime requirements;
RP23	<i>Ozothamnus adnatus</i>	Identify fire regime requirements;
RP24	<i>Parahebe lithophila</i>	Identify fire regime requirements;
RP25	<i>Persoonia oxycoccoides</i>	Identify fire regime requirements;
RP26	<i>Pseudanthus divaricatissimus</i>	Identify fire regime requirements;
RP27	<i>Rupicola apiculata</i>	Identify fire regime requirements;
RP28	<i>Rupicola sprengelioides</i>	Identify fire regime requirements;
RP29	<i>Sphaerocionium lyallii</i>	Identify fire regime requirements;
RP30	<i>Sprengelia monticola</i>	Identify fire regime requirements;
RP40	<i>Tetralthea neglecta</i>	Identify fire regime requirements;

*Fauna Species Guidelines***Table 26: Endangered Animal Species (EA) Fire Management Guidelines**

Map ID	Common Name Scientific Name	Fire Management Guidelines
EA1	Southern Brown Bandicoot <i>Isodon obesulus</i>	<ul style="list-style-type: none"> - Vegetation regenerating after fire supports an abundant supply of insect food, which decreases as the vegetation matures. Therefore, for a stable population to be established, the area should be burnt fairly regularly, creating a mosaic of suitable habitat (Strahan, 1995). - Avoid burning in winter breeding season
EA2	Bush Thick-knee <i>Burhinus magnirostris</i>	<ul style="list-style-type: none"> - Implement low intensity mosaic burns to retain ground refuge areas - Identify additional fire regime requirements
EA3	Regent Honeyeater <i>Xanthomyza phrygia</i>	<ul style="list-style-type: none"> - High intensity fire may decrease the suitability of mature feeding trees and destroy nests (possibly containing eggs) - Avoid burning within suitable habitat during the breeding season (July – November) - Avoid removing suitable feeding and nesting trees from potential or known habitat as part of fire management activities
EA4	Blue Mountains Water Skink <i>Eulamprus leuraensis</i>	<ul style="list-style-type: none"> - Implement low intensity mosaic burns to retain ground refuge areas - Identify additional fire regime requirements
EA5	Broad-headed Snake <i>Hoplocephalus bungaroides</i>	<ul style="list-style-type: none"> - Avoid unnecessary clearing of bush rock during fire management activities - Avoid moderate to high and frequent fire regimes which may reduce the number of fallen logs and tree hollows (which are suitable retreats for reptiles) as well as decreasing prey diversity - Implement low intensity mosaic burns to retain ground refuge areas

Table 27: Vulnerable Animal Species (VA) Fire Management Guidelines

Map ID	Common Name Scientific Name	Fire Management Guidelines
VA1	Spotted-tail Quoll <i>Dasyurus maculatus</i>	<ul style="list-style-type: none"> - Avoid high intensity fires over large areas - Avoid burning woodland and forest habitat during winter and spring breeding season, - Monitor population demography of this species, especially in relation to fire
VA2	Koala <i>Phascolarctus cinereus</i>	<ul style="list-style-type: none"> - Individuals likely to be unaffected by low to medium (small scale, <10ha) intensity fires, however dense smoke from such fires may be detrimental - Koalas prefer new growth for food (Tanton, 1996), therefore, implementing a variety of fire regimes may be beneficial to this species - High intensity crown fires have the potential to kill individuals directly and reduce habitat - Protect known populations from fire, especially during the summer breeding season - Monitor population demography of this species, especially in relation to fire
VA3	Brush-tailed Rock Wallaby <i>Petrogale penicillata</i>	<ul style="list-style-type: none"> - Individuals likely to escape low to moderate intensity fire - Avoid high intensity fires over large areas - Avoid burning during the breeding season - Maintain a variety of age classes in understorey vegetation by implementing a mosaic of fire intensities and frequencies - Monitor population demography of this species, especially in relation to fire

