



NSW National Parks  
and Wildlife Service

# Fire Management Strategy

Bouddi National Park &  
Cockle Bay Nature Reserve



**FIRE MANAGEMENT STRATEGY**

**BOUDDI NATIONAL PARK AND COCKLE BAY NATURE RESERVE**

NSW National Parks and Wildlife Service (NPWS)  
Central Coast Hunter Range Region  
July 2008

## ACKNOWLEDGEMENTS

This Fire Management Strategy was prepared by the staff of the Central Coast Hunter Range Region of the NSW National Parks and Wildlife Service (NPWS).

Cover Photograph: Looking north from Hawke Head Drive over Bouddi National Park (Jeff Betteridge).

Published by the Department of Environment and Climate Change (NSW) July 2008.

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ISBN 1 74137 858 3

DEC: 2006/120

# TABLE OF CONTENTS

<b>1</b>	<b>INTRODUCTION .....</b>	<b>6</b>
1.1	SCOPE, TERM AND PURPOSE .....	6
1.2	RESERVE FIRE MANAGEMENT STRATEGY OBJECTIVES .....	7
1.3	DESCRIPTION OF THE RESERVES .....	9
1.3.1	<i>Location and Terrain</i> .....	9
1.3.2	<i>Natural and Cultural Heritage Values</i> .....	10
1.3.3	<i>Recreational Use and Facilities</i> .....	12
1.3.4	<i>Reserve Interface and Infrastructure</i> .....	12
1.3.5	<i>The Fire Environment</i> .....	12
1.3.6	<i>Summary of Key Fire Issues</i> .....	18
<b>2</b>	<b>BUSHFIRE RISKS.....</b>	<b>19</b>
2.1	INTRODUCTION .....	19
2.2	LIFE AND PROPERTY RISKS .....	19
2.2.1	<i>Utilities and infrastructure</i> .....	20
2.2.2	<i>Visitor Safety</i> .....	21
2.3	NATURAL HERITAGE RISKS .....	21
2.3.1	<i>Inappropriate fire regimes</i> .....	21
2.3.2	<i>Adverse fire management activities</i> .....	22
2.3.3	<i>Soil Erosion</i> .....	22
2.3.4	<i>Pest species invasion</i> .....	22
2.4	CULTURAL HERITAGE RISKS.....	23
2.4.1	<i>Aboriginal Heritage Values</i> .....	23
2.4.2	<i>Historic Heritage Values</i> .....	23
<b>3</b>	<b>BUSH FIRE RISK MANAGEMENT STRATEGIES .....</b>	<b>24</b>
3.1	INTRODUCTION .....	24
3.2	FIRE MANAGEMENT ZONES .....	24
3.3	COOPERATIVE MANAGEMENT.....	26
3.4	BUSHFIRE PREVENTION .....	26
3.5	BUSHFIRE SUPPRESSION .....	27
3.5.1	<i>Incident Preparedness</i> .....	27
3.5.2	<i>Response</i> .....	28
3.5.3	<i>Recovery</i> .....	28
3.6	FUEL MANAGEMENT.....	29
3.6.1	<i>Prescribed Burning</i> .....	29
3.6.2	<i>Fire Breaks</i> .....	30
3.7	FIRE MANAGEMENT ACCESS .....	30
3.7.1	<i>Classification of Trails</i> .....	30
3.7.2	<i>Trail Construction &amp; Maintenance</i> .....	31
3.7.3	<i>Walking Tracks</i> .....	31
3.7.4	<i>Hand tool lines</i> .....	32
3.8	OTHER FIRE CONTROL ADVANTAGES.....	32
3.9	ENVIRONMENTAL ASSESSMENT .....	32
3.9.1	<i>Smoke Management</i> .....	33
3.10	COMMUNITY EDUCATION AND COOPERATION .....	33
3.11	RESEARCH AND MONITORING .....	34
<b>4</b>	<b>REFERENCES .....</b>	<b>35</b>
	STRATEGIC FIRE ADVANTAGE ZONES .....	49
	LAND MANAGEMENT ZONES .....	54

## **LIST OF FIGURES**

FIGURE 1 FIRE MANAGEMENT PLANNING FRAMEWORK .....	8
FIGURE 2 ANNUAL AREA BURNT BY WILDFIRES .....	14
FIGURE 3 CAUSES OF WILDFIRE IGNITIONS.....	14
FIGURE 4 MONTH OF IGNITION FOR WILDFIRES.....	15
FIGURE 5 AREA TREATED BY PRESCRIBED BURNS. ....	16
FIGURE 6 CALCULATIONS OF BUSHFIRE BEHAVIOUR POTENTIAL.....	62

## **LIST OF MAPS**

MAP 1 LOCATION OF BOUDDI NATIONAL PARK AND COCKLE BAY NATURE RESERVE.....	9
MAP 2.1 BUSHFIRE RISKS – PROPERTY, VISITOR SITES, HISTORIC HERITAGE VALUES .....	68
MAP 2.2 BUSHFIRE RISKS – ENDANGERED ECOLOGICAL COMMUNITIES.....	68
MAP 2.3 BUSHFIRE RISKS – THREATENED FLORA & FAUNA.....	68
MAP 2.4 BUSHFIRE RISKS – EROSION HAZARDS, ACID SULPHATE SOILS.....	68
MAP 2.5 BUSHFIRE RISKS – FIRE REGIME ANALYSIS.....	68
MAP 3.1 FIRE MANAGEMENT STRATEGIES – ZONATION.....	68
MAP 3.2 FIRE MANAGEMENT STRATEGIES – ACCESS TRAILS .....	68
MAP 3.3 FIRE MANAGEMENT STRATEGIES – BUSHFIRE BEHAVIOUR POTENTIAL.....	68

## **LIST OF TABLES**

TABLE 1 VEGETATION COMMUNITIES OF REGIONAL SIGNIFICANCE.....	110
TABLE 2 SPECIES OF HIGH CONSERVATION SIGNIFICANCE.....	11
TABLE 3 PROPERTY AND FACILITIES AT RISK FROM WILDFIRE.....	20
TABLE 4 SUMMARY OF FIRE MANAGEMENT ZONES.....	25
TABLE 5 CLASSIFICATION OF FIRE TRAILS.....	31
TABLE 6 VEHICLE CARRYING CAPACITY.....	31
TABLE 7 PRIORITIES FOR FIRE MANAGEMENT RESEARCH.....	34

## **LIST OF APPENDICIES**

APPENDIX 1: FIRE REGIME GUIDELINES FOR VEGETATION COMMUNITIES .....	39
APPENDIX 2: FIRE REGIME GUIDELINES FOR THREATENED FLORA SPECIES.....	40
APPENDIX 3: FIRE MANAGEMENT GUIDELINES FOR THREATENED FAUNA SPECIES.....	41
APPENDIX 4: GUIDELINES FOR ABORIGINAL HERITAGE MANAGEMENT .....	45
APPENDIX 5: GUIDELINES FOR HISTORIC HERITAGE MANAGEMENT .....	47
APPENDIX 6: FIRE MANAGEMENT ZONES .....	48
APPENDIX 7: STANDARD OPERATIONAL GUIDELINES .....	56
APPENDIX 8: FIRE TRAIL & ROAD REGISTER.....	59
APPENDIX 9: BUSHFIRE BEHAVIOUR POTENTIAL .....	61
APPENDIX 10: GLOSSARY .....	63

# 1 INTRODUCTION

## 1.1 Scope, Term and Purpose

This document describes the strategies the National Parks and Wildlife Service (NPWS) plans to implement to meet its fire management responsibilities under the *Rural Fires Act 1997*, *National Parks and Wildlife Act 1974*, *Threatened Species Conservation Act 1995*, and other relevant legislation in Bouddi National Park and Cockle Bay Nature Reserve (hereafter referred to as *the Reserves*).

The strategy has been prepared in accordance with the policies and procedures detailed in the NPWS Fire Management Manual. It complies with the management objectives detailed in the Bouddi National Park Draft Plan of Management (NPWS, 1999b) and the Cockle Bay, Rileys Island, Pelican Island, and Saratoga Island Nature Reserves Draft Plan of Management (DECC, 2007). In addition, the strategy has been prepared in consultation with the Gosford Bush Fire Management Committee, the NSW Rural Fire Service, park neighbours and other stakeholders.

The relationship between this strategy and other planning documents is shown in Figure 1.

This strategy is supported by:

- Gosford District Bush Fire Management Committee's Plan of Operations and Bushfire Risk Management Plan;
- Fire Management Work Schedules that are prepared annually and list the fire management strategies to be implemented each year;
- Bushfire Suppression Guidelines, a map based Fire Management Strategy for the reserves, which identify natural and cultural values, and infrastructure to be protected from bushfire;
- Central Coast Hunter Range Region Incident Procedures which are prepared annually and detail general bushfire preparedness and response procedures; and
- Hardcopy maps and a Geographic Information System (GIS) database maintained at the NPWS Central Coast Hunter Range Regional Office, Gosford.

This fire management strategy will be reviewed five years from the date of approval or as required in consultation with Gosford Bush Fire Management Committee. It is likely that wildfires will occur during this period which will affect proposed fire regimes. If fires occur, the prescribed burning program will be modified so that a mosaic pattern of fire is maintained across the environment.

## **1.2 Reserve Fire Management Strategy Objectives**

In accordance with the statutory obligations and policies of NPWS as defined in the NPWS Fire Management Manual (NPWS, 2006), the fire management objectives for Bouddi National Park and Cockle Bay Reserve are to:

- Objective 1: protect life, property & community assets from the adverse impact of fire;
- Objective 2: develop & implement cooperative & coordinated fire management arrangements with other fire authorities, reserve neighbours & the community;
- Objective 3: manage fire regimes within reserves to maintain & enhance biodiversity;
- Objective 4: protect Aboriginal sites known to exist within NSW & historic places & culturally significant features known to exist within reserves from damage by fire; &
- Objective 5: assist other fire agencies, land management authorities & landholders in developing fire management practices to conserve biodiversity & cultural heritage across the landscape.

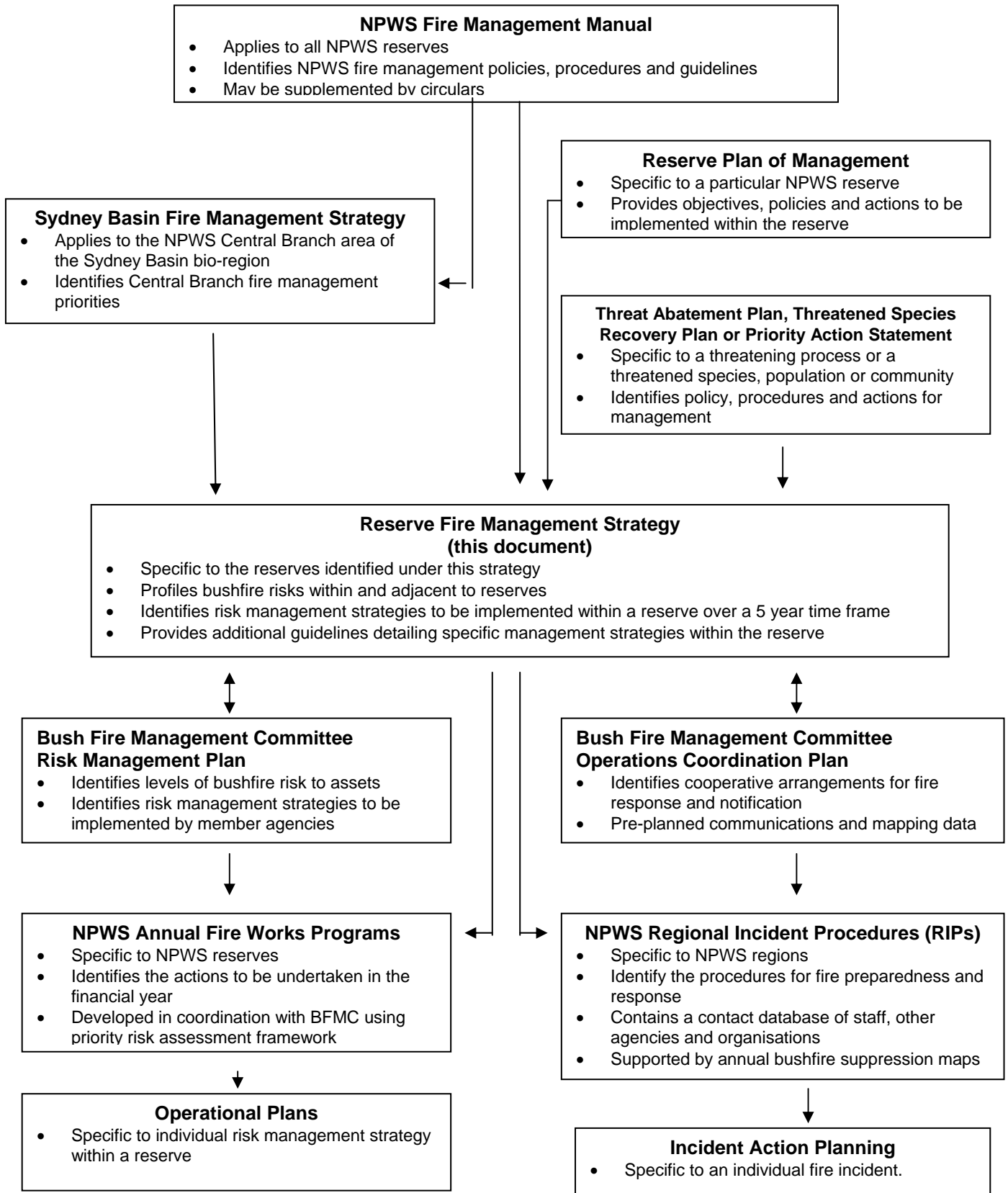


Figure 1 Fire Management Planning Framework



### 1.3 Description of the Reserves

#### 1.3.1 Location and Terrain

This fire management strategy applies to Bouddi National Park (1532 ha) and Cockle Bay Nature Reserve (44 ha).

In addition to the Reserves, the strategy also considers fuels, assets and fire control advantages that are outside but contiguous with, or adjacent to, those in the Reserves including 24.5 ha of land identified as proposed additions to Cockle Bay Nature Reserve.

The Reserves are located within Gosford Local Government Area on the Central Coast of New South Wales approximately 20km south-east of Gosford (Map 1). The Reserves protect a large area of the Bouddi Peninsula extending from Box Head to MacMasters Beach through to Kincumber, Cockle Bay and Half Tide Rocks.

#### Map 1 Location of Bouddi National Park and Cockle Bay Nature Reserve



Elevation within the reserves extends from sea level to 166m at Mt Bouddi. The reserves contain a range of coastal landform features, from the sandstone plateau of Bouddi Ridge to protected foreshores of Brisbane Water.

Hawkesbury sandstone dominates the higher levels forming plateau outliers and prominent spurs running in a NW direction at Box Head-Wagstaffe, Daleys Point, NW Ridge and MacMasters Ridge. The Narrabeen Group (Terrigal Formation), which underlies the Hawkesbury Sandstone occurs extensively throughout the reserve and is evident on the steep hills, coastal slopes and headlands. Steep, semi-circular catchments, backed by sandstone escarpments occur at Tallow Beach, Putty Beach and Maitland Bay. Bouddi National Park protects a number of small catchments each with intermittent watercourses and two semi-permanent coastal lagoons. Catchments, watercourses and coastal lagoons in a largely natural condition and unaffected by surrounding development are uncommon along the Sydney/ Central Coast/ Newcastle coastline.

Cockle Bay Nature Reserve is part of a floodplain dominated by Quaternary Alluvium with some minor outcrops from the Terrigal Formation.

### 1.3.2 Natural and Cultural Heritage Values

#### Flora

A number of vegetation surveys have been carried out within the study area, including those by Siddiqi et al. (1971-76), Strom et al. (1986), McRae (1990), Payne (1997) and Bell (2004). Over 700 plant species amongst 20 vegetation communities have been recorded within the reserves (Kelly 2001, Bell 2004). These include a variety of structural forms ranging from grassland, heath, woodland, shrubland, and forest communities. The most common vegetation communities are highly flammable dry sclerophyll forest, woodland, heath and shrublands which occupy over 70% of the Reserves. A list of vegetation communities found within the Reserves along with their fire regime guidelines is provided in Appendix 1.

Several of the vegetation communities occurring within the area are of regional significance (Map 2.2), they are listed in Table 1.