Map ID	Common Name Scientific Name	Fire Management Guidelines
VA4	Yellow-bellied Glider <i>Petaurus australis</i>	<ul style="list-style-type: none"> - Alteration of prescribed burning regimes to ensure the enhancement and maintenance of floristic and structural diversity - Avoid high intensity fires over large areas, should be less than half of home range (35ha) - During mop-up avoid felling potential habitat trees, sap site trees and winter flowering eucalypts - Time prescribed burns in areas to avoid breeding season (May September) of known populations - Should not be adversely affected by low-medium intensity fire - On going monitoring of population demography in relation to fire
VA5	Squirrel Glider <i>Petaurus norfolcensis</i>	<ul style="list-style-type: none"> - Species should not be adversely affected by low to moderate intensity fires - Avoid large scale, high intensity fires which may fragment habitat – potentially isolating populations and affecting breeding success - Maintain a mosaic of fire frequencies to ensure the maintenance and enhancement of floristic and structural diversity - Avoid disturbing breeding sites and feeding trees (buffer known locations) during fire management activities, especially during the breeding season - Monitor population demography of this species, especially in relation to fire
VA6	Large-footed Myotis <i>Myotis adversus</i>	<ul style="list-style-type: none"> - Unlikely to be adversely effected by inappropriate fire regimes, as it hibernates in winter and can utilise a wide range of forest types - Avoid high intensity fire around known roosting sites during the breeding season (Nov – Dec) - Maintain a mosaic of age classes within habitat - Avoid high frequency fire in habitats caves, mine shafts and buildings as this will decrease prey diversity
VA7	Large Pied Bat <i>Chalinolobus dwyeri</i>	<ul style="list-style-type: none"> - Avoid high intensity fire in known roost locations (caves, mine tunnels, Fairy Martin nests, culverts) - Fire should be low intensity for preservation of den sites - Avoid fire during the breeding season (early winter to spring) - Avoid fire during the summer months, to minimise impact on actively foraging species - High intensity fires may decrease the density of important foraging habitat – potentially affecting the diversity and abundance of prey species
VA8	Common Bent-wing Bat <i>Miniopterus schreibersii</i>	<ul style="list-style-type: none"> - Frequent fire near nursery caves may impact upon breeding success - Potential for inappropriate fire regimes to reduce habitat and prey diversity - Maintain a mosaic of age classes within habitat - Avoid fire management activities within close proximity (<100m) to known roosting caves / trees / mines especially during the breeding season (May to June), birth (November to December) and weaning (February) periods - Fire should be low intensity with low flame heights for preservation of roost sites
VA9	Powerful Owl <i>Ninox strenua</i>	<ul style="list-style-type: none"> - Fire unlikely to impact on adults - Potential for inappropriate fire regimes to reduce habitat and prey diversity - Potential for moderate to high intensity fire to impact on reproduction during breeding season (June - September) - Maintain a mosaic of age classes within habitat (Eucalyptus forests / woodland with large old trees). - Physically protect (reduce fuels from base of tree) known nesting trees from burning activities - Encourage low to moderate intensity fuel reduction burns
VA10	Masked Owl <i>Tyto novaehollandiae</i>	<ul style="list-style-type: none"> - Fire may be detrimental to this species if there is a loss of large trees for nesting and loss of key habitat for prey species - Burning at low to moderate intensity may encourage the formation of hollows for nesting, however, it would be detrimental during the breeding season (autumn/ winter) - Avoid impacting hollow bearing trees during fire management activities - Maintain a mosaic of age classes within habitat to encourage prey diversity and to prevent habitat fragmentation

Map ID	Common Name Scientific Name	Fire Management Guidelines
VA11	Sooty Owl <i>Tyto tenebricosa</i>	<ul style="list-style-type: none"> - Fire unlikely to impact on adults - Potential for inappropriate fire regimes to reduce habitat (tall, wet forests in sheltered east and south-east facing mountain gullies) and prey diversity - Potential for moderate to high intensity fires to impact on reproduction - Clearing by fire likely to increase foraging potential - Maintain a mosaic of age classes within habitat - Avoid impacting hollow bearing trees during activities - Avoid burning within known nesting habitats during the breeding season (April – June)
VA12	Glossy Black Cockatoo <i>Calyptorhynchus lathami</i>	<ul style="list-style-type: none"> - Fire likely to impact upon adults - Avoid high intensity fires within potential habitat, to prevent damage to nesting sites (tree hollows) - Avoid implementing large area prescribed burns within habitat (<i>Allocasuarina spp</i> present) to avoid loss of sole food source – mosaic burn - Protect known nest sites by a 50-200 metre buffer strip - Maintain diversity of age structure over wide areas - Low intensity mosaic burn
VA13	Australasian Bittern <i>Botaurus poicilopilus</i>	<ul style="list-style-type: none"> - Fire unlikely to affect this species (wet habitat) - Avoid high intensity fires within close proximity to wetlands to minimise siltation into water - Avoid fire within riparian vegetation surrounding wetlands - Avoid fire during the breeding season (September December) - Avoid disturbing reed beds for trail construction. Construction of board – walks may be more suitable
VA14	Turquoise Parrot <i>Neophema pulchella</i>	<ul style="list-style-type: none"> - Maintain a mosaic of age classes within habitat (eucalypt woodlands and open forests with a ground cover of grasses and low understorey of shrubs) - Avoid high intensity fires around known nesting sites during the breeding season (August – January) - Avoid high intensity, frequent fire within habitat over large areas - Alter prescribed burning regimes to ensure the enhancement and maintenance of floristic and structural diversity - Low intensity mosaic burn within known habitat. Avoid total clearance of nesting sites and food sources (especially in eucalypt woodland) - Avoid removal of nesting trees and stumps. Protect known and potential nesting areas from disturbance
VA15	Olive Whistler <i>Pachycephala olivacea</i>	<ul style="list-style-type: none"> - Avoid burning habitat (wetter rainforests, forests, woodlands, riparian vegetation, scrubs, heath) during the breeding season (September – January)
VA15	Pink Robin <i>Petroica rodinogaster</i>	<ul style="list-style-type: none"> - Avoid burning habitat during the breeding season (September – January) - Avoid high intensity, frequent fire within habitat over large areas
VA16	Wompoo Fruit Dove <i>Ptilinopus magnificus</i>	<ul style="list-style-type: none"> - Avoid burning habitat during the breeding season (September – January) - Avoid high intensity, frequent fire within habitat over large areas
VA17	Red-crowned Toadlet <i>Pseudophryne australis</i>	<ul style="list-style-type: none"> - 100m buffer potential or known habitat (Talus slopes below sandstone outcrops. Can be found besides temporary creeks, gutters and soaks, under rocks and logs) from all fire management activities - Fire may remove critical habitat (ground and canopy cover) therefore, mosaic burn to ensure refuge areas are available - Avoid high frequency fires – may lead to a build up of sediments in small ponds used for breeding. May also simplify the structure and alter species composition of habitat - Avoid fire during the breeding season

Map ID	Common Name Scientific Name	Fire Management Guidelines
VA18	Giant Burrowing Frog <i>Heleioporus australiacus</i>	<ul style="list-style-type: none"> - Avoid fire regimes that reduce or encroach on rainforest boundaries in known habitat - Avoid burning 100m either side of creek lines to avoid sedimentation into creeks and ponds - Implement low intensity mosaic burns to ensure refuge areas are available - Avoid high intensity, frequent fires adjacent to known habitat – may cause sedimentation and potentially simplify the structure and species composition of the surrounding habitat
VA19	Southern Barred Frog <i>Mixophes iteratus</i>	<ul style="list-style-type: none"> - Implement low intensity mosaic burns to ensure refuge areas are available - Avoid high intensity, frequent fires adjacent to known habitat – may cause sedimentation and potentially simplify the structure and species composition of the surrounding habitat

Endangered Ecological Community Guidelines

Table 28: Endangered Ecological Communities (VC) Fire Management Guidelines

Map ID	Vegetation communities	Fire Management Guidelines
EC1	Shale sandstone transition forest	- Manage according to fire regime D; Identify fire regimes requirements
EC2	Sydney Turpentine – Ironbark forest	- Manage according to fire regime D; Identify fire regimes requirements
EC3	Blue Mountains Sedge Swamps'	- Manage according to fire regime E; Identify specific fire regime requirements
EC4	Blue Mountains Shale Cap forest	- Manage according to fire regime D; Identify fire regimes requirements

4.7.5 Water Catchment Values

Cooperative Agreements have been established between the SCA and NPWS for the joint management of the Special Area landscapes (Sydney water supply catchment areas). The NPWS has incorporated the strategies and the works proposed under the Blue Mountains and Warragamba Special Areas Fire Management Strategy (Bush fire and Environmental Services 2002 a and b) into its Policy and schedules. The specific strategies for the protection of water quality include:

- The cooperative management of an initial attack remote fire fighting resource on standby for the prompt suppression of ignitions specifically within the Special Areas.
- Incorporating Water Quality Protection Zones (WQPZ) around storages. These will consist of a vegetated filter strip of 20 – 100 metres above the full level around the Lake Burragorang and the Woodford, Blackheath and Katoomba Cascades water storages. The dimensions of the WQPZ will generally be determined by slope, ground cover and soil erosion potential. Prescribed fire will be excluded from the WQPZs except where it is required for asset protection or biodiversity conservation, and;
- Wildfire suppression strategies will aim to minimise the intensity of wildfire within 500m of stored waters and major inflows.