**Table 1 Vegetation communities of regional significance in Bouddi National Park and Cockle Bay Nature Reserve.**

Community	Location
Swamp Sclerophyll Forest on Coastal Floodplains Endangered Ecological Community dominated by <i>Eucalyptus robusta</i> , <i>Melaleuca quinquenervia</i> .	Bensville, Rileys Bay and within Cockle Bay Nature Reserve
Swamp Oak Floodplain Forest Endangered Ecological Communities.	Cockle Bay Nature Reserve
Coastal Saltmarsh Endangered Ecological Community.	Cockle Bay Nature Reserve
Themeda grassland on sea-cliffs and coastal headlands Endangered Ecological Communities.	Bouddi National Park
Wagstaffe Spotted Gum-Ironbark Forest occurs on soils derived from the Narrabeen series. This community has strong similarities to the Pittwater Spotted Gum Forest Endangered Ecological Community.	Hardys Bay and Wagstaffe
Coastal Sand Wallum Heath dominated by <i>Banksia aemula</i> occurs on Pleistocene sand dunes. This community has strong similarities to Eastern Suburbs Banksia Scrub Endangered Ecological Community.	Bombi and Mourawaring Moors within Bouddi National Park
Killcare Hawkesbury Woodland on Laterite- Hawkesbury Sandstone Geology with soils of the Somersby soil landscape unit. The community shows strong similarities with Duffys Forest Endangered Ecological Community	Killcare Heights
Coastal Warm Temperate Forest occurs within sheltered gullies on Narrabeen Sandstone. The community contains examples of Lowland	Bouddi Grand Deep

Rainforest in the Sydney Basin Endangered Ecological Community.	
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The Reserves contain a number of local endemic flora species, which are threatened primarily by development, habitat loss, weed invasion and inappropriate fire regimes. Two species listed as vulnerable under the *Threatened Species Conservation Act 1995* have been recorded within Bouddi National Park: *Syzygium paniculatum* and *Melaleuca biconvexa* (Map2.3). A list of threatened flora species found within the Reserves along with their fire regime guidelines is provided in Appendix 2.

The Reserves also protect a number of species of high conservation significance which are listed in Table 2.

**Table 2 Species of high conservation significance in Bouddi National Park and Cockle Bay Nature Reserve.**

• <i>Syzygium paniculatum</i> (TSC - Vulnerable)	• <i>Melaleuca biconvexa</i> (TSC - Vulnerable)
• <i>Acacia quadrilateralis</i>	• <i>Howittia trilocularis</i>
• <i>Alpinia arundelliana</i>	• <i>Lepidosperma quadrangulatum</i>
• <i>Banksia aemula</i>	• <i>Olearia nernstii</i>
• <i>Banksia robur</i>	• <i>Parachidendron pruinosum</i>
• <i>Blechnum ambiguum</i>	• <i>Parsonsia velutina</i>
• <i>Brachycome</i> sp.	• <i>Ripogonum fawcettianum</i>
• <i>Cryptocarya rigida</i>	• <i>Rulingia hermaniifolia</i>
• <i>Eucalyptus capitellata</i>	• <i>Tetrastigma nitens</i>
• <i>Eucalyptus robusta</i>	• <i>Tylophora barbata</i>
• <i>Eucalyptus scias</i> ssp. <i>scias</i>	

### Fauna

The Reserves protect important habitat for native animals on the Central Coast. The diversity of habitats in the Reserves support populations of about 254 native vertebrate animal species (including 12 amphibian, 166 bird, 36 reptile and 40 mammal species including marine mammals).

Thirty fauna species listed under the *Threatened Species Conservation Act, 1995*, occur within the Reserves, of which 21 are considered to be at risk from fire and fire management activities (Appendix 3). The Regent Honeyeater (*Xanthomyza phrygia*), Bush Stone-curlew (*Burhinus grallarius*), and Swift Parrot (*Lathamus discolor*) are listed as Endangered (Schedule 1) and are the highest priority species within the area (Map2.3).

### Cultural Heritage

Over 70 Aboriginal sites containing over 200 features have been recorded within the Reserves. Aboriginal occupation is evident in the form of grinding grooves, rock engravings, shelters containing art, middens, deposits, burials and scarred trees. Figures commonly depicted in engravings are fish, shields and wallabies. No Aboriginal sites are recorded in Cockle Bay Nature Reserve, although middens and open artefact scatter sites are likely to occur (Lambert, D pers. comm.). Appendix 4 lists the guidelines for Aboriginal heritage management.

Twenty seven historic sites and features occur in Bouddi National Park (Appendix 5). These include the Maitland Bay Store, Strom's House, Murray's House ruins, Bombi military emplacements, Dingledei Memorial Shelter, memorial plaques, the Maitland Shipwreck, foundations of fishing huts and associated landscaping at Lobster Beach and infrastructure associated with mining. No sites are recorded in Cockle Bay Nature Reserve.

### **1.3.3 Recreational Use and Facilities**

Bouddi National Park provides an important recreational resource, receiving 150,000 – 200,000 visitors each year. During the bushfire danger period there may be as many as 500 visitors within the reserve, particularly near Putty Beach.

Bouddi National Park offers a variety of recreational opportunities ranging from camping, picnicking, bushwalking, mountain bike riding, fishing and other beach activities. Recreational opportunities in Cockle Bay Nature Reserve are limited and public visitation is estimated at less than 1000 visitors annually.

Facilities within the Reserves include NPWS buildings, camping areas, picnic areas, amenities, lookouts and work sheds. These are listed in Table 3 (p.20) and illustrated in Map 2.1.

### **1.3.4 Reserve Interface and Infrastructure**

The Reserves are adjacent to medium-density residential development and small semi-rural holdings in the MacMasters Beach, Bensville, Killcare Heights, Hardys Bay, Pretty Beach, Wagstaffe, Daleys Point and Empire Bay areas.

The reserves have approximately 30km of residential interface, with approximately 850 properties immediately adjoining the Reserves.

Isolated houses or sheds occur on the perimeter of the Reserves at Empire Bay (Oyster Shed), Lobster Beach, The Scenic Road, Grahame Drive, MacMasters Beach and Maitland Bay Drive. A large proportion of existing assets and property do not conform to Australian Standards for building construction nor have established and maintained Asset Protection Zones on private property as described in Planning for Bushfire Protection (RFS, 2006a).

### **1.3.5 The Fire Environment**

#### **Fire History**

Fire history records for the NPWS Central Coast Hunter Range Region date back to 1968. Records have been compiled from NPWS and NSW Rural Fire Service maps, incident reports and anecdotal evidence from service staff, local fire brigade members and reserve neighbours. With age, the accuracy and relevance of the fire history records decreases, therefore, conclusions made from the database have been drawn with caution. This data has been compiled onto the regional Geographic Information System (GIS).

Knowledge of fire regimes prior to European settlement is limited; however it is likely that large-scale uncontained wildfires would have occurred in the area. Historic patterns of fire in the landscape have changed as a result of fragmentation caused by development and improvements in contemporary fire suppression methods.

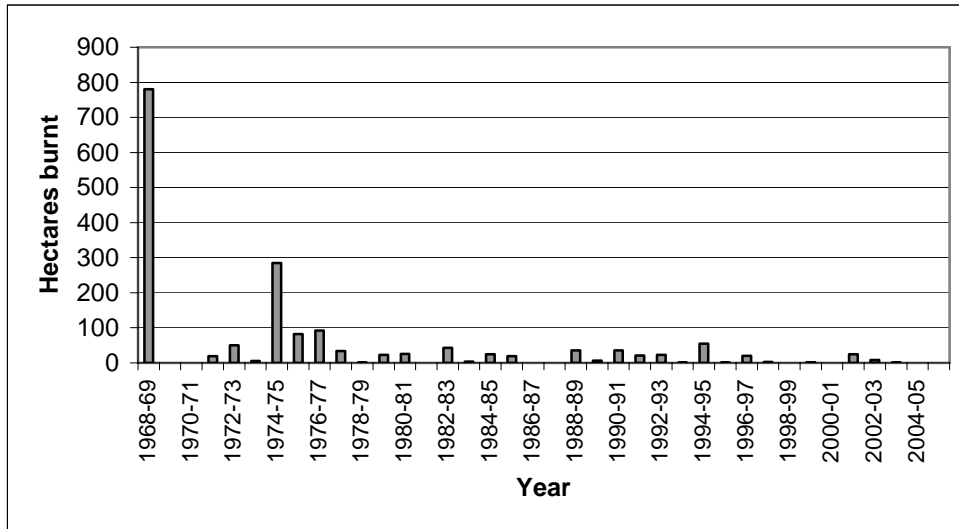
About 200 fires (wildfires and prescribed burns) have been recorded in the reserves in the 38 year period between 1968 and 2007. Figure 2 shows the annual area burnt by wildfires in the Reserves. The incidence of wildfires varies greatly from season to season. Three large wildfires in 1968, 1974 and 1976 have together burnt most of the Bouddi National Park. The 1968-69 fire season was the most significant with approximately 70% of the park being burnt in one fire event. Since 1980, the reserve has experienced a lower number of fires and on average a lower area burnt per annum. This is a result of improved fire management practices (such as improved state of

readiness, reduced response times, improved access, high suppression capability and a committed prescribed burning program) within the Reserves.

Traditionally, large fires have moved from the Bensville and South Kincumber areas under a north-westerly influence along the main ridgelines (NW Ridge, Daleys Point Ridge and MacMasters Ridge) into the Killcare Heights and MacMasters Beach area.

Cockle Bay Nature Reserve was gazetted in March 1992. Limited information is available on the fire history of the reserve before this time. Approximately 20 hectares was burnt by a wildfire in 1991 with smaller fires occurring in 1998 and 2002 (<2 hectares).

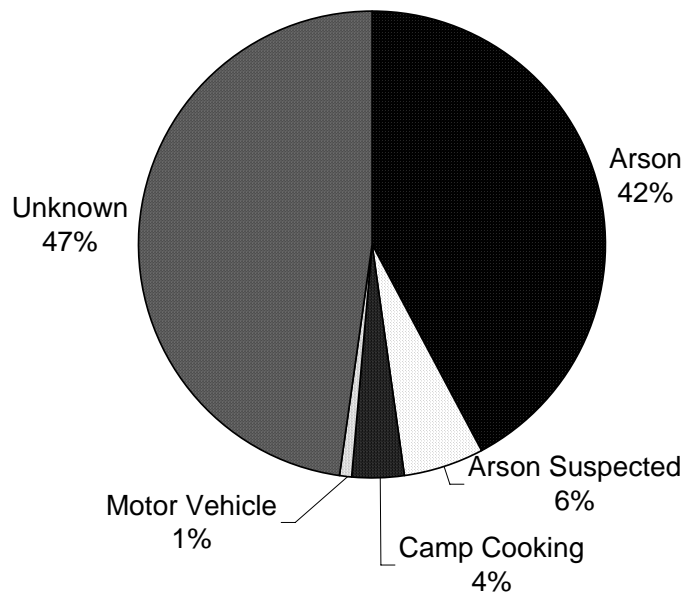
The majority of the Reserves, with the exception of Bouddi Grand Deep and estuarine communities within Cockle Bay Nature Reserve have experienced fire.



**Figure 2 Annual area burnt by wildfires in the Reserves between 1968-2006**

**Bushfire Ignitions**

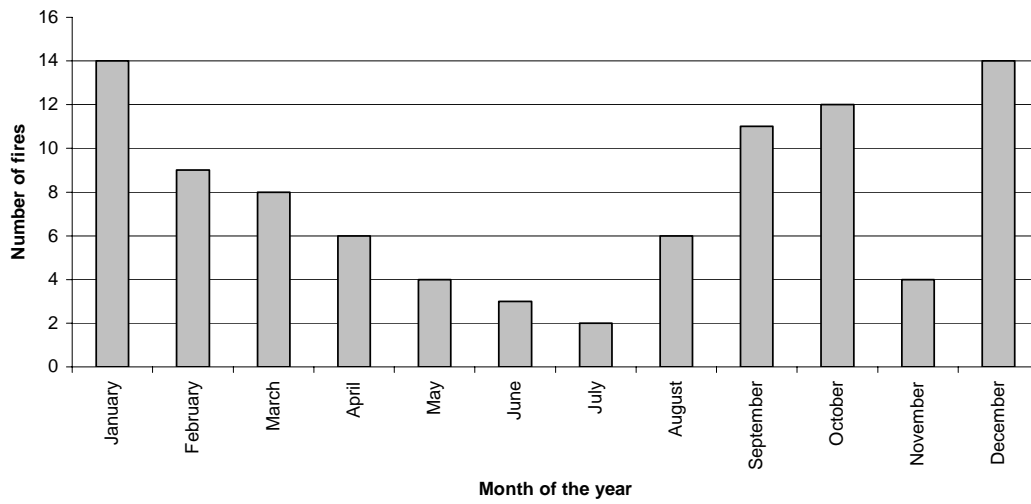
The main causes of wildfire ignitions in the Reserves are from arson or suspected arson (Figure 3). The cause of 47% of wildfires occurring in the reserves remains unknown. This is due to limited information, particularly for older records and limited post fire investigation and reporting.



**Figure 3 Causes of wildfire ignitions in Bouddi National Park and Cockle Bay Nature Reserve between 1968- 2006.**

An analysis of the distribution of known ignition points indicates a trend for ignitions along roads, tracks, trails, camping areas and other key visitor sites.

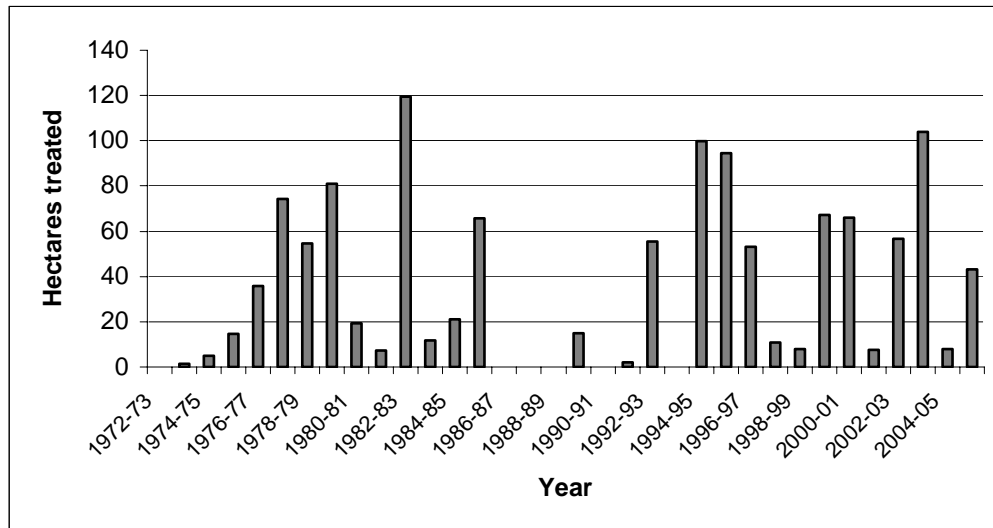
Figure 4 shows the monthly occurrence of wildfires within the Reserves. Fires may occur at any time during the year if conditions permit. The majority of fires generally occur from September through to February, with a peak in December and January. There is a marked decline in the number of fires after January likely associated with high moisture, easterly weather patterns and less windy conditions.



**Figure 4 Month of ignition for wildfires within Bouddi National Park and Cockle Bay Nature Reserve between 1968-2006 (records where no information is available on the date of ignition have been omitted from the analysis).**

### Prescribed burning

Since 1973, 90 prescribed burns have been completed within Bouddi National Park. No prescribed burns have been undertaken in Cockle Bay Nature Reserve. The area burnt by prescribed burns each year within the reserves is shown in Figure 5. The majority of prescribed burns are small in area but are strategically located to reduce fuel loads adjacent to high-risk assets and in areas of high arson probability or to strengthen existing fire control advantages. A small number of prescribed burns have been implemented to maintain ecological processes within vegetation communities.



**Figure 5 Area treated by prescribed burns in Bouddi National Park between 1973-2006.**

### Fire frequency

Fire frequency is defined simply as the number of fires over a given period of time. Both Bouddi National Park and Cockle Bay Nature Reserve have a history of infrequent wildfires. Large areas of the Reserves have only been burnt once since 1968 during wildfire events. Areas along the Scenic Road, Killcare Heights and Beachview Esplanade, MacMasters Beach have been burnt up to eight times since 1968; largely as a result of active prescribed burning programs.

### Fire Weather

The climate of the Bouddi Peninsula is classified as temperate and is influenced by two major circulation patterns (BoM, 2001). In summer, synoptic high pressure systems move south causing prevailing winds with an easterly influence. Low pressure troughs between the highs bring first dry, hot north-westerly's and then a wind shift to cooler southerlies. Rain may occur from troughs or orographic influences. Convective rainfall on hot afternoons is common (Bridgman and Oliver, 1995). Afternoon north-easterly and south-easterly have a moderating effect on temperatures.

In winter, the sub-tropic ridge moves north, resulting in the dominance of a westerly regime. Cold fronts alternate with synoptic high pressure systems, bringing relatively cold airstreams from the southern oceans and rainfall. The prevailing winds are north-westerly.

The average maximum temperature ranges from 9 - 27°C during December to March, and 4-17°C from June to August, however days in excess of 30°C frequently occur during summer. The average annual rainfall for the area is approximately 1400mm with February and March being on average the wettest months.



### **Conditions associated with bush fires**

Weather conditions associated with serious bushfire seasons and events include:

- High temperature air masses brought from the interior of the continent in high pressure systems;
- Several days of strong NW winds prior to the passage of cold fronts;
- Low relative humidity;
- Negative SOI;
- KBDI greater than 80;
- FDI greater than 24; and
- Soil dryness Index (SDI) greater than 80

### **Conditions suitable for prescribed burns**

Prescribed burning generally occurs outside of the bushfire danger period between 1<sup>st</sup> April and 30<sup>th</sup> September. To ensure that burns will be contained within predetermined boundaries, specific weather and climatic parameters must be met.

Preferred conditions for prescribed burns include:

- Temperature: suitable temperatures 17-27°C;
- Wind speed: less than 18km / h on the fire ground;
- Wind direction: low probability of strong, dry north-westerly winds;
- Relative humidity: optimum 30-60%, which affects fuel moisture;
- Dew point: a high level of moisture recovery in fine fuels at night;
- Days since rain: minimum 3 - maximum 35;
- Fire Danger Index: Low to Moderate;
- Drought Factor: 4-8; and
- Synoptic weather systems: stable, slow moving high pressure system, followed by rain bearing trough; bringing light north to north-westerly winds.

Within the Reserves, there is a small window of opportunity (15-30 days per annum) where the above mentioned climatic conditions are suitable for prescribed burning. These days usually occur between April to June and August to October.

The main limiting factor for successful burning into winter is the high probability of rain in late autumn and early winter. Rainfall in the study area is not strongly seasonal and conditions for prescribed burning in the cooler months are variable from year to year. The prevailing temperatures, humidity and shorter daylight hours during this period may prevent drying of surface fuels especially on southerly aspects, which have greater moisture retention due to shadows from topography and canopy vegetation.

### **1.3.6 Summary of Key Fire Issues**

- The majority of the Reserves contain vegetation communities that can accumulate high fuel loads and are prone to high intensity fires under a wide range of conditions.
- Arson and suspected arson are responsible for a large number of bushfires within the reserves.
- The reserves have an extensive residential-bushland interface, with a moderate number of neighbours.
- There are a large number of community assets within and adjacent to the reserves and bushfires have the potential to threaten or damage these assets.
- A large proportion of existing assets and property do not conform to Australian Standards for building construction and have not established or maintained appropriate Asset Protection Zones on private property.
- The reserves protect natural and cultural heritage values that are vulnerable to inappropriate fire regimes and fire management activities.

## 2 BUSHFIRE RISKS

### 2.1 Introduction

Bushfire risk is defined as the chance of a fire or fire management activities impacting on significant values within the Reserves. For the purpose of this strategy, bushfire risks have been divided into three major groups:

- life and property risks;
- natural heritage risks; and
- cultural heritage risks.

In accordance with the NPWS Risk Management System, determining the level of risk requires an understanding of the likelihood of bushfire event occurring and the magnitude of its consequences (i.e. the extent of damage or impact on significant values).

The risk assessment process involves the identification of all assets and values within and adjacent to the Reserves that are considered to be at risk from bushfires and the factors that contribute to their level of risk. In conjunction with Gosford BFMC, the level of risk that each asset and value is exposed to is determined. A major tool that supports the risk analysis process is a bushfire behaviour potential model that incorporates terrain (slope, aspect and altitude) and fuel (vegetation, fire history). Appendix 10 provides a description of how the model has been developed to classify the Reserves into one of four bushfire behaviour classes. The results of the risk analysis enable a range of risk management strategies and controls described in Section 3 to be applied.


























### 2.2 Life and Property Risks

Bushfire risk is a complex interaction between a number of variables, including:

- ignition sources and patterns in the landscape;
- the ability of property owners, residents and visitors to take appropriate action in the event of a fire;
- the adherence of properties to the building design and construction standards detailed in AS 3959;
- the establishment and maintenance of adequate asset protection zones as described by *Planning for Bushfire Protection* (RFS 2006a) within private lands;
- the relative degree of isolation of communities and properties;
- access for fire fighters to protect property;
- the adequate deployment and response times of fire fighting resources, both ground and air, to suppress fire and protect property; and
- the fire behaviour potential of the landscape based on the interaction of topography, vegetation type, fire history and fuel accumulation rates.

There are 25 locations within and around the reserves where property and facilities are at risk from bushfires (Map 2.1) including isolated facilities and residential communities at MacMasters Beach, Bensville, Killcare Heights, Hardys Bay, Pretty Beach, Wagstaffe, Daleys Point and Empire Bay (Table 3).

**Table 3 Property and facilities at risk from wildfire within and adjacent to the Reserves**

Map ID	Location	Tenure	Map ID	Location	Tenure
 T1	Putty Beach Day Use Area	NPWS	 T14	Bouddi Shed	NPWS
 T2	Mt Bouddi (Dingeldei) Day Use Area	NPWS	 T15	Boobialla House	NPWS
 T3	Lobster Beach Day Use Area	NPWS		Bouddi Coastal Walk (main section of timber boardwalk)	NPWS
 T4	Little Beach Camping Area	NPWS	 T17	MacMasters Beach Community	Private
 T5	Putty Beach Camping Area	NPWS	 T18	Bensville Community	Private
 T6	Tallow Beach Camping Area	NPWS	 T19	Killcare Heights Community	Private
 T7	Maitland Bay Centre	NPWS	 T20	Hardys Bay Community	Private
 T8	Allen Strom Lookout	NPWS	 T21	Pretty Beach Community	Private
 T9	Killcare Heights (Marie Byles) Lookout	GCC	 T22	Wagstaffe Community	Private
 T10	Flannel Flower Track Lookout	NPWS	 T23	Daleys Point Community	Private
 T11	Gerrin Point Lookout	NPWS	 T24	Empire Bay Community	Private
 T12	Buggeries Lookout	NPWS	 T25	Empire Bay Oyster Shed	Private
 T13	Strom's House & Centre	NPWS			

### 2.2.1 Utilities and infrastructure

Within and adjacent to the reserves there are a variety of public and private utilities that are considered at risk from bushfires, including:

- Energy Australia powerlines and substations;
- Gosford City Council Water infrastructure;
- Telecommunications infrastructure; and
- DECC managed transmission lines, water pipelines and sewage pumping stations.

## **2.2.2 Visitor Safety**

High visitation areas considered at risk include:

- Little Beach Camping Area
- Mt Bouddi Picnic Area
- Maitland Bay Precinct including Marie Byles Lookout
- Putty Beach Precinct
- Bouddi Coastal Walk
- Tallow Beach Camping Area
- Lobster Beach Precinct

There is a history of anti-social behaviour at Putty Beach, Little Beach and Tallow Beach camping areas and Mount Bouddi picnic area resulting in an increased incidence of illegal fires.

## **2.3 Natural Heritage Risks**

Natural heritage values at risk (such as endangered ecological communities, threatened flora and fauna, sensitive catchments and landscapes susceptible to erosion) are shown on Maps 2.2, 2.3 & 2.4. Natural heritage values may be placed at risk as a result of inappropriate fire regimes, adverse fire management activities, and post fire erosion and pest species invasion.

### **2.3.1 Inappropriate fire regimes**

Fire regimes are defined by the combination of fire frequency, intensity, season of occurrence, fire type and extent (Whelan, 1995).

High fire frequency has been identified as a key threatening process, as it disrupts key life cycle processes in plants and animals. High fire frequency fire may cause the local extinction of species and populations by directly killing individuals, altering critical habitat requirements of species, changing the availability of resources, and enhancing the opportunities for predation and the spread of weeds. Alternatively, the exclusion of fire for an extended period of time may lead to the senescence of plants and their seed banks and the transition of other communities.

An analysis of fire regimes within the Reserves shows a representative range of successional stages (age classes) exist within major vegetation communities. There are small areas within the reserves that have been burnt more frequently than the minimal interval and are exceeding their lower thresholds. There are also some areas that are exceeding their upper thresholds. Many of these areas are of major significance as they represent long un-burnt vegetation which is very rare (Map 2.5).

Large wildfire events are a major risk to natural heritage values within the Reserves. This is because the Reserves are fragmented and isolated from other conservation reserves which reduces opportunities for species recruitment and recolonisation after major fire events. It is important that a single fire event does not completely burn a significant proportion (i.e. >50%) of a particular community type or the reserve. Unburnt areas within the Reserves provide a refuge for fauna species that may have suffered habitat loss during and soon after fire. These areas then become extremely important for the recolonisation and protection of species.

### **2.3.2 Adverse fire management activities**

Fire management activities associated with fire suppression operations, prescribed burning programs or fire trail maintenance may have an adverse impact on natural heritage features. Activities include the use of fire fighting equipment and heavy plant in the construction of fire breaks and trails and the use of salt water for fire suppression.

### **2.3.3 Soil Erosion**

Many of the soil landscapes within the reserves are prone to erosion. High intensity fires, track and trail construction, maintenance and other fire management works may contribute to greater levels of soil erosion and potential siltation. Specific impacts from soil erosion and run off may include alteration of landforms, the smothering of vegetation, increased sedimentation of drainage lines and water bodies, alteration of aquatic habitat and the invasion of weeds. Extreme erosion events following high intensity wildfires are of particular concern. These produce massive sediment loads and reduce the regenerative capacity of ecosystems through the removal of seed banks and nutrients.

### **2.3.4 Pest species invasion**

The establishment of vertebrate pest and weed species represents one of the major threats to the natural and cultural heritage values of the Reserves. Disturbance by fire may cause an increase in the invasion by weeds and predation and competition by vertebrate pests.

Management of pest species within the Reserves is undertaken in accordance with the *Central Coast Hunter Range Region Pest Management Strategy, 2007-2011* (NPWS, 2007).

## **2.4 Cultural Heritage Risks**

### **2.4.1 Aboriginal Heritage Values**

Aboriginal sites are susceptible to damage and may be destroyed by fire and fire suppression operations (English, 2000). Risks may include:

- High-intensity wildfires which impact on scar trees;
- Soil erosion may be accelerated by fire by removing vegetation, logs and trees which help hold soil *in situ*, exposing Aboriginal sites resulting in artefact movement and making them susceptible to damage;
- Art sites may be damaged from smoke staining, which may lead to chemical weathering, particularly if protective vegetation is removed. Intense heat may also cause exfoliation of the rock surface; and
- Vehicle traffic, including fire appliances, bulldozers, slashers or tritters, may damage sites.

Aboriginal sites occur throughout Bouddi National Park and adjacent to Cockle Bay Nature Reserve. Due to cultural sensitivity, sites locations have not been shown in this strategy. The location of sites is available through AHIMS at all NPWS offices. Appendix 4 lists the guidelines for Aboriginal site management.

### **2.4.2 Historic Heritage Values**

Fire may damage Historic heritage values within the Reserves through a number of factors:

- Bushfires may directly remove or destroy combustible material such as timber structures.
- High-intensity fires may permit soil erosion, which may lead to displacement of foundations, artefact movement and damage to archaeological deposits.
- Vehicles or bulldozers may physically damage features.
- Fire may damage or destroy vegetation with historical significance.
- High-intensity fire may also cause the spalling of rock artefacts.

Historic Heritage Site locations are shown on Map 2.1. Appendix 5 lists the guidelines for historic site management.

## **3 BUSH FIRE RISK MANAGEMENT STRATEGIES**

### **3.1 Introduction**

This Section describes the strategies that will be implemented to reduce bushfire risk to assets and values within and adjacent to the Reserves (as identified in Section 2).

Given the large number of assets within and around the reserves it is not possible to implement strategies and controls for all assets and values every year in all locations. A Fire Management Works Schedule will be prepared annually, listing priority fire management strategies for the Reserves.

An integrated approach to fire management has been adopted, using a range of strategies including public education, land-use planning, fuel reduction, fire trail maintenance, specialised suppression activities, and cooperative arrangements with other authorities and neighbours.

The strategies are implemented in consultation with Gosford BFMC, the Rural Fire Service (RFS), NSW Fire Brigades, park neighbours and other stakeholders. The cooperation of the community is critical to the success of many strategies. In particular, the NPWS must work with BFMCs to encourage neighbours to accept responsibility for the management of fuels on their properties, to prepare and maintain their properties in accordance with AS 3959, and to develop personal action plans that can be activated in the event of a bushfire.

### **3.2 Fire Management Zones**

The Reserves and adjacent bushland have been divided into Fire Management Zones according to a zoning system described by the NPWS. Fire Management Zones developed for the reserves were created in consultation with the Gosford Bush Fire Management Committee and will be incorporated into the revised Gosford Bush Fire Risk Management Plan.

As far as possible the boundaries of Fire Management Zones have been defined by fire control advantages including roads, water and areas of low bushfire potential. This has resulted in many Fire Management Zones extending beyond the boundaries of the Reserves onto other land tenures. The strategies proposed for other land tenures are suggested only and are not binding on neighbouring land owners / occupiers. NPWS will pursue the implementation of these strategies on neighbouring land in consultation with the Gosford Bush Fire Management Committee.

A summary of fire management zones used for the reserves is shown in Table 4. Specific management objectives for each zone are shown in Appendix 6 and Map 3.1.



**Table 4: Summary of Fire Management Zones**

<b>Zone type</b>	<b>Management objective</b>	<b>General location of zone</b>
<b>Asset Protection Zones (APZ)</b>	<ul style="list-style-type: none"> <li>To protect human life, including permanent residents, visitors and fire fighters from bushfires</li> <li>To protect residential areas, utilities, camping areas, day use areas, cultural heritage sites and other built assets</li> </ul>	<ul style="list-style-type: none"> <li>Adjacent to assets, in accordance with <i>Planning for Bush Fire Protection</i></li> </ul>
<b>Strategic Fire Advantage Zones (SFAZ)</b>	<ul style="list-style-type: none"> <li>To reduce fire intensity and spotting distance so as to assist in the control and containment of bushfires</li> <li>To reduce the probability of bushfires being ignited adjacent to assets</li> <li>To complement APZs and to strengthen existing fire control lines.</li> <li>To restrict the movement of bushfires between fire management zones.</li> <li>To restrict the movement of bushfires from other land onto NPWS lands and from NPWS lands onto neighbouring land</li> <li>To break up large continuous areas of high potential for bushfire and to reduce the probability of large landscape-scale bushfires</li> </ul>	<ul style="list-style-type: none"> <li>Adjacent to economic assets</li> <li>In areas with a proven history of bushfire ignitions</li> <li>Adjacent to existing fire control advantages or in linked fire control advantages</li> <li>Adjacent to APZs</li> <li>Other strategic areas for controlling the spread of bushfires</li> </ul>
<b>Land Management Zones (LMZ)</b>	<ul style="list-style-type: none"> <li>To maintain and enhance biodiversity by preventing the extinction of species which occur naturally within the reserves</li> <li>To protect Aboriginal sites, historic heritage sites and other culturally significant features from fire</li> <li>To promote awareness of the values that may be threatened by bushfires or inappropriate fire regimes within the LMZ</li> </ul>	<ul style="list-style-type: none"> <li>Core areas of reserve not satisfying the criteria for inclusion in APZs or SFAZs and being managed consistent with the principles outlined in the <i>National Parks and Wildlife Act 1974</i></li> </ul>

### **3.3 Cooperative management**

This strategy promotes the development and implementation of cooperative and coordinated fire management arrangements and the reduction of bushfire hazards with other fire authorities, reserve neighbours and the community. Cooperative arrangements are derived from the Bush Fire Coordinating Committee (BFCC) and implemented through the Gosford Bush Fire Management Committee.

This strategy is a relevant plan in accordance with section 38 (4) and section 44 (3) of the Rural Fires Act 1997. The NPWS is seeking the cooperation of all fire authorities in adopting the strategies outlined within this document when responding to bushfires within these reserves.