4.7.6 Scenic Landscapes & Tourism

Strategies to minimise the impacts of bush fires and fire management activities on the landscape's aesthetic values include;

- Consultation with tourism authorities and operators regarding the impact of fires and fire management activities ,
- Employing Minimal Impact Suppression Techniques (MIST) as part of operations,

- Implementing a prescribed burning mosaic that is sensitive to scenic views and high visitation areas, and
- Implementing alternate fuel management strategies in high visitation areas.

4.7.7 Weed and Pest Species Impacts

Major strategies to minimise the impacts of fire regimes on the abundance and distribution of weed and pest species within the Reserve include;

- Selecting gravel and fill materials for trail maintenance from local sources that will not affect the fertility of the soil or contain exotic seeds;
- Undertaking post fire weed and pest species monitoring and control programs on a cooperative basis with other agencies and local community groups;
- Avoiding the movement of vehicles or hand crews from weed infested to natural areas.
- Avoiding slashing, selective shrub removal or under scrubbing where it may promote weed invasion;
- Washing down vehicles, particularly earthmoving machinery, before it commences operations within the Reserve;
- Utilising prescribed fire or pile burns to stimulate the germination of soil stored seed banks in combination with post fire mechanical or chemical control techniques, and;
- Undertaking monitoring and research into the effects of fire on the weed and pest species.

4.7.8 Areas Under Regeneration/ Rehabilitation

Major strategies to protect areas under regeneration or rehabilitation include;

- Assessing the regenerative capacity of flora and fauna populations to determine the affect of introducing fire;
- Utilising prescribed fire to assist in rehabilitation projects, and;
- Excluding fire in the absence of more detailed information.

4.7.9 Soil Erosion Impacts

The major strategies to minimise the impact of high intensity fires and fire management activities on soil landscapes is to construct and maintain all trails to the standards prescribed in the Guidelines for the Planning Construction and Maintenance of Tracks (NSW Soil Conservation Service).

4.8 Strategies for Cultural Heritage Management

The Reserve contains a large number of Aboriginal and historic heritage values. Some of these are at a high risk of damage from wildfire or fire management operations. Major strategies for cultural heritage protection include;

- Managing cultural heritage in accordance with the 'Burra Charter' ICOMOS (1988);
- Consulting the Gundungara, Darruk, Tharawal, Derrubbin and Wiradjuri Aboriginal Land Councils, historic heritage groups, other non- Aboriginal cultural heritage groups and experts for the protection of cultural heritage values;
- Maintaining databases and a geographic information system (GIS) on the location and nature of cultural heritage sites and landscapes. The database will be referenced as part of fire management and operational planning, and;
- Developing conservation plans to protect or rehabilitate damaged sites.

5 IMPLEMENTATION

The NPWS will prepare an annual Fire Management Works Schedule based on the strategies prescribed in this Reserve Fire management Strategy. It will consider;

- recent fire history (both planned and unplanned fires),
- recent and prevailing drought and weather conditions,
- community concerns and impact on local economy,
- the level of bush fire risk to assets, life, cultural heritage and natural heritage,
- the cost and availability of resources to implement the strategy, and
- the probability of success and general practicality of implementing the strategy.

Fire Management Works Schedules are subject to change due to unfavourable seasonal conditions, unavailability of resources, equipment break-downs or wildfire events which make the scheduled work inappropriate.

5.1 Fire Management Database Works

Table 29 details the Geographic Information System and text databases that the NPWS will maintain on an annual basis. Databases will be available on a share basis for the preparation of fire management operations and the Bush Fire Suppression Maps.

Table 29: Fire Management Database Works Schedule

Database	Tasks
Neighbours contacts	<ul style="list-style-type: none"> - Obtain neighbour details from Councils. - Link neighbour details (name, address, and telephone numbers) to cadastral layers and assets register,
Assets register	<ul style="list-style-type: none"> - Verify the accuracy of the urban areas layer, - Accurately plot the location of remote assets,
Fire history	<ul style="list-style-type: none"> - Maintain GIS wild fires and prescribed burns databases, - Merge RFS and SCA fire history data, - Supply data to RFS for BRIMS (Bushfire Risk Information Management System) - Obtain satellite imagery of major fires to evaluate fire intensity and effects.
Biodiversity	<ul style="list-style-type: none"> - Maintain databases on the abundance and distribution of endangered, threatened, rare or regionally significant species populations, communities and critical habitat. - Identify source information used to compile databases including the results of field surveys, the Wildlife Atlas, data from the Royal Botanic Gardens, Rare Or Threatened Australian Plant records, or known NPWS staff and other specialists. - Update field survey data, - Update Wildlife Atlas data, - Complete 1:25k mapping of the Reserve and verify the accuracy of fire regime classifications, - Generate species lists for vegetation communities,
Cultural heritage	<ul style="list-style-type: none"> - Maintain Aboriginal sites register that details the locations and sensitivity of sites, - Map the location of culturally significant landscapes (story places, teaching and bush food),
Fire advantages	<ul style="list-style-type: none"> - Link GIS database to assets register and asset maintenance system - Review unnamed trails and map cliff lines, - Evaluate the effectiveness of major creek lines and classify GIS layer, - Map and verify the location of other fire management advantages including suitable water points (both helicopter and vehicle accessible), helipads, radio towers, airbases, base camps and safe areas, - Map the possible locations of temporary control advantages in GIS
Climate and weather	<ul style="list-style-type: none"> - Update SDI and SOI other index databases and analyse data
Monitoring	<ul style="list-style-type: none"> - Develop monitoring programs and databases for fuel, biodiversity, and water quality assessments - Map the location of sampling sites on GIS
Literature	<ul style="list-style-type: none"> - Maintain the Regional library of scientific literature, leaflets and pamphlets.

5.2 Fuel Management Works

5.2.1 Prescribed Burning

Priorities for prescribed burning are scheduled annually after consultation with District Bush Fire Management Committees. These are generally implemented in cooperation the Rural Fire Service Brigades. Table 30 details the process in annual prescribed burning scheduling. Implementing works in Asset Protection Zones will be given the highest priority over implementing works in Strategic Fire Management Zones which, in turn, will be given a higher priority than implementing works in Heritage Management Zones.

Table 30: Prescribed burning works

Steps	Tasks
Update databases	<ul style="list-style-type: none"> - Update fire history on GIS generate year - Record results of previous years programs
Review burn prescriptions	<ul style="list-style-type: none"> - Review prescription burn requirements on GIS and set priorities, - Undertake GIS threat analysis, - Undertake GIS fire regime evaluation,
Fuel Sampling	<ul style="list-style-type: none"> - Undertake fuel sampling in areas for proposed burns and collate data
Prepare burn proposals for DBFMC's	<ul style="list-style-type: none"> - Submit prescribed burning proposals to District Bush Fire Management Committees - Seek approval by DBFMC's
Review of Environmental Factors	<ul style="list-style-type: none"> - Prepare Hazard Reduction Certificate or review of environmental factors (REF) - Undertake field assessments if required - Seek approval for HR certificate or REF
Risk assessment	<ul style="list-style-type: none"> - Undertake field inspection to assess risks with implementing burns
Prepare operations plans	<ul style="list-style-type: none"> - Prepare operations plan - Seek operations plan approval
Implement Burns	<ul style="list-style-type: none"> - Identify appropriate conditions to implement burns by monitoring weather conditions - Notify RFS fire control centres, emergency service agencies and neighbours - Organise resources including RFS crews
Post burn assessment	<ul style="list-style-type: none"> - Undertake post burn assessments for effectiveness
Monitoring and Reporting	<ul style="list-style-type: none"> - Report to DBFMC's on the success of the prescribed burning program. Maintain internal databases and reporting protocols. - Percentage of the total area actually treated

5.2.2 Asset Protection Zones works

Annual works schedules will identify priority locations for mechanical fuel reduction works. The Region will use the '*Planning for Bush Fire Protection*' (RFS & Dept Planning 2001) as a guideline for addressing the required works within existing APZs.