### **3.4 Bushfire Prevention**

The NPWS may implement the following strategies for bushfire prevention within the Reserves:

- Fire investigators will cooperate with police, RFS and NSW FB to investigate all suspicious ignitions within the reserves and to thoroughly investigate unknown causes.
- Close all or part of the reserves during total fire bans, park fire bans, periods of extended fire danger or if bushfires occur adjacent to the reserves in order to control the risk of arson or accidental fires and to ensure public safety.
- Install and maintain locked fire trail gates where necessary and maintain key registers with other agencies and organisations in order to control access.
- Undertake patrols and promote cooperative surveillance programs on days of very high and extreme fire danger to manage the risk of arson and other accidental ignitions.
- Support the implementation of fire prevention education.
- Replace wood or fuel barbecues with gas barbecues in accordance with plans of management in order to minimise the risk of fires starting from abandoned cooking fires.
- Liaise with permit issuing authorities (e.g. RFS and councils) to ensure neighbours obtain appropriate hazard reduction certificates and fire permits in order to minimise the potential for fires escaping private property.
- Liaise with infrastructure authorities to determine appropriate prevention strategies for potential ignition sources associated with their operations and assets in or adjacent to the reserves.
- Ensure that prescribed burns are planned to appropriate agency standards, are directed by appropriately trained and experienced staff, and are undertaken within weather prescriptions in order to prevent fire escapes.
- Ensure thorough mop-up and patrol of perimeter of wildfires and prescribed burns during or before the onset of extreme weather conditions in order to minimise the potential for re-ignition of fires.
- Prohibit the use of wood fires in the Reserves. Consideration will need to be given to options for Mt Bouddi picnic area.

### **3.5 Bushfire Suppression**

Fire suppression relates to all actions or operations undertaken to contain and control a bushfire, from the time it is detected until it is extinguished. The control and suppression of bushfires is given the highest priority over all other activities. During fire suppression, the protection of life and property has the highest priority, followed by the protection of natural and cultural heritage features.

The following strategies for bushfire suppression may be implemented within the reserves:

#### **3.5.1 Incident Preparedness**

NPWS maintains a level of bush fire suppression preparedness to ensure that it can meet its objectives for fire management on NPWS managed lands and to assist other agencies with coordinated responses. The level of preparedness is based on forecast fire danger and drought indices. Incident preparedness strategies include:

- Participate with Gosford BFMC in the review of Section 52 operations coordination plans in order to document cooperative agreements for the coordination of the first response to a fire, notification of a fire, agency resources and fire suppression guidelines.
- Prepare annual RIPs in order to maintain a contact database of NPWS staff, other fire agencies and support agencies or organisations, and detailed procedures relating to preparedness and management of bushfires.
- Maintain appropriate levels of personal protective equipment, training, vehicles, equipment and other materials to ensure the safety of fire fighters and their ability to respond to bushfire ignitions.
- Maintain effective radio communication systems to facilitate efficient and safe fire management operations. Known areas of poor reception include Putty Beach and Little Beach.
- Develop resource dispatch strategies for different bushfire scenarios in order to increase the probability of first attack success and the protection of assets and features at risk.
- Undertake multi-agency incident-management team exercises in order to review response strategies, to identify high risk fire scenarios, and to develop close working relationships and understanding between agencies and other organisations.

In preparing for incidents, the NPWS advocates the importance of neighbours taking responsibility to prepare their properties in accordance with building protection standards, including cleared setback areas and building standards, as outlined in Planning for Bushfire Protection (RFS 2006a).

### **3.5.2 Response**

Incident response strategies include:

- Maintain cooperation and communication with the RFS, NSW FB and other support agencies to ensure adequate and effective resource dispatch for the suppression of bushfires on or adjacent to the Reserves in order to minimise the spread of fire.
- Ensure that fire suppression activities within the Reserves take into consideration guidelines for threatened species, cultural heritage and the standard operational guidelines detailed in Appendices 1-7 in order to minimise environmental impacts on the reserves.
- Remain prepared and modify work programs according to the level of fire danger in order to maintain appropriate response time to ignitions.
- Develop media and public relations strategies to engender community confidence in, awareness of and support for bushfire management.
- Manage bushfires in accordance with the incident control system to ensure coherent command and control and the safety of fire fighters and the community. Incident management is co-ordinated from the NPWS Regional Office or the Emergency Operations Centre, at Kariong. The Maitland Bay Centre and Strom Centre are suitable as forward command locations.
- Use aircraft to attack inaccessible fires in order to minimise the spread of fires and to protect assets and features at risk.
- Report fire suppression activities through the RFS Incident Control Online system (ICON) and in NPWS geographic information systems so as to maintain a record of all fires.

### **3.5.3 Recovery**

NPWS considers post fire recovery and rehabilitation as an integral component of fire management. The need for post fire rehabilitation will be assessed by the Incident Controller as part of the incident management process. A recovery / rehabilitation officer will be appointed during incidents where necessary.

Where necessary, a detailed rehabilitation plan will be prepared in accordance with the NPWS Fire Management Manual. Urgent rehabilitation works should be undertaken during incident de-escalation, particularly the closure and drainage requirements of temporary access trails.

Strategies will be developed, where necessary for the rescue of injured wildlife.

## **3.6 Fuel Management**

Fuel management is the practice of maintaining fuels at acceptable levels in areas where assets are at risk from bushfires and in areas critical to the suppression of fires. Fuel management can be achieved by a variety of techniques including prescribed burning, mechanical slashing, mowing, and under scrubbing.

### **3.6.1 Prescribed Burning**

Prescribed burning is the controlled use of fire under preferred environmental and weather conditions to a predetermined area with the aim of reducing fire risk under adverse conditions by modifying fuel loads and structure.

A number of variables are considered in determining priority areas for prescribed burning. These include:

- **Zone type**—generally areas that are zoned as SFAZs or APZs will be considered for treatment more frequently than LMZs.
- **Fire history**—the known history and frequency of bushfires within the zone indicate the likelihood of future events and can be used to determine the prescribed burning intervals.
- **Proximity to assets at risk**—influences the frequency of prescribed burning to maintain reduced fuel loads and to modify vegetation structure adjacent to assets.
- **The strategic value of the area**—influences the priorities for strategically locating prescribed burns in the landscape to provide an advantage during a fire suppression operation.
- **Fuel accumulation rates**—known rates of fuel accumulation are used to identify fire interval thresholds to manage fuels within certain levels.
- **Known and modelled fire behaviour**—the characteristics of fuel, aspect and terrain are assessed to determine the required fire intervals to manage likely fire behaviour (Map 3.3).
- **Ecological requirements**—are considered to ensure that appropriate fire regime requirements are maintained for vegetation communities (Appendix 1), threatened flora (Appendix 2), threatened fauna (Appendix 3), Aboriginal heritage (Appendix 4), historic heritage (Appendix 5) and standard operating guidelines (Appendix 7).

### 3.6.2 Fire Breaks

Fire breaks are manually or mechanically reduced areas of bush fire fuels, typically along the boundary between a reserve and neighbouring properties, which aim to enable safe fire fighter access under moderate conditions and compliment preparedness works undertaken by neighbours.

For the purposes of this *Fire Management Strategy*, fire breaks are considered a Strategic Fire Advantage Zone. The locations of fire breaks within the reserves are shown in Map 3.1 and the management strategies for each fire break are outlined in Table A6.3 in Appendix 6.

In many areas, the presence of cliffs, escarpments and slopes over 18° create a situation where there may be no physical or practical means of establishing a fire break. In these circumstances, NPWS will work with Gosford BFMC to encourage neighbours to undertake other appropriate measures to prepare their properties.

The establishment of new fire breaks will be subject to an environmental assessment either by a review of environmental factors or in accordance with the *Bushfire Environmental Assessment Code* (RFS 2006b). In addition, the cumulative impacts of fire breaks on the reserves will be assessed.

### 3.7 Fire Management Access

The NPWS maintains a system of roads, management trails and walking tracks within the Reserves to support fire suppression and prevention operations. The location of trails within the Reserves are illustrated in Map 3.2 and described in Appendix 8. Approximately 26km of management trails exist within the Reserves including Daleys Point Trail and Hawke Head Drive which are partly managed by Gosford City Council.

The Reserves are accessible from public roads maintained by Gosford City Council including Empire Bay Drive, Palmers Lane, Wards Hill Rd, Maitland Bay Drive, The Scenic Road, part of Putty Beach Drive, Graham Drive and Hawke Head Drive. Public roads managed by the NPWS include part of Putty Beach Drive and Mount Bouddi Road.

#### 3.7.1 Classification of Trails

The classification of fire trails is based on the Bush Fire Coordinating Committee (BFCC) Policy 2/2007 (Tables 5 & 6). This classification system provides the basis for the development of maintenance regimes for existing trails and the standards for proposed upgrades to trails. The classification of trails has been undertaken in consultation with Gosford BFMC and is consistent across member agencies, and takes into account slope, clearance height and width, vehicle weights (in terms of bridges, sand and waterlogged soils), passing bays and turning circles. Any proposed upgrades to trails will be subject to a review of environmental factors.

**Table 5 Classification of Fire Trails (BFCC 2007)**

Classification	Description
Essential	• Fire trail essential for fire response and suppression.
Important	• Fire trail suitable for fire management.
Dormant	• Track or trail that is closed, but has strategic value as a control line.

**Table 6 Vehicle Carrying Capacity**

Classification	Description
Public road	• Any major or minor public road accessible by two-wheel-drive vehicles.
Cat 1 heavy tanker	• Trail that can be safely traversed by a Category 1 fire fighting appliance.
Cat 7 light tanker	• Trail that can be safely traversed by a Category 7 fire fighting appliance.
Cat 9 light tanker	• Trail that can be safely traversed by a Category 9 fire fighting appliance.

### 3.7.2 Trail Construction & Maintenance

Trails in the reserves are maintained in accordance with NPWS policy in the *Fire Management Manual* (NPWS 2006), the relevant reserve plan of management and Soil Conservation Service standards (DLWC, 1994). The trail maintenance program for the reserves is managed using the NPWS Asset Maintenance System, which establishes a cyclic maintenance program for trails within the reserves.

Appendix 9 details the tenure and the maintenance responsibilities for each trail and is illustrated in Map 3.2.

The construction of additional management trails will be limited to the following situations:

- Re-alignment of an existing route to a more environmentally acceptable location, combined with rehabilitation of the original route;
- Where the trail will provide protection of specific natural or cultural heritage values;
- Where the additional trail is essential for fire management; and
- Temporary trails in emergency situations such as wildfire control.

Authorised access to reserve trails may be undertaken by fire authorities, support agencies and utility companies. Keys will be issued to relevant authorities to facilitate access for emergency and incident management purposes,

### 3.7.3 Walking Tracks

The network of formal and informal walking tracks provides important fire advantages for suppression and prevention operations. Walking tracks within the reserves are managed in accordance with policies and procedures detailed in the relevant plans of management for the reserves.

### 3.7.4 Hand tool lines

A hand tool line is a temporary fire control line generally less than 2 metres wide constructed with hand tools in terrain that is too rugged or environmentally sensitive for use of machines. The following strategies can be used for the management of hand tool lines within reserves:

- Hand tool lines are constructed in accordance with best practice guidelines to minimise the potential for environmental degradation.
- The location and route of hand tool lines used during fire suppression operations or prescribed burns are mapped and recorded for future reference and re-use.
- Where necessary, hand tool lines are rehabilitated to prevent erosion and the establishment of informal access routes.
- In some instances, routine maintenance of vegetation regrowth along a hand tool line may be considered where the hand tool line is of strategic value.

### 3.8 Other Fire Control Advantages

Other fire control advantages are features that may be used to support bushfire suppression operations and include water points for vehicles and helicopters, helipads and refuge areas. The locations of advantage points in the Reserves are shown on bushfire suppression maps.

Strategies for the management of other fire control advantages include the following:

- Advantage points are mapped where possible using GPS (Geographic Positioning System), or from air photos or local knowledge;
- Advantage points are inspected as part of a cyclic program in order to determine works requirements;
- Advantages are incorporated into the BFMC Section 52 operations coordination plans; and
- The fire advantage network within and adjacent to the Reserves is evaluated to determine additional advantage requirements in conjunction with Gosford BFMC. If required, other fire control advantages may be strategically located in the reserves to support fire management operations.

### 3.9 Environmental Assessment

The construction of trails, fire breaks and the implementation of prescribed burns are subject to site-specific environmental assessment by the NPWS, either by a review of environmental factors or in accordance with the *Bushfire Environmental Assessment Code* (RFS, 2006b). In addition, an assessment will be undertaken to assess the cumulative impacts of hazard reduction regimes on populations and communities within the landscape. The management requirements for vegetation communities (Appendix 1), threatened flora (Appendix 2), threatened fauna (Appendix 3), Aboriginal heritage (Appendix 4), and historic heritage (Appendix 5) within each fire management zone are considered during assessments.



### **3.9.1 Smoke Management**

Smoke from bushfires and prescribed burns can impact significantly on communities. It is a particular problem affecting residential areas, schools and hospitals, retirement villages and major transport routes.

Smoke sensitive areas adjacent to the reserves include urban and residential areas of MacMasters Beach, Killcare Heights, Killcare, Pretty Beach, Wagstaffe, Hardys Bay, Daleys Point, Empire Bay and Bensville.

Prescribed burning operations should be undertaken during favourable weather conditions to allow for the swift dispersal of smoke from the vicinity of the fire. NPWS Operational Guidelines for smoke management are detailed in the Appendix 7. These guidelines will be considered during the development of prescribed burning strategies.

### **3.10 Community Education and Cooperation**

Community education programs may facilitate public appreciation and understanding of the fire management risks and management strategies to be implemented within the Reserves. In conjunction with other member agencies of the BFMC, the NPWS may implement the following strategies during the life of this strategy:

- Support the RFS in FireWise activities in vulnerable communities to increase the number of community members who prepare for fire on their properties.
- Support the NPWS Discovery program to incorporate fire management issues in displays, shows, guided walks and field study trips.
- Investigate requests for hazard reduction or hazard complaints, where necessary jointly with the RFS or NSW FB. In all instances, NPWS will promote a holistic approach to the management of hazard complaints and promote the principle of shared responsibility for risk management with neighbours.

### 3.11 Research and monitoring

The principles of adaptive fire management will be adopted for the reserves. Adaptive fire management provides a framework for the effective integration of research, management, monitoring and review of management actions.

Research is required to provide a better understanding and to establish a knowledge base for effective fire management.

Monitoring to assess the outcomes of management actions against set objectives and performance indicators will be undertaken across the Reserves in order to inform future management.

Priorities for fire management research are outlined in Table 7. Collaborative studies between the NPWS and external institutions will be encouraged.

**Table 7 Priorities for fire management research within the Reserves**

Environmental works	
<b>Species</b>	<ul style="list-style-type: none"> <li>Record life history attributes of individuals and population responses of plant and animal species in response to fire.</li> <li>Priority will be given to those listed under the <i>Threatened Species Conservation Act</i> or identified as of high conservation significance including indicator species within EECs (i.e. <i>Banksia aemula</i>, <i>Themeda australis</i>).</li> </ul>
<b>Populations Communities</b>	<ul style="list-style-type: none"> <li>Test differences in structure, composition diversity of communities/ populations approaching/ exceeding suggested fire management thresholds (i.e. Bombi Moors, Box Head).</li> <li>Identify indicator species to measure the distribution of communities in relation to fire. Priority will be given to those listed under the <i>Threatened Species Conservation Act</i> or identified as of high conservation significance.</li> <li>Identify critical habitat of animal species. Measure critical habitat attributes versus relative abundance.</li> </ul>
<b>Threats</b>	<ul style="list-style-type: none"> <li>Record and monitor vertebrate <b>pest</b> distribution / density before and after fire; including predator/ prey relationships.</li> <li>Record and map the distribution / density of <b>introduced plant</b> species before and after fire.</li> <li>Monitor rates of <b>soil erosion</b> as a result of track, trail, road construction, prescribed burning and wildfire.</li> <li>Examine the impact of salt water (used in water bucketing operations) on plant species and communities.</li> </ul>
<b>Fuel</b>	<ul style="list-style-type: none"> <li>Undertake fuel sampling before and after fire in order to measure:               <ol style="list-style-type: none"> <li>Fuel accumulation/ distribution in selected fuel types</li> <li>The effectiveness of prescribed burns</li> <li>Fire behaviour in varying conditions</li> </ol> </li> <li>Carry out fuel moisture measurements during prescribed burning operations.</li> </ul>
<b>Weather</b>	<ul style="list-style-type: none"> <li>Record climatic variables such as maximum temperature, rainfall, drought indices, predominant wind direction and speeds on a daily basis.</li> </ul>
<b>Cultural</b>	<ul style="list-style-type: none"> <li>Monitor the condition of Aboriginal Sites following fire and fire management activities in cooperation with the Darkinjung ALC.</li> </ul>

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## APPENDIX 1: FIRE REGIME GUIDELINES FOR VEGETATION COMMUNITIES

Table A1 outlines the fire interval guidelines for vegetation communities in the reserves. The guidelines have been compiled from best available information and research on the fire ecology of the communities (NPWS, 2003c). The fire interval thresholds are based on a consideration of the broad vegetation type and the species composition of communities. The minimum interval is based on the primary juvenile periods of species sensitive to extinction under frequent fire regimes and does not include the time to replenish seed bank reserves. The maximum interval indicates the time since a fire at which species may be lost from the community due to senescence. The figures for maximum intervals are largely based on assumptions and generalisations rather than on quantitative life history studies.

It is important to note that the fire intervals identified in Table 1A provide a guide to identifying inappropriate fire regimes within the Reserves. They do not specify the preferred or desired fire intervals for vegetation communities on a long-term basis. Desired fire regimes are those that provide a diversity of fire intervals (within the intervals range identified) along with patterns of fire intensity, season of occurrence and spatial extent. Extinctions are most likely to occur when fire regimes of relatively fixed intensity, frequency and extent prevail without variation.

**Table A1: Fire interval guidelines for vegetation communities**

Regime	Vegetation Community	Minimum Interval (years)	Maximum Interval (years)	Area ha (%)
<b>A</b>	<ul style="list-style-type: none"> <li>Coastal Headland Grassland</li> </ul> <i>Includes Themeda grassland on sea cliffs and coastal headlands EEC</i>	2	10	2.15ha (0.08%)
<b>B</b>	<ul style="list-style-type: none"> <li>Phragmites Rushland</li> </ul>	6	35	0.28ha (0.02%)
<b>C</b>	<ul style="list-style-type: none"> <li>Coastal Headland Shrubland</li> <li>Bouddi Sandstone Coastal Heath</li> <li>Killcare Hawkesbury Woodland</li> </ul> <i>Includes Duffys Forest EEC</i> <ul style="list-style-type: none"> <li>Exposed Hawkesbury Woodland</li> <li>Coastal Sand Wallum-Heath</li> </ul> <i>Includes Eastern Suburbs Banksia Scrub EEC</i> <ul style="list-style-type: none"> <li>Coastal Sand Foredune Scrub</li> <li>Coastal Sand Banksia Scrub</li> <li>Wagstaffe Spotted Gum Ironbark Forest</li> </ul> <i>Includes Pittwater Spotted Gum Forest EEC</i> <ul style="list-style-type: none"> <li>Swamp Mahogany-Paperbark Forest</li> <li>Swamp Paperbark Thicket</li> <li>Coastal Sand Swamp Forest</li> </ul> <i>Includes Swamp Sclerophyll Forest EEC</i> <ul style="list-style-type: none"> <li>Coastal Headland Low Forest</li> <li>Coastal Narrabeen Ironbark Forest</li> <li>Narrabeen Coastal Blackbutt Forest</li> <li>Coastal Sand Apple- Blackbutt Forest</li> </ul>	7	35	1389.45 (56.7%)
<b>D</b>	<ul style="list-style-type: none"> <li>Coastal Narrabeen Moist Forest</li> </ul>	25	60	916.95 (37.4%)
<b>E</b>	<ul style="list-style-type: none"> <li>Estuarine Mangrove Scrub</li> <li>Estuarine Saltmarsh/ Grassland</li> </ul> <i>Includes Coastal Saltmarsh EEC</i> <ul style="list-style-type: none"> <li>Estuarine Swamp Oak Forest</li> <li>Coastal Warm Temperate Forest</li> </ul> <i>Includes Lowland Rainforest EEC</i>	<ul style="list-style-type: none"> <li>Fire Exclusion</li> <li>Any fire likely to lead to a decline in plant species.</li> <li>Fire should be avoided</li> </ul>		142.85 (5.8%)

## APPENDIX 2: FIRE REGIME GUIDELINES FOR THREATENED FLORA SPECIES

**Table A2: Fire regime guidelines for threatened flora species**

Map ID <sup>1</sup>	Scientific Name	Conservation Status <sup>2</sup>	Regeneration	Min Interval <sup>3</sup>	Max Interval <sup>4</sup>	Flowering season	Management Guidelines
FL1	<i>Melaleuca biconvexa</i>	TSC V,	Survives 100% scorch, resprouter, Not enough data to rank sensitivity	?	?	Summer	For all species; <ul style="list-style-type: none"> <li>• Mature individuals tolerate fire, but at unknown frequencies and intensities. Since this species has been recorded in fire sensitive vegetation communities, fire should be avoided in known species locations.</li> </ul>
FL2	<i>Syzygium paniculatum</i>	TSC V, ESP V, Rotap 3VCi	Variable fire response (seeder, resprouter), Fire may lead to extinction	>2	200	Summer	<ul style="list-style-type: none"> <li>• Avoid the use of earth machinery in known locations.</li> <li>• Avoid the use of retardants and foams in locations where this species occurs (usually as remnant riparian vegetation).</li> </ul>

**Map ID<sup>1</sup>** Code to be used to identify features on NPWS operational maps. Based on functional fire response and life history species group based on the vital attributes groups of Noble & Slatyer (1980). See Also the NSW Flora Fire Response Database (NPWS 2000). FL? = Unknown functional group.

**Conservation Status<sup>2</sup>** NSW Threatened Species Conservation Act (TSC) & Commonwealth Endangered Species Protection Act (ESP) listings; Source: NSW Scientific Committee; E = endangered, V = vulnerable, U = Unprotected; ROTAP codes follow Briggs & Leigh; Source: Briggs, J.D. & Leigh, J.H. (1996) Rare or Threatened Australian Plants. 1995 Revised Edition. CSIRO, Canberra.; codes not prefixed by 'Rotap' are suggestions from other sources and not listed in Briggs & Leigh 1996.

**Min Interval<sup>3</sup>**—Minimum intervals based on NSW flora fire response database. Intervals marked with an \* indicate a local variation of interval requirement.






**Max Interval<sup>4</sup>**—Maximum Intervals based on NSW flora fire response database. Intervals marked with an\* indicate a local variation of interval requirement.








**Note** - Species of high conservation significance will be managed in accordance with Appendix 1 Fire Regime Guidelines for Vegetation Communities.












### APPENDIX 3: FIRE MANAGEMENT GUIDELINES FOR THREATENED FAUNA SPECIES

Table A3: fire management guidelines for threatened fauna species

Map ID <sup>1</sup>	Scientific Name	Common Name	Conservation Status <sup>2</sup>	Management Guidelines
 FA1	<i>Pseudophryne australis</i>	Red-crowned Toadlet	V	<ul style="list-style-type: none"> <li>Avoid frequent burning that may reduce leaf litter in known habitat</li> <li>Habitat preference indicates that the populations will survive less frequent fires.</li> <li>Maintain appropriate fire regimes of 8–10 years in preferred Habitats including coastal heath, low open woodland, open forest particularly damp leaf litter in ephemeral drainage lines and soaks.</li> <li>Avoid the use of retardants and foam in creek lines, soaks and gutters.</li> </ul>
 FA2	<i>Pyrrholaemus sagittatus</i>	Speckled Warbler	V	<ul style="list-style-type: none"> <li>Pairs are sedentary and occupy a breeding territory of about ten hectares, with a slightly larger home-range when not breeding.</li> <li>Utilise mosaic burn; no slashing, trittering or tree removal.</li> </ul>
 FA2	<i>Xanthomyza phrygia</i>	Regent Honeyeater	E1	<ul style="list-style-type: none"> <li>Itinerant species generally not affected by fire.</li> <li>Keep fire out of canopy;</li> <li>Avoid burning <i>Eucalyptus robusta</i> forests during flowering season.</li> <li>Maintain appropriate fire regimes within known habitat including Red Ironbark, Red River Gum, also other eucalypts and mistletoe clumps and casuarinas in dry eucalypt woodland and dry sclerophyll forest with mature flowering trees, and riparian vegetation for breeding;</li> </ul>
 FA3	<i>Burhinus grallarius</i>	Bush Stone-curlew	E1	<ul style="list-style-type: none"> <li>High frequency fire may cause local extinction.</li> <li>Fallen wood debris is crucial to the long term survival of species and populations within the reserves.</li> <li>Exclude fire from known Bush Stone Curlew nesting and roosting sites particularly during the breeding season August-March.</li> <li>Ensure prescribed fire is managed to maintain under storey mosaic and to minimise impact on the under storey and large fallen logs.</li> <li>Avoid the use of vehicles or heavy equipment in known nest sites. No slashing, trittering or tree removal.</li> <li>Carry out post fire pest control program.</li> </ul>
 FA3	<i>Callocephalon fimbriatum</i>	Gang-gang Cockatoo	V	<ul style="list-style-type: none"> <li>Nest in tree hollows, high up and usually near water.</li> <li>Avoid burning of riparian corridors in known locations.</li> <li>Avoid felling of potential roost trees (those with hollows) during mop-up operations;</li> <li>Avoid burning during September to December breeding season.</li> <li>Maintain appropriate fire regimes within known habitat including wet forests, especially densely wooded gullies and adjacent lowland woodlands.</li> <li>Ensure a single fire does not burn all potential food resources (<i>Allocasuarina spp.</i>)</li> </ul>

Map ID	Scientific Name	Common Name	Conservation Status <sup>2</sup>	Management Guidelines
 FA3	<i>Calyptorhynchus lathamii</i>	Glossy Black-cockatoo	V	<ul style="list-style-type: none"> <li>Avoid high intensity fires in <i>Allocasuarina</i> dominated vegetation communities with a recurrent frequency of &lt; 15 years.</li> <li>Maintain diversity in of age structures in community's particularly open forests (with tree hollows for roosting) dominated by <i>Allocasuarina spp.</i></li> <li>Protect known nest sites by a 50–200 metre buffer strip.</li> <li>Avoid burning during March to August breeding season.</li> </ul>
 FA3	<i>Lathamus discolor</i>	Swift Parrot	E1	<ul style="list-style-type: none"> <li>Itinerant species, generally not effected by fire.</li> <li>Avoid burning <i>Eucalyptus robusta</i> forests during flowering season.</li> <li>Maintain appropriate fire regimes within community thresholds for Eucalypt forest and woodland, especially where eucalypts are flowering profusely and an abundance of psyllids is available</li> </ul>
 FA3	<i>Ninox connivens</i>	Barking Owl	V	<ul style="list-style-type: none"> <li>Should not be affected by low/medium intensity fires.</li> <li>Maintain appropriate fire regimes within known habitat including Moist Forest Communities.</li> <li>Avoid high intensity fires to minimise damage to hollow-bearing trees, recruitment trees and stags.</li> <li>Protect potential habitat trees prior to prescribed burning and during mop up operations, particularly during winter/spring breeding season.</li> </ul>
 FA3	<i>Ninox strenua</i>	Powerful Owl	V	<ul style="list-style-type: none"> <li>Avoid high intensity prescribed burns or wildfires over large areas that reduce forage habitat</li> <li>Maintain appropriate fire regimes within known habitat including Forests and woodlands (requires tree hollows for roosting).</li> <li>Avoid high intensity fires to minimise damage to hollow-bearing trees, recruitment trees and stags.</li> <li>Protect potential habitat trees prior to prescribed burning and during mop up operations, particularly during winter breeding season.</li> </ul>
 FA3	<i>Pandion haliaetus</i>	Osprey	V	<ul style="list-style-type: none"> <li>Avoid burning near known nesting sites (off-park, South Kincumber), particularly during breeding season (April to July)</li> <li>Maintain appropriate fire regimes within known habitat including Coastal waters, inlets, estuaries, offshore islands, occasionally far up rivers.</li> </ul>
 FA3	<i>Tyto novaehollandiae</i>	Masked Owl	V	<ul style="list-style-type: none"> <li>Maintain appropriate fire regimes within known habitat including Open woodland/forest with tree hollows for roosting.</li> <li>Avoid high intensity fires to minimise damage to hollow-bearing trees, recruitment trees and stags.</li> <li>Protect potential habitat trees prior to prescribed burning and during mop up operations, particularly during winter/spring breeding season.</li> </ul>
 FA3	<i>Tyto tenebricosa</i>	Sooty Owl	V	<ul style="list-style-type: none"> <li>Should not be affected by low/medium intensity fires.</li> <li>Maintain appropriate fire regimes within known habitat including Tall, wet forests in sheltered east and south-east facing mountain gullies.</li> <li>Avoid high intensity fires to minimise damage to hollow-bearing trees, recruitment trees and stags.</li> <li>Protect potential habitat trees prior to prescribed burning and during mop up operations, particularly in winter/spring breeding season.</li> </ul>

Map ID	Scientific Name	Common Name	Conservation Status <sup>2</sup>	Management Guidelines
 FA4	<i>Dasyurus maculatus</i>	Spotted-tailed Quoll	V	<ul style="list-style-type: none"> <li>• Avoid high intensity fires over large areas.</li> <li>• Avoid burning immediately prior and during the April to August breeding period.</li> <li>• Protect potential den site in hollow logs prior to prescribed burning and during mop up operations;</li> <li>• Avoid fires greater than the home range of the species which is approximately 800 ha;</li> </ul>
 FA5	<i>Petaurus australis</i>	Yellow-bellied Glider	V	<ul style="list-style-type: none"> <li>• Maintain appropriate fire regimes that maintain large, mature eucalypts in the overstorey.</li> <li>• Avoid high intensity fires that minimise damage to hollow-bearing trees, recruitment trees and stags.</li> <li>• Protect potential habitat trees prior to prescribed burning and during mop up operations.</li> <li>• Avoid use of machinery around known den sites (tree hollows) during breeding season (August-September).</li> </ul>
 FA9	<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	V	<ul style="list-style-type: none"> <li>• Avoid burning around known roost sites (caves, crevices in cliffs).</li> <li>• Utilise mosaic burn in foraging habitat; avoid fire in the breeding season (Spring-Summer).</li> <li>• Exclude fire from rainforest / moist forest communities and drainage lines.</li> </ul>
 FA9	<i>Miniopterus australis</i>	Little Bent-wing Bat	V	<ul style="list-style-type: none"> <li>• Unlikely to be adversely affected by prescribed fire regimes due to winter hibernation and can utilise a wide range of forest types.</li> <li>• Avoid high intensity fire around known roosting sites during breeding season and to preserve den sites.</li> <li>• Avoid high frequency fire in habitats, as this will decrease prey (invertebrate density).</li> <li>• Maintain a mosaic of age classes within habitat.</li> </ul>
 FA9	<i>Miniopterus schreibersii oceanensis</i>	Eastern Bent-wing Bat	V	<ul style="list-style-type: none"> <li>• Unlikely to be adversely affected by prescribed fire regimes due to winter hibernation and can utilise a wide range of forest types.</li> <li>• Avoid high intensity fire around known roosting sites during breeding season and to preserve den sites.</li> <li>• Avoid high frequency fire in habitats, as this will decrease prey (invertebrate density).</li> <li>• Maintain a mosaic of age classes within habitat.</li> </ul>
 FA9	<i>Mormopterus norfolkensis</i>	Eastern Freetail-bat	V	<ul style="list-style-type: none"> <li>• Occurs in dry sclerophyll forest and woodland. Roost mainly in tree hollows but will also roost under bark or in man-made structures.</li> <li>• Utilise mosaic burn in foraging habitat; avoid fire in the breeding season (Spring-Summer).</li> <li>• Exclude fire from rainforest / moist forest communities and drainage lines.</li> </ul>
 FA9	<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	V	<ul style="list-style-type: none"> <li>• Maintain appropriate fire regimes within community thresholds for forests and woodlands with well developed understorey.</li> </ul>
 FA9	<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheath-tail-bat	V	<ul style="list-style-type: none"> <li>• Avoid high intensity fires to maintain large mature eucalypts in the canopy.</li> <li>• Protect hollow bearing trees in areas where species is known to occur.</li> </ul>

Map ID <sup>1</sup>	Scientific Name	Common Name	Conservation Status <sup>2</sup>	Management Guidelines
 FA9	<i>Scoteanax rueppellii</i>	Greater Broad-nosed Bat	V	<ul style="list-style-type: none"> <li>Utilises a variety of habitats from woodland through to moist and dry eucalypt forest and rainforest, though it is most commonly found in tall wet forest.</li> <li>Although this species usually roosts in tree hollows, it has also been found in buildings.</li> <li>Avoid high intensity fires to maintain large mature eucalypts in the canopy.</li> <li>Protect hollow bearing trees in areas where species is known to occur.</li> </ul>

**Map ID<sup>1</sup>** Code to be used to identify features on NPWS operational maps. Based on functional fire response and life history species group FA1 = Amphibians, FA2 = Passerine Birds, FA3 = Non Passerine Birds, FA4 = Ground Mammals, FA5 = Arboreal Mammals, FA6 = Macropods, FA7 = Reptiles, FA8 = Invertebrates, FA9 = Bats

**Conservation Status<sup>2</sup>** NSW Threatened Species Conservation Act (TSC) & Commonwealth Endangered Species Protection Act (ESP) listings; Source: NSW Scientific Committee; E = endangered, V = vulnerable, U = Unprotected.