5.3 Fire Management Access Works

Annual works schedules will identify the priorities for fire management access maintenance and construction works including grading, slashing, selective shrub removal and rehabilitation. Priorities for works will be based on the strategic value of access routes (including previous success in fire containment) with regard to DBFMCs respective Fire Trail Registers. Access routes will be monitored regularly for soil erosion and weed invasion.

5.4 Fire Control Advantage Works

Fire control advantage works will be strategically planned in consultation with DBFMC's.

Table 31 outlines the considerations for the maintenance and construction requirements for fire control advantages within the Reserve.

Table 31: Fire Control Advantage Works

Consideration	Proposed works
Fire detection lookouts	- Evaluate and maintain Narrowneck fire tower to OH & S requirements
Vehicle Water Points	- Identify locations where vehicle water points need to be constructed in semi remote areas to reduce turn around times.
Helicopter Water Points	- Identify locations where helicopter water points need to be constructed in remote areas or where bouy walls can be located to reduce the turn around times for aircraft.
Airbases	- Maintain the facilities at Blackheath Depot and Medlow airstrip for multiple helicopters and fixed wing aircraft.
Helipads	- Identify and map locations for refuelling.
Refuge areas	- Identify critical locations where refuge areas need to be maintained or constructed.
Base camps	- Identify areas where base camps may be located.

5.5 Monitoring Works

Fire management activities will be monitored for their effectiveness and impact on natural and cultural heritage. Impacts will then be analysed and evaluated against research data. Table 32 outlines the components of the monitoring program incorporated into annual works schedules (Gill and Nicholls 1989; Gellie and Jones 1993; Keith and Tozer 1997; NPWS 1999 c and d).

Table 32: Monitoring and field assessment works

Monitoring Component	Specific data to be collected
Fuel accumulation	- Monitor overall fuel hazards in Asset Protection Zones and Strategic Fire Management Zones to identify priorities for fuel management activities (Holme and Gellie 1989)
Prescribed Burning	Pre burn assessment - Plant species composition - Demographic characteristics of key indicator species recorded Burn assessment - Capture data on the relative intensity of fire based on observed flame height. Post burn assessment - Post burn regeneration of species and integrated into register - Scorch height, and diameter of burnt branches, - Percentage of area burnt, - The range and average flame height, - The range and average scorch height - Percent canopy scorch - Percent understory removed - Proportion of leaf litter removed - The percentage of dry aerial fuels created
Threatened species	- Undertake census for threatened species to improve data on the distribution and abundance of species.
Significant vegetation units	- Monitor the effect of fire regimes on biodiversity dynamics within other fire sensitive vegetation communities on alluvial deposits, limestone, basalt, diatremes, and shale substrates,
Cultural	- Monitor the impact of wild fires and fire management activities on cultural heriatge

Monitoring Component	Specific data to be collected
heritage	sites
Water Quality	- Monitor Bio-indicators in water catchment areas in conjunction with Sydney Catchment Authority and other agencies.
Weather/ Climate	- Monitor drought indices as triggers for preparedness, park closures, and fire bans
Effectiveness of suppression operations	- Evaluate the effectiveness of fire suppression operations in relation to priorities and objectives.
Performance indicators	- Monitor and evaluate the effectiveness of fire management strategies in achieving the objectives of this plan.

5.6 Staff Training and Development

NPWS will ensure personnel are appropriately trained in fire fighting techniques, Incident Control Systems, fire management operations and the use of resource systems to aid decision making. Training and refresher programs will be undertaken regularly to ensure competencies are current.

5.7 Equipment and Facilities

Table 33 outlines the purchasing and maintenance requirements for fire management equipment and facilities to be considered in the development of annual works schedules.

Table 33: Equipment and facilities works

Equipment item	Tasks
Personal Protective Equipment	- Ensure all staff have appropriate personal safety and fire fighting equipment as detailed in the NPWS Fire Management Manual.
Vehicles	- Ensure strikers, tankers, bulk water carts, and plant equipment (bull dozers, and 4WD tractors/slashers) and associated equipment including fittings and hoses are operational from the onset of the fire season
Communications equipment	- Undertake an annual maintenance check prior to the fire season, - Including mobile radios in vehicles, hand held radios, batteries and chargers, - Acquire necessary equipment to communicate with other agencies - Assess mobile phone coverage
Support equipment	- Ensure adequate catering unit supplies and accommodation facilities are operational
Retardant and foams	- Ensure adequate supply
Aviation equipment	- Ensure mast trailers, bouy walls and aviation command trailer are operational - Ensure fuel supplies are adequate
Incendiary shot guns, injection equipment.	- Ensure adequate supply
Weather equipment	- Ensure both hand held and remote weather stations are functional,
Navigational equipment	- Ensure adequate supply of topographic maps, Global Positioning Systems (GPS), and compasses.