**Note** The list does not include Little Tern, Pied Oystercatcher, Sooty Oystercatcher, Lesser Sand Plover, and Terek Sandpiper, which are unlikely to be affected by fire management activities and Squirrel Glider, Southern Brown Bandicoot and Eastern Chestnut Mouse which are considered to be erroneous records.

## APPENDIX 4: GUIDELINES FOR ABORIGINAL HERITAGE MANAGEMENT

The Department of Environment and Climate Change (DECC) Aboriginal Heritage Information Management System (AHIMS) details the location and types of Aboriginal sites within the landscape and the risk of damage that may be caused by fire management activities. The database lists twenty different types of site features currently recognised. The Aboriginal site features in AHIMS have been grouped in Table A4 into five groups on the basis that certain features will respond similarly to fire management activities. For each site group, management strategies have been identified to prevent possible damage to features.

In addition to the strategies in Table A4, effective consultation should be undertaken with local Aboriginal representatives, DECC site officers or the DECC Cultural Heritage Unit to determine appropriate management strategies.

**Table A4: Guidelines for Aboriginal Cultural Heritage management**

Map ID	Site group <sup>2</sup>	Management strategies
<b>AH1</b>	Artefact (AFT) Earth mound (ETM) <i>including middens</i> Hearth (HTH) Non-human bone (BOM) Ochre quarry (OCQ) Potential archaeological deposit (PAD) Shell (SHL)	<ul style="list-style-type: none"> <li>Do not break earth around known sites, especially where there is surface evidence of artefacts, shell, charcoal or ochre.</li> <li>Any surface alteration adjacent to site must be immediately reversed to previous state. A note must be made of site location, and details of site disturbance must be provided to DECC Cultural Heritage Unit.</li> <li>Vehicles or heavy equipment must not be used on or within these sites unless a path exists that will not damage the site.</li> <li>Vegetation which is screening the site must not be damaged.</li> <li>There must be no slashing/trittering of vegetation, no tree removal, and no use of earthmoving equipment such as bulldozers.</li> <li>If using fire, place the control lines well away from the site.</li> </ul>
<b>AH2</b>	Art (ART) <i>including shelters and engravings</i> Grinding groove (GRG)	<ul style="list-style-type: none"> <li>If burning, loose leaf litter must be carefully removed from rock platforms and from under overhangs. Leaf litter is to be returned to the site after the fire, as site may be covered for protection from vandalism.</li> <li>If using fire, place control lines well away from the site.</li> <li>Heavy equipment (including vehicles) must not be used on rock platforms or within 10 m of sites unless an existing road is available for use.</li> <li>If burning, rake loose leaf litter away from vegetation near the site if smoke is likely to mark rock paintings.</li> <li>Do not use chemicals or other retardants within 20 m of art sites. If windy, the distance is to be extended to 50 m.</li> <li>Vegetation which is screening the site must not be damaged.</li> <li>There must be no slashing/trittering of vegetation, no tree removal, and no use of earthmoving equipment such as bulldozers.</li> </ul>
<b>AH3</b>	Aboriginal resource & gathering (ARG) Habitation structure (HAB) Modified tree (TRE) Water hole (WTR)	<ul style="list-style-type: none"> <li>Loose leaf litter and low ground cover are to be manually cleared by raking for 10 m around carved or scarred trees and wooden structures. Wooden structures and trees of concern are to be protected at the time of burn. For example, dampen earth around structures and trees to be protected, and minimise risk of ember attack.</li> <li>If using fire, place control lines well away from the site.</li> <li>Trees of concern must be examined as soon as possible after the passage of the fire, and embers that might cause the tree to burn must be extinguished.</li> <li>Chemicals or other retardants that can harm plants and animals used by Aboriginal people or cause damage to water holes must not be used.</li> <li>There must be no slashing/trittering of vegetation, no tree removal, and no use of earthmoving equipment such as bulldozers.</li> </ul>

*If site is used by Aboriginal people, then liaise with the Aboriginal community to ensure that hazard reduction is timed to cause minimal damage to the resource and is not disruptive to gathering practices. Do not proceed if damage cannot be avoided.*

Map ID	Site group <sup>2</sup>	Management strategies
<b>AH4</b>	Fish trap (FSH) Stone arrangement (STA) Stone quarry (STQ)  <i>Note: there is a high likelihood that other sites from Grouping 1 will be in the general vicinity.</i>	<ul style="list-style-type: none"> <li>Do not move loose stones (i.e. to create a 'natural fire break'), especially where they have been already grouped or arranged.</li> <li>Heavy machinery is not to be used in or adjacent to these sites.</li> <li>Do not drive vehicles or use heavy equipment within these sites unless a path exists that will not damage the site.</li> <li>Vegetation which is screening the site must not be damaged.</li> <li>There must be no slashing/trittering of vegetation,</li> <li>Do not remove trees or use earthmoving equipment such as bulldozers.</li> <li>If using fire, place control lines well away from the site.</li> </ul>
<b>AH5</b>	Aboriginal ceremony & dreaming (ACD) Burial (BUR) Ceremonial ring (CMR) Conflict (CFT)  <i>Note: there is a high likelihood that sites from the other groupings will be in the general vicinity</i>	<ul style="list-style-type: none"> <li>There must be no slashing/trittering of vegetation, no tree removal, and no use of earthmoving equipment such as bulldozers.</li> <li>There must be no breaking of earth near known sites of this group, especially near burials and ceremonial rings.</li> <li>If human skeletal remains are located (and it cannot be confirmed that they are a known Aboriginal burial), then the police must be called, and the immediate location must be treated as a 'crime scene'.</li> <li>Vehicles or heavy equipment must not be used on or within these sites unless on established vehicular access.</li> <li>Vegetation which is screening the site must not be damaged.</li> <li>If using fire, place control lines well away from the site.</li> </ul> <p><i>These types of sites are highly sensitive. Discussions must be held between DECC Aboriginal Heritage Conservation Officer and the local Aboriginal people before any hazard reduction works are undertaken. Do not proceed if a resolution cannot be reached.</i></p>

**1. Map ID:** Code used to identify features on NPWS operational maps.






**2. Site group:** Used to group sites recorded in AHIMS by like environmental variables, i.e. relative to likely fire and hazard reduction impacts. Does not indicate any grouping of sites features on the ground.

## APPENDIX 5: GUIDELINES FOR HISTORIC HERITAGE MANAGEMENT

The DECC's Historic Heritage Information Management System (HHIMS) details the location and types of historic sites within the landscape. Site features in HHIMS have been grouped in Table A5 into five groups on the basis that certain features will respond similarly to fire management activities. For each site group, management strategies have been identified to prevent possible damage to features.

In addition to the strategies in Table A5, consultation will be undertaken by NPWS with archaeologists, DECC Historic Sites officers or the DECC Cultural Heritage Unit to determine appropriate management strategies.

**Table A5: Fire management guidelines to protect historic heritage**

Map ID <sup>1</sup>	Site group <sup>2</sup>	Management strategies
 1	Flammable, structurally sound and unsound, buildings, wooden fences, signs, stock rails	<ul style="list-style-type: none"> <li>As far as possible, protect site from fire.</li> <li>Avoid all ground disturbances, including the use of earthmoving machinery, handline construction and driving over sites.</li> <li>Avoid water bombing.</li> <li>Use of foams, wetting agents and retardant is acceptable.</li> </ul>
 2	Flammable, gardens and exotic vegetation	<ul style="list-style-type: none"> <li>As far as possible, protect site from fire.</li> <li>Avoid all ground disturbances, including the use of earthmoving machinery, handline construction and driving over sites.</li> </ul>
 3	Low flammability but structurally unsound sites, including dry stone walls	<ul style="list-style-type: none"> <li>Avoid all ground disturbances, including the use of earthmoving machinery, handline construction and driving over sites.</li> <li>Avoid water bombing.</li> <li>Use of foams, wetting agents and retardant is acceptable.</li> <li>Site may be burnt by bushfire, back-burn or prescribed burn without damage.</li> </ul>
 4	Low flammability and structurally sound sites and earthworks, including stone foundations, drainage lines	<ul style="list-style-type: none"> <li>Avoid all ground disturbances, including the use of earthmoving machinery, handline construction and driving over sites.</li> <li>Use of foams, wetting agents and retardant not permitted in drainage lines.</li> <li>Site may be burnt by bushfire, back burn or prescribed burn without damage.</li> </ul>
 5	Low, flammability, mines, quarries, monuments, plaques, items with very little intact fabric	<ul style="list-style-type: none"> <li>Site unlikely to be affected by fire or any fire management activities.</li> </ul>

**1. Map ID:** Code used to identify features on NPWS operational maps.

**2. Site group:** Used to group sites identified in HHIMS by like environmental variables, i.e. relative to likely fire and hazard reduction impacts. Does not indicate any grouping of sites features on ground.

## APPENDIX 6: FIRE MANAGEMENT ZONES

### Asset Protection Zones

Asset Protection Zones (APZs) are fuel-reduced areas around assets or groups of assets, which are adjacent to bushfire hazards. Seven asset protection zones have been defined within the Reserves (Map 3.1). The primary fire management objective in APZs is the protection of life and property (see Section 3.2), which will be achieved by implementing strategies described in Table A6.1.

**Table A6.1 Asset Protection Zones objectives and strategies**

Map ID.	Map/s	Zone Name	Zone Area (ha) <sup>1</sup>	Specific Objectives	Strategies
APZ1	3.1	Tallow Beach Camping Area	<1	<ul style="list-style-type: none"> <li>To protect campers and infrastructure at Tallow Beach Camping Area from fire.</li> </ul>	<ul style="list-style-type: none"> <li>Maintain fire breaks around NPWS buildings, camp grounds and facilities.</li> <li>Annual maintenance to NPWS buildings to reduce ignition from embers</li> <li>Wood fires to be removed from all picnic and camping areas and regular enforcement of regulations re: no fires.</li> <li>Display notices at appropriate locations during total &amp; reserve fire ban periods.</li> <li>Maintain, where possible vehicular access to all assets.</li> <li>Notify visitors of fire operations within the reserve.</li> <li>Reserve may be closed to the public when it is considered necessary due to conditions which create an extreme fire danger or during fire fighting operations.</li> <li>Prescribed burning of adjacent fire management units at appropriate intervals to manage the overall fuel hazard.</li> </ul>
APZ2	3.1	Putty Beach Picnic & Camping Area	1	<ul style="list-style-type: none"> <li>To protect campers and infrastructure at Putty Beach Picnic Area and Camping Area from fire.</li> </ul>	
APZ3	3.1	Strom Centre / Bouddi Shed	<1	<ul style="list-style-type: none"> <li>To protect Strom House, Centre, gardens and Bouddi Shed from fire.</li> </ul>	
APZ4	3.1	Little Beach Camping Area	<1	<ul style="list-style-type: none"> <li>To protect campers and infrastructure at Little Beach Camping Area from fire.</li> </ul>	
APZ5	3.1	Maitland Bay Day Use Area	<1	<ul style="list-style-type: none"> <li>To protect visitors and infrastructure including Maitland Bay Centre from fire.</li> </ul>	
APZ6	3.1	Mount Bouddi Day Use Area	<1	<ul style="list-style-type: none"> <li>To protect visitors and infrastructure including facilities and Dingeldei Memorial Shelter from fire.</li> </ul>	
APZ7	3.1	Boobialla House	<1	<ul style="list-style-type: none"> <li>To protect residents and Boobiala House from fire.</li> </ul>	

<sup>1</sup> All areas generated by GIS and hence may differ slightly from gazetted areas.



### Strategic Fire Advantage Zones

Forty three strategic fire advantage zones (SFAZs) have been defined within and around the Reserves (Map 3.1). The primary fire management objectives in SFAZs are to reduce the occurrence of human caused unplanned fires in the reserves and to prevent the spread of fire within, from and into the reserves (see Section 3.2). SFAZs also contribute towards preventing the extinction of all species which are known to occur naturally within the reserves (conserving biodiversity) by affording some measure of control over the spread of unplanned fires which would otherwise result in adverse fire regimes and local species extinctions. These objectives will be achieved by:

#### Land-use planning

- Ensure provisions for bushfire protection planning are included in DCPs, LEPs and DAs for fire prone lands adjacent to the reserves.

#### Preparedness and prevention measures

- Fuel management will be undertaken by various methods, including prescribed burning in consultation with various landholders, and selective shrub removal as part of an approved “*Firewise*” activity or under the *Draft Policy on Co-operative Arrangements for Fuel Management on Common Boundaries*. Mechanical clearing and maintenance of tracks, trails and fire breaks.

#### Education

- Promote bushfire preparedness and encourage neighbours to implement fuel protection measures on their own property.

#### Fire Management

- Immediately suppress wildfires.

Specific strategies for each strategic fire advantage zone are shown in Table A6.2. Note that the fire breaks and trails described in table & 9 also serve an important role in preventing the spread of fire within, from and into the reserves.

**Table A6.2: Strategic Fire Advantage Zones Objectives and Strategies – Prescribed burning compartments**

Map ID.	Map	Zone Name	Zone Area (ha) <sup>1</sup>	Specific Objectives	Strategies
SFAZ1	3.1	Wagstaffe Point	12	<ul style="list-style-type: none"> <li>• To assist in the protection of residential, natural and cultural heritage assets in the Wagstaffe / Lobster Beach / Pretty Beach and Hardys Bay area.</li> <li>• To assist in the strategic control of wildfires to reduce wildfire intensity and spotting intensity.</li> </ul>	<ul style="list-style-type: none"> <li>• Implement prescribed burn of each individual unit on a cyclic pattern, in consultation with affected neighbours but not more than once every 7 years.</li> <li>• Burning to be undertaken cooperatively with neighbours, where required.</li> <li>• Implement threatened species and cultural heritage management strategies (Appendices 1-5).</li> </ul>
SFAZ2	3.1	Albert Street	7		
SFAZ3	3.1	Lobster Beach	6		
SFAZ4	3.1	Flannel Flower Track (Deakes)	4		
SFAZ5	3.1	Pretty Beach	13		
SFAZ6	3.1	Hawke Head Drive	11		
SFAZ7	3.1	Hardys Bay	18		
SFAZ8	3.1	Grandview Crescent	17		

Map ID.	Map	Zone Name	Zone Area (ha) <sup>1</sup>	Specific Objectives	Strategies
SFAZ9	3.1	MacDonald Street	9	<ul style="list-style-type: none"> <li>To assist in the protection of residential, natural and cultural heritage assets in the Putty Beach, Killcare Heights area including park facilities at Putty Beach precinct and Bouddi Coastal Walk.</li> </ul>	<ul style="list-style-type: none"> <li>Implement prescribed burn of each individual unit on a cyclic pattern, in consultation with affected neighbours but not more than once every 7 years.</li> <li>Burning to be undertaken cooperatively with neighbours, where required.</li> <li>Implement threatened species and cultural heritage management strategies (Appendices 1-5).</li> <li>Implement prescribed burn of each individual unit on a cyclic pattern, in consultation with affected neighbours but not more than once every 7 years.</li> <li>Burning to be undertaken cooperatively with neighbours, where required.</li> <li>Implement threatened species and cultural heritage management strategies (Appendices 1-5).</li> </ul>
SFAZ10	3.1	Putty Beach Drive	8		
SFAZ11	3.1	Jacqueline Ave (west)	1	<ul style="list-style-type: none"> <li>To assist in the strategic control of wildfires to reduce wildfire intensity and spotting intensity.</li> </ul>	
SFAZ12	3.1	Putty Beach Catchment	61		
SFAZ13	3.1	Killcare Heights Lookout	2	<ul style="list-style-type: none"> <li>To assist in preventing fires entering or exiting Bouddi National Park.</li> <li>To strengthen The Scenic Rd and Mt Bouddi Rd as a fire control advantage to assist in preventing fires spreading from NW Ridge and MacMasters Ridge Bouddi Grand Deep Land Management Zone.</li> </ul>	
SFAZ14	3.1	Stroms Track	7		
SFAZ15	3.1	The Scenic Road	9		
SFAZ16	3.1	Mount Bouddi Rd (West)	3	<ul style="list-style-type: none"> <li>To assist in the protection of residential, natural and cultural heritage assets in the Bombi Rd and Grahame Dr area.</li> </ul>	
SFAZ17	3.1	Mount Bouddi Rd (East)	4		
SFAZ18	3.1	Dunlop Estate	32	<ul style="list-style-type: none"> <li>To assist in the strategic control of wildfires to reduce wildfire intensity and spotting intensity.</li> </ul>	
SFAZ19	3.1	Little Beach	3		

Map ID.	Map	Zone Name	Zone Area (ha) <sup>1</sup>	Specific Objectives	Strategies
SAFZ20	3.1	Grahame Drive	25		<ul style="list-style-type: none"> <li>Implement prescribed burn of each individual unit on a cyclic pattern, in consultation with affected neighbours but not more than once every 7 years.</li> <li>Burning to be undertaken cooperatively with neighbours, where required.</li> <li>Implement threatened species and cultural heritage management strategies (Appendices 1-5).</li> <li>Implement prescribed burn of each individual unit on a cyclic pattern, in consultation with affected neighbours but not more than once every 7 years.</li> <li>Burning to be undertaken cooperatively with neighbours, where required.</li> <li>Implement threatened species and cultural heritage management strategies (Appendices 1-5).</li> <li>Caution needs to be taken in interpreting thresholds, as some areas to the north and south of Little Beach are located on sand and better described as Coastal Sand Apple – Blackbutt Forest rather than Coastal Narrabeen Moist Forest.</li> </ul>
SFAZ21	3.1	South Pacific	11		
SFAZ22	3.1	Mourawaring Point	26		
SFAZ23	3.1	Beachview	1		
SFAZ24	3.1	Malonys	3	<ul style="list-style-type: none"> <li>To assist in the protection of residential, natural and cultural heritage assets in the MacMasters Beach area.</li> <li>To assist in the strategic control of wildfires to reduce wildfire intensity and spotting intensity.</li> </ul>	
<b>SFAZ25</b>	3.1	Damian Drive	8	<ul style="list-style-type: none"> <li>To assist in the protection of residential, natural and cultural heritage assets in the Bensville area.</li> <li>To assist in the strategic control of wildfires to reduce wildfire intensity and spotting intensity, particularly moving in a NW direction towards the Scenic Rd.</li> </ul>	<ul style="list-style-type: none"> <li>Implement prescribed burn of each individual unit on a cyclic pattern, in consultation with affected neighbours but not more than once every 7 years.</li> <li>Burning to be undertaken cooperatively with neighbours, where required.</li> <li>Implement threatened species and cultural heritage management strategies (Appendices 1-5).</li> </ul>
<b>SFAZ26</b>	3.1	McMasters Ridge East	27		
<b>SFAZ27</b>	3.1	Karuk Rd	43		
<b>SFAZ28</b>	3.1	McMasters Ridge West	19		
<b>SFAZ29</b>	3.1	North West Ridge	13		
<b>SFAZ30</b>	3.1	Turkey Track	10		
<b>SFAZ31</b>	3.1	Currong	22		

Map ID.	Map	Zone Name	Zone Area (ha) <sup>1</sup>	Specific Objectives	Strategies
SFAZ32	3.1	Pomona Road	48		<ul style="list-style-type: none"> <li>Implement prescribed burn of each individual unit on a cyclic pattern, in consultation with affected neighbours but not more than once every 7 years.</li> <li>Burning to be undertaken cooperatively with neighbours, where required.</li> <li>Implement threatened species and cultural heritage management strategies (Appendices 1-5).</li> </ul>
SFAZ33	3.1	The Triangle Killcare Heights	6	<ul style="list-style-type: none"> <li>To assist in the protection of residential, natural and cultural heritage assets in the Daleys Pt, Empire Bay and Killcare Heights area.</li> <li>To assist in the strategic control of wildfires to reduce wildfire intensity and spotting intensity, particularly moving in a NW direction towards Wards Hill Rd.</li> </ul>	<ul style="list-style-type: none"> <li>Implement prescribed burn of each individual unit on a cyclic pattern, in consultation with affected neighbours but not more than once every 7 years.</li> <li>Burning to be undertaken cooperatively with neighbours, where required.</li> <li>Implement threatened species and cultural heritage management strategies (Appendices 1-5).</li> <li>Implement prescribed burn of each individual unit on a cyclic pattern, in consultation with affected neighbours but not more than once every 7 years.</li> <li>Burning to be undertaken cooperatively with neighbours, where required.</li> <li>Implement threatened species and cultural heritage management strategies (Appendices 1-5).</li> </ul>
SFAZ34	3.1	Wards Hill North	5		
SFAZ35	3.1	Wards Hill Road	3		
SFAZ36	3.1	Fletchers Glen	12		
SFAZ37	3.1	Rocky Point	4		
SFAZ38	3.1	Rileys Bay	43		
SFAZ39	3.1	Fisherman's Pde	23		
SFAZ40	3.1	Awinya Close	10		
SFAZ41	3.1	Daleys Point North	16		
SFAZ42	3.1	Daleys Point South	15		

**Table A6.3 Strategic Fire Advantage Zones Objectives and Strategies – Fire Breaks**

Map ID.	Map	Zone Name	Zone Area (ha) <sup>1</sup>	Specific Objectives	Strategies
FB 1	3.1	Cockle Bay Fire Break	0.5	<ul style="list-style-type: none"> <li>To assist in the protection of residential assets along Empire Bay Road.</li> <li>To assist in the strategic control of wildfires to reduce wildfire intensity and spotting intensity.</li> </ul>	<ul style="list-style-type: none"> <li>Maintain existing fire break by slashing , tritter or underscrubbing as required</li> <li>Maintain Cat 9 access</li> </ul>
FB 2	3.1	Beachview Esp Fire Break (Malonys)	802	<ul style="list-style-type: none"> <li>To provide safe access for fire agency crews and to assist in the protection of assets between Beachview Esp, Namatjira Dr &amp; MacMaster Pde.</li> </ul>	<ul style="list-style-type: none"> <li>Maintain existing fire break by slashing , tritter or underscrubbing as required</li> <li>Maintain Cat 9 access</li> <li>Consider the requirments to extend fire break to the SE as a result of new developments.</li> </ul>
FB 3	3.1	Killcare Heights Fire Break (Baden St)	259	<ul style="list-style-type: none"> <li>To provide safe access for fire agency crews and to assist in the protection of assets near Baden St &amp; Jacqueline Ave</li> </ul>	<ul style="list-style-type: none"> <li>Maintain existing fire break by slashing , tritter or underscrubbing as required</li> </ul>
FB 4	3.1	Wards Hill Fire Break	51	<ul style="list-style-type: none"> <li>To provide safe access for fire agency crews and to assist in the protection of assets in Wards Hill Rd.</li> </ul>	<ul style="list-style-type: none"> <li>Maintain existing fire break by slashing , tritter or underscrubbing as required</li> <li>Maintain walking access only</li> </ul>

<sup>1</sup> All areas generated by GIS and hence may differ slightly from gazetted areas.

- Consideration will be given to the construction of fire breaks to the west of properties at Grahame Drive, MacMasters Beach, and east of properties at Bundaleer Crescent / Yowie Close, Bensville.

## Land Management Zones

Sixteen Land Management Zones (LMZs) have been defined within and around the Reserves (Map 3.1). The primary fire management objectives in LMZs are to prevent the extinction of all species which are known to occur naturally within the reserves (conserve biodiversity) and to protect Aboriginal sites, historic heritage sites and other culturally significant features from fire (see Section 1.2). Except where noted otherwise, these objectives will be achieved by:

- suppressing bushfires and, where necessary, conducting prescribed burns to maintain fire regimes within the biodiversity thresholds specified in Appendix 1, 2, & 3; and
- Implementing the threatened species and cultural heritage management guidelines specified in Appendix 2 to 5 in locations where threatened species and cultural heritage sites are known or likely to occur.

Table A6.3 describes the specific fire management objectives and strategies to be applied in each land management zone.

**Table A6.4 Land Management Zones Objectives and Strategies**

Map ID.	Map	Zone Name	Zone Area (ha)	Area (ha) by Vegetation Threshold Class <sup>1</sup> (Table 1)					Threatened Fauna Guidelines (Table 3)	Threatened Flora Guidelines (Table 2)	Cultural Heritage Guidelines (Tables 4,5)	Strategies
				A	B	C	D	E				
LMZ1	3.1	Little Box Head	50	0.0		32.6	14.2	0.2	-	-	AH1	<ul style="list-style-type: none"> <li>• Suppress bushfires and conduct prescribed burns as appropriate to maintain fire regimes within the vegetation thresholds specified in Appendix 1.</li> </ul>
LMZ2	3.1	Iron Ladder	19	0		15.2	0.7	0.0	-	-	-	
LMZ3	3.1	Little Tallow Beach	27	0		5.2	17.7	0.4	FA14, FA21	-	-	
LMZ4	3.1	Tallow Beach	47	0		13.9	28.4	0.1	-	-	-	
LMZ5	3.1	Bullimah Spur	48	0		35.7	7.1	0.0	FA21	-	-	
LMZ6	3.1	Bouddi Grand Deep	172	8.6		146.5	7.2	0.8	FA2, FA8, FA13, FA14, FA19, FA29	FL1	AH2, HH2, HH3, HH4	

Map ID.	Map	Zone Name	Zone Area (ha)	Area (ha) by Vegetation Threshold Class <sup>1</sup> (Table 1)					Threatened Fauna Guidelines (Table 3)	Threatened Flora Guidelines (Table 2)	Cultural Heritage Guidelines (Tables 4,5)	Strategies
				A	B	C	D	E				
LMZ7	3.1	Caves Gully	101	2.7		71.9	22.9	3.1	FA8, FA14, FA18, FA21, FA28, FA29	-	HH3	<ul style="list-style-type: none"> <li>Implement the threatened species management strategies specified in Appendix 2 &amp; 3.</li> <li>Implement the cultural heritage management strategies specified in Appendix 4 &amp; 5.</li> </ul>
LMZ8	3.1	Caves Bay	53	0		5.0	37.1	1.5	-	-	-	
LMZ9	3.1	Bombi Moors	33	0		4.1	26.7	0.0	FA2	-	-	
LMZ10	3.1	Old Quarry Trail	25	0		13.2	5.3	6.2	FA21	-	AH1	
LMZ11	3.1	81	18	0		6.2	9.3	0.0	FA21	-	-	
LMZ12	3.1	78	14	0		9.0	3.6	0.0	FA2, FA15, FA29	-	-	
LMZ13	3.1	Mourawaring South	11	0		5.1	4.8	0.8	-	-	-	
LMZ14	3.1	Mourawaring Moors	15	0		0.4	13.7	0.8	-	-	-	
LMZ15	3.1	Little Valley	34	8.3		25.4	0.0	0.0	FA18, FA28	-	-	
LMZ16	3.1	Cockle Bay Land Management	65	0		37	0	28	FA2, FA9, FA13, FA14, FA17, FA18, FA19, FA20, FA22, FA30	-	-	

<sup>1</sup>All areas generated by GIS and hence may differ slightly from gazetted areas.

## APPENDIX 7: STANDARD OPERATIONAL GUIDELINES

Table A7: Standard operational guidelines

Issue	Guidelines
<b>Aerial water bombing</b>	<ul style="list-style-type: none"> <li>The use of bombing aircraft should support containment operations by aggressively attacking hotspots and spot-overs.</li> <li>The use of bombing aircraft without the support of ground-based suppression crews should be limited to very specific circumstances.</li> <li>Where practicable, foam should be used to increase the effectiveness of the water.</li> <li>Ground crews must be alerted to water bombing operations.</li> <li>Where practicable, fresh water should be used for water bombing in preference to salt water.</li> </ul>
<b>Aerial ignition</b>	<ul style="list-style-type: none"> <li>Aerial ignition may be used during backburning or fuel reduction operations where practicable, but only with the prior consent of a senior NPWS officer.</li> <li>Use incendiaries to rapidly progress backburns downslope where required.</li> </ul>
<b>Backburning</b>	<ul style="list-style-type: none"> <li>Temperature and humidity trends must be monitored carefully to determine the safest times to implement backburns. Generally, when the Fire Danger Index (FDI) is very high or greater, backburning should begin when the humidity begins to rise in the late afternoon or early evening. With a lower FDI, backburning may be safely undertaken during the day.</li> <li>Where practicable, clear a 1 m radius around dead and fibrous-barked trees adjacent to containment lines before backburning, or wet down these trees as part of the backburn ignition.</li> <li>Avoid ignition of backburns at the bottom of slopes where a long and intense upslope burn is likely.</li> </ul>
<b>Command &amp; control</b>	<ul style="list-style-type: none"> <li>The first combatant agency on site may assume control of the fire, but then must ensure that the relevant land management agency is notified promptly.</li> <li>On the arrival of other combatant agencies, the initial incident controller will consult with regard to the ongoing command, control and incident management team requirements as per the relevant BFMC plan of operations.</li> </ul>
<b>Containment lines</b>	<ul style="list-style-type: none"> <li>Construction of new containment lines should be avoided, where practicable, except where they can be constructed with minimal environmental impact. New containment lines require the prior consent of a senior NPWS officer.</li> <li>Where practicable, containment lines should be stabilised and rehabilitated as part of the wildfire suppression operation.</li> <li>All containment lines not required for other purposes should be closed at the cessation of the incident.</li> <li>All personnel involved in containment line construction should be briefed on both natural and cultural heritage sites in the location.</li> </ul>
<b>Earthmoving equipment</b>	<ul style="list-style-type: none"> <li>Earthmoving equipment may be used only with the prior consent of a senior NPWS officer, and then only if the probability of its success is high.</li> <li>Earthmoving equipment must be always guided and supervised by an experienced officer, and accompanied by a support vehicle. When engaged in direct or parallel attack, this vehicle must be a fire fighting vehicle.</li> <li>Containment lines constructed by earthmoving equipment should consider the protection of drainage features, observe the <i>Threatened Species and Cultural Heritage Operational Guidelines</i>, and be surveyed, where possible, to identify unknown cultural heritage sites.</li> <li>Restrict the use of earthmoving equipment in environmentally sensitive areas including slopes greater than 18 degrees, and areas of Acid Sulphate Soils.</li> <li>Earthmoving equipment should be washed down, where practicable, before entering NPWS estate.</li> </ul>
<b>Fire advantage recording</b>	<ul style="list-style-type: none"> <li>All fire advantages used during wildfire suppression operations must be mapped and, where relevant, added to the database.</li> </ul>
<b>Fire suppression chemicals</b>	<ul style="list-style-type: none"> <li>Wetting and foaming agents (surfactants) are permitted for use in wildfire suppression.</li> <li>The use of fire retardant is permitted only with the prior consent of the senior NPWS officer, and should be avoided where reasonable alternatives are available.</li> <li>Exclude the use of surfactants and retardants within 50 m of rainforest, watercourses, dams and swamps.</li> <li>Areas where fire suppression chemicals are used must be mapped, and the names of the products must be recorded.</li> <li>The <i>Threatened Species Operational Guidelines</i> are to be observed.</li> </ul>



Issue	Guidelines
<b>Response &amp; Mop-up</b>	<ul style="list-style-type: none"> <li>• Vehicles should avoid areas with waterlogged soils, which appear to have dry surface conditions. This particularly applies to Cockle Bay NR.</li> <li>• Subject to risk, stags, trees with hollows, and fallen debris will be protected.</li> <li>• Soils with high organic matter content have the potential for re-ignition. Sustained periods of patrol are required in these environments. This is of particular concern in Cockle Bay NR.</li> </ul>
<b>Rehabilitation</b>	<ul style="list-style-type: none"> <li>• Where practicable, containment lines should be stabilised and rehabilitated as part of the wildfire suppression operation.</li> <li>• Where necessary, undertake pest control programs to prevent the invasion and spread of pest species.</li> </ul>
<b>Smoke management</b>	<ul style="list-style-type: none"> <li>• The potential impacts of smoke and possible mitigation tactics must be considered when planning for wildfire suppression and prescribed burning operations.</li> <li>• If smoke becomes a hazard on local roads or highways, the police and relevant media must be notified.</li> <li>• Smoke must be managed in accordance with RTA traffic management guidelines.</li> </ul>
<b>Visitor management</b>	<ul style="list-style-type: none"> <li>• The reserve may be closed to the public during periods of extreme fire danger or during wildfire suppression operations.</li> </ul>