5.8 Community Education and Awareness

NPWS will provide support to Community Education and Awareness programs through District Bush Fire Management Committees. Table 34 outlines the community education and awareness programs to be considered in the development of annual works programs.

Table 34: Community education and awareness programs

Program	Key Projects
Ignition prevention	- Promote neighbourhood watch programs in areas with high levels of arson.
Fire wise	- Support DBFMCs in approved activities
NPWS Discovery program	- Incorporate fire management messages in displays, shows, guided walks, field study trips,
Media	- Provide regular public bulletins on the outlook and status of the fire season, - Providing material for newspapers, radio, television, magazines, billboards, signs posters, and newsletters - Publications available to the public to increase community understanding and acceptance for the need for fire management activities
School programs	- Provide media for school resource kits.
Preparedness days	- Assist the RFS in bush fire preparedness days,
Smoke management	- Notify neighbours and visitors of proposed management activities through mail and public media
Park closures and fire bans	- Install signage and interpretations to inform park users and neighbours of total fire bans, reserve fire bans, reserve closures and other fire management operations
tourism industry	- Provide information on the actions for self preservation, total and reserve fire bans, reserve closures and other fire management operations
Interpretations	- Provide information at interpretation sites on the activities that lead to fires and actions for self preservation.
Community fire plans	- Community protection plans will be undertaken in key bush fire threat areas.
Face to face contact	- Ensure fire issues can be adequately dealt with at visitor information centres, public meetings, community fire guard groups, other community groups, shopping centres, open days, fetes, shows and visits to neighbours.
Internet	- Provide information on the Service web page about fire management, reserve closures, and total and reserve fire bans
media and public relations strategy	- Preparation of a media and public relations strategy as part of the incident action plan for major incidents, - Development of a media protocol between agencies to ensure coordinated and accurate reporting

5.9 Bush fire Management Research

Research is required on an ongoing basis to establish a knowledge base for effective fire management. Table 35 outlines the priorities for research.

Table 35: Bush fire management research priorities

Research Area	Key Projects
Establish MOUs	- Prepare and promote research prospectus and establish Memorandum of Understanding (MOU) with major tertiary institutions to facilitate research into bush fire management issues.
Biodiversity impacts	- Effects of fire exclusion of seed-bank dynamics - Identify appropriate fire management guidelines for threatened species populations and communities.
Cultural heritage	- Assess the effects of fire on different site types - Assess the cultural sensitivity of landscapes through computer predictive modelling,
Water quality	- Assess the effects of high intensity fire on soil erosion and water quality in cooperation with SCA
Fire behaviour	- Analyse the relationship between prescribed fire and its effect on the behaviour of wild fires.

Remote sensing of fire patterns	- Investigate the use of satellite technology for estimating fire intensity and spatial consistency
Community education	- Determine the most effective programs for community education and awareness

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Appendix 1: Fire Management and Access Trails and Roads

The public vehicle access system within the Reserve includes approximately 175km of roads. These roads are maintained to access facilities such as lookouts, picnic and camping areas, walking track heads, and for uses such as vehicle touring, cycling and horse riding. The Reserve also has approximately 275kms of vehicle tracks which are not available for general public access but provide strategic access for fire fighting or other management works.

In 2003, the Bushfire Coordinating Committee released a policy on classification and standards of fire trails. The classification consists of primary (suitable for 4wd Cat1 tankers), secondary (generally suitable for Cat7/9 Slipons /Strikers) and dormant (not maintained but could be reopened).

District Bushfire Management Committees are required to maintain a Strategic Fire Trails Register of such trails within the District. The review of the Fire Trails Register against classification standards is an ongoing consultative process within the DBMCs and is current for major areas within the Blue Mountains National Park. The maintenance and/or upgrade of registered trails to these specified standards is NPWS's responsibility but subject to available funding and resources.

Rather than list the trails here, reference is made to this process and the Bush Fire Districts Fire Trail Register system for identification and management of strategic fire access trails. Details of trails on the Register should be referred to the Executive of the DBFMCs.



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