## APPENDIX 8: FIRE TRAIL & ROAD REGISTER

Table A8: fire trail and road register

Map No	Name	Current accessibility	Proposed BFCC Class	Strategy	Tenure <sup>1</sup>	Length (m)
3.2	Bombi Rd North	Cat 1	Essential		GCC	334
3.2	Bombi Rd South	Cat 1	Essential		GCC	231
3.2	Grahame Drive	Cat 1	Essential	<ul style="list-style-type: none"> <li>Undertake annual inspection of road condition and maintenance requirements.</li> <li>Maintenance in accordance with Asset Maintenance System</li> <li>Liaise with Gosford City Council regarding joint maintenance agreement.</li> </ul>	NPWS/GCC	417
3.2	Hawke Head Drive	Cat 1	Essential		GCC/NPWS	1789
3.2	Mount Bouddi Road	Cat 1	Essential		NPWS	709
3.2	Putty Beach Drive	Cat 1	Essential		NPWS	512
3.2	72 Trail (Mourawaring Moor)	Cat 9	Important			NPWS
3.2	78 Trail (Bombi Moor)	Cat 9	Important	<ul style="list-style-type: none"> <li>Undertake annual inspection of trail condition and maintenance requirements.</li> <li>Maintenance in accordance with Asset Maintenance System</li> <li>Consider the requirements to upgrade Box Head Trail (Leos Arm) to Cat 7 standard</li> </ul>	NPWS	347
3.2	81 Trail (Bombi Moor)	Cat 9	Important		NPWS	734
3.2	Bombi Moor Trail	Cat 9	Important		NPWS	1369
3.2	Box Head Trail (Leos Arm)	Cat 9	Important		NPWS	288
3.2	Cockle Bay Trail	Cat 9	Important		NPWS	289
3.2	Daleys Point Aboriginal Site Access Trail	Cat 7	Important	<ul style="list-style-type: none"> <li>Undertake annual inspection of trail condition and maintenance requirements.</li> <li>Maintenance in accordance with Asset Maintenance System</li> <li>Consider the requirements to upgrade to Essential standard.</li> </ul>	NPWS	267
3.2	Daleys Point Trail	Cat 7	Important		NPWS/GCC	2145
3.2	Fishermans Trail	Cat 7	Important	<ul style="list-style-type: none"> <li>Undertake annual inspection of trail condition and maintenance requirements.</li> <li>Maintenance in accordance with Asset Maintenance System</li> <li>Consider the requirements to upgrade Hardys Bay Trail to Cat 7 standard.</li> </ul>	NPWS	1081
3.2	Hardys Bay Trail (Lot 5)	Cat 9	Important		NPWS/PP	659
3.2	Killcare Trail	Cat 9	Important		NPWS	502
3.2	Little Beach Trail	Cat 7	Important	<ul style="list-style-type: none"> <li>Undertake annual inspection of trail condition and maintenance requirements.</li> <li>Maintenance in accordance with Asset Maintenance System</li> <li>Consider the requirements to upgrade to Essential standard.</li> </ul>		565
3.2	Little Valley Trail	Cat 7	Important		NPWS	1728
3.2	MacMasters Ridge Trail	Cat 1	Important	<ul style="list-style-type: none"> <li>Undertake annual inspection of trail condition and maintenance requirements.</li> <li>Maintenance in accordance with Asset Maintenance System</li> <li>Consider the requirements to upgrade to Essential standard.</li> </ul>		1666
3.2	Mourawaring Moor	Cat 9	Important		NPWS	733

Map No	Name	Current accessibility	Proposed BFCC Class	Strategy	Tenure <sup>1</sup>	Length (m)
	Trail			• Maintenance in accordance with Asset Maintenance System.		
3.2	North West Ridge Trail	Cat 9	Important		NPWS	797
3.2	Old Quarry Trail	Cat 9	Important		NPWS	1009
3.2	Old Wagstaffe Trail	Cat 9	Important		NPWS	1487
3.2	Oyster Lease Trail	Cat 9	Important		NPWS	227
3.2	Rocky Point Trail	Cat 7	Important	• Undertake annual inspection of trail condition and maintenance requirements.	NPWS	889
3.2	Second Point (Mourawaring) Trail	Cat 9	Important	• Maintenance in accordance with Asset Maintenance System	NPWS	532
3.2	South Pacific Trail	Cat 9	Important	• Consider the requirements to upgrade Old Wagstaffe Trail to Cat 7 standard	NPWS	147
3.2	Stroms Trail	Cat 9	Important	• Consider the requirements to upgrade Tallow Beach Trail to Essential standard.	NPWS	2099
3.2	Tallow Beach Trail	Cat 7	Important		NPWS	1125
3.2	Third Point (Bombi) Trail	Cat 9	Important		NPWS	704
3.2	Turkey Trail	Cat 9	Important		NPWS	663

## **APPENDIX 9: BUSHFIRE BEHAVIOUR POTENTIAL**

Fire behaviour is the manner in which a fire reacts to the variables climate, topography and vegetation. The accurate prediction of fire behaviour is very complex. Listed below are the methods for developing a bushfire behaviour model that incorporates terrain (slope, aspect and altitude) and fuel (vegetation) for the Reserves.

### **Terrain**

For the purposes of modelling fire behaviour, two slope classes are derived: slopes of less than 10 degrees and greater than 10 degrees. This allows for a convenient division of the Reserves into flat /level and hilly/ steep divisions for modelling, directly representing increasing bushfire intensity and rate of spread.

Aspect has a significant influence on fire behaviour. Three aspect classes were selected: north-west (>225 to 45 degrees), east (>45 to 135 degrees), and south (which were then ranked according to their influence on fire intensity and rate of spread. Fire intensity and rate of spread tends to increase with the drier aspects. In the Sydney Region this tends to be the north, north-west and western slopes. Vegetation on these slopes is generally drier than the vegetation on the southern and eastern slopes. High Fire Danger Indices (FDI) occur on the western and to a lesser degree northern aspects in the Sydney Region (Bradstock et al. 1998).

### **Fuel**

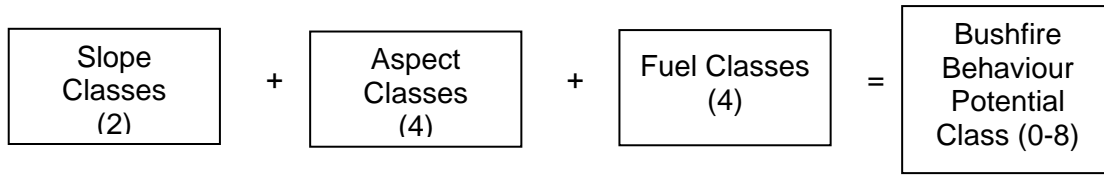
The vegetation within the Reserves ranges from sedgeland, mangroves, grassland, open-heath, closed-heath, low open woodland, woodland to open forest. These groups provide an indication of the continuity, structure, quantity of fuels and the frequency of fuel availability during the average bushfire season. For the purposes of modelling bushfire behaviour the vegetation types were ranked according to their potential to influence fire intensity and rate of spread, refer to Table A10.1.

Shrubland is concentrated on gradual to intermediate slopes with a strong coastal influence. Open forest is more prevalent on steep slopes which have a northerly facing aspect, while woodland is found over the full range of environmental variables.

The results of a fuel sampling study undertaken within the Sydney Basin indicate that shrubland (33.25 t/ha) had the potential to accumulate the highest amounts of total fine fuels after about 30 years, followed by woodland (23.57 t/ha), open forest (18.37 t/ha), grassland (10.1 t/ha) and rainforest (8 t/ha) in that order (Conroy, 1993).

For grassland and wet forest groups there appears to be very little correlation between age since fire and fuel accumulation. Other factors such as drought and growing season are likely to play a much greater factor in determining fuel loads.

Slope, aspect and fuel groups may be combined to provide a model of the bushfire behaviour potential for the Reserves (Map 3.3). The model does not take into account fire weather however climatic differences are represented indirectly through the fuel and aspect classes. The model has been developed according to Figure 6 and classes then assigned based on the output values of this model (Tables A10.1 & A10.2). These classes are a simple arithmetic division of the output range and should be viewed as relative classes for the Reserves rather than stand alone. For instance a very high class on the Reserves may not be equivalent to a similar class in another area showing drier characteristics.



**Figure 6 Calculations of bushfire behaviour potential**

**Table A9.1 Parameters used to calculate the value of bushfire behaviour potential**

Aspect	North 316°-45°		East 46°-135°		South 136° - 225°		West 226°-315°	
	<10°	>10°	<10°	>10°	<10°	>10°	<10°	>10°
Shrubland	4	2	4	2	3	2	1	1
Woodland	6	3	6	3	5	2	2	1
Open Forest	7	3	7	3	6	3	4	1
Grassland	-	-	-	-	-	-	-	-

**Table A9.2 Bushfire risk analysis for Bouddi National Park and Cockle Bay Nature Reserve.**

Class	Value	Locations
Very High	1-2	Westerly facing aspects of Box Head to Wagstaffe Point, Daleys Point, Rocky Point, Bullimah and Bouddi Spurs, North West Ridge, MacMasters Trail and Mourawaring Moors.
High	3-4	Areas in the general vicinity of Hawke Head Drive, Rileys Bay, Bombi Point, Mourawaring Point and northerly facing slopes of Bouddi Ridge.
Medium	5-6	Along Stroms Track, Tallow Beach and the SE portion of Cockle Bay Nature Reserve.
Low	7-8	Cockle Bay Nature Reserve.

## APPENDIX 10: GLOSSARY

*The definitions described below are based on the Australian Fire Authorities Council (AFAC) Glossary of Rural Fire Terminology (1996) and the NPWS Fire Management Manual (2006).*

<b>Aerial Detection</b>	Discovering, locating and reporting of fires from aircraft.
<b>Aerial Fuels</b>	The standing and supporting combustibles not in direct contact with the ground and consisting mainly of foliage, twigs, branches, stems, bark and creepers.
<b>AHIMS</b>	Aboriginal Heritage Information Management System (AHIMS). A database for all Aboriginal objects, Aboriginal places and other Aboriginal heritage values in NSW that have been reported to the NPWS.
<b>Aspect</b>	The direction towards which a slope faces, e.g. north-east. Slopes on a west to north-westerly aspect are the most hazardous during fire fighting operations.
<b>Asset Protection Zone (APZ)</b>	A zone which is proven to provide effective protection from radiation damage to both assets and firefighters in all but the most extreme wildfire events.
<b>Assets at Risk</b>	The natural resources or improvements that may be jeopardised if a fire occurs. Examples include: threatened species habitat, rainforests, forestry coups, human built structures or infrastructures, park information signs, transmission poles etc. and may also include scenic values. For the fire manager it may also include natural values that may be threatened by a fire (e.g. water catchment quality).
<b>Backburning</b>	A fire started intentionally along the inner edge of a fireline to consume the fuel in the path of a wildfire.
<b>Buffer</b>	A strip or block of land on which the fuels are reduced to provide protection to surrounding lands.
<b>Burning Program</b>	All the prescribed burns scheduled for a designated area over a nominated period of time.
<b>Bush Fire Management Zone (BFMZ)</b>	Management areas where a specified fire management operation objective, strategy and performance Indicator has been developed.
<b>Bush Fire Management Zone Area</b>	Management areas of a variable size that define containment blocks in the event of a wildfire. Alternatively they are also designated as areas of specific ecosystem types defined by fire management authorities for monitoring and prescribed burning for natural heritage management
<b>Coarse Fuels</b>	Dead woody material, greater than 25mm in diameter, in contact with the soil surface (fallen trees and branches).
<b>Controlled Burning</b>	<i>see Prescribed Burning.</i>
<b>Crown Fire</b>	A fire burning in the crowns of trees and usually supported by fire in ground fuels. It is a fast travelling fire that usually consumes all available fuels in its path.
<b>Drought Index</b>	A numerical value, such as the Keetch-Byram Drought Index, reflecting the dryness of soils, deep forest litter, logs and living vegetation.
<b>Ecosystem</b>	The interacting system of a biological community, both plant and animal, and its non living surroundings
<b>Edge Burning</b>	A term used to describe perimeter burning of an area in mild conditions prior to large scale prescribed burning. This practice is used to strengthen buffers and to reduce mop-up operations.
<b>Fine Fuels</b>	Grass, leaves, bark and twigs less than 6mm in diameter.
<b>Fire</b>	The chemical reaction between fuel, oxygen and heat. Heat is necessary to start the reaction and once ignited, fire produces its own heat and becomes self-supporting. Removal of any one of the three elements of fuel, oxygen and heat will extinguish a fire.

<b>Fire Behaviour</b>	The manner in which a fire reacts to the variables of fuel, weather and topography. Changes in any of these variables with result in a change in the fires behaviour.
<b>Fire Break</b>	Any natural or constructed discontinuity in a fuel bed used to segregate, stop and control the spread of a wildfire, or to provide a fireline from which to suppress a fire.
<b>Fire Danger Index (FDI)</b>	A relative number denoting an evaluation of rate of spread, or suppression difficulty for specific combinations of fuel, fuel moisture and wind speed.
<b>Fire Extent</b>	The area burnt by a wildfire, measured in hectares. Within that area there will be "islands" of unburnt vegetation (these islands are generally included in the total fire extent). <i>NB: it is preferable that fire effect only part of a vegetation community at any one time so that nearby areas of more mature plants may provide a seed source for recolonisation and animals will have suitable unburnt habitat in order to seek shelter and forage.</i>
<b>Fire Front</b>	The part of a fire where the rate of spread, flame height and intensity are greatest, usually when burning downwind or upslope.
<b>Fire Intensity</b>	The rate of energy released per unit length of fire front. This is usually expressed as kilowatts per metre (kW/m).
<b>Fire Management</b>	All activities associated with the management of fire-prone land, including the use of fire to meet land management goals and objectives.
<b>Fire Perimeter</b>	The entire outer boundary of a fire area.
<b>Fire Regime</b>	The history of fire in a particular vegetation type or area including the frequency, intensity and season of burning (season in this context refers to the time of the year in which the fire occurred). It may also include proposals for the use of fire in a given area.
<b>Fire Season</b>	The period(s) of the year during which fires are likely to occur, spread and do sufficient damage to warrant organised fire control. In New South Wales the core fire season is from 1st October to the 31st March of the following year. <i>At the regional scale, the season may be introduced or extended by one month dependant upon the prevailing weather conditions, drought indexes and number of wildfire's that may already be burning within that area.</i>
<b>Fire Storm</b>	Violent convection caused by a large continuous area of intense fire; often characterised by destructively violent surface indrafts, a towering convection column, long distance spotting, and sometimes by tornado-like whirlwinds.
<b>Flame Height</b>	The vertical distance between the tip of the flame and ground level, excluding higher flame flashes. Expressed in vertical metres.
<b>Fuel</b>	Any material such as grass, bark, leaf litter and living vegetation which can be ignited and sustains a fire. Fuel is usually measured in tonnes per hectare of dry weight.
<b>Fuel Arrangement</b>	A general term referring to the spacing and arrangement of fuel in a given area.
<b>Fuel Bed</b>	The arrangement and vertical profile of all readily combustible materials lying on the ground.
<b>Fuel Load</b>	The oven dry weight of fuel per unit area. Commonly expressed as tonnes per hectare.
<b>Fuel Management</b>	Modification of fuels by prescribed burning, manual removal, slashing, grazing, or other means. The objective is to reduce the fuel thereby reducing the risk posed by wildfire's.
<b>Fuel Type</b>	An identifiable association of fuel elements of distinctive species, form, size, arrangement, or other characteristics that will cause predictable rate of spread or difficulty of control under specified weather conditions.



<b>Habitat</b>	A physical portion of the environment that is inhabited by an organism or population of organisms. A habitat is characterised by a relative uniformity of the physical environment and fairly close interaction of all the biological species involved. <i>Organisms within a given habitat will express a level of co-dependency upon one-another. The loss of the physical characteristics of a given habitat can have severe and long term detrimental effects upon the organisms living in that habitat.</i>
<b>Hazard Reduction</b>	<i>see Fuel Management</i>
<b>HHIMS</b>	Historic Heritage Information Management System (HHIMS) manages information on around 9000 heritage items, most of which are in national parks and reserves.
<b>Land Management Zone (LMZ)</b>	Land Management Zones conserve natural and cultural heritage items which may be damaged or destroyed by inappropriate fire regimes
<b>Island</b>	An unburnt area within a fire perimeter. Islands are critical for species survival and recruitment after a wildfire event.
<b>Keetch-Byram Drought Index (KBDI)</b>	A numerical value reflecting the dryness of soils, deep forest litter, logs and living vegetation, and expressed as a scale from 0 - 200 points. When 100 points has been reached in an area, that area is said to be in drought.
<b>NPWS</b>	The National Parks and Wildlife Service of New South Wales.
<b>NSWFB</b>	The New South Wales Fire Brigades.
<b>Prescribed Burning</b>	The controlled application of fire under specified environmental and weather conditions to a predetermined area and at the time, intensity, and rate of spread required to attain planned resource management objectives.
<b>Rate of Spread</b>	The forward progress per unit time of the head of the fire or another specified part of the fire perimeter.
<b>RFS</b>	The Rural Fire Service.
<b>RIPs</b>	Region Incident Procedures containing important contact information, procedures for the detection and response to an incident, and fire preparedness guidelines.
<b>Scorch Height</b>	The height above ground level up to where foliage has been browned by a fire. This height is roughly ten times the actual flame height of the fire.
<b>Service, the</b>	The National Parks and Wildlife Service of New South Wales.
<b>SF</b>	State Forests of New South Wales.
<b>Slip-on Unit</b>	A fire fighting unit that can be placed on to the back of a four wheel drive vehicle to convert it to a fire tanker. <i>Depending upon the units water carrying capacity, a four wheel drive tray top vehicle could be converted to Category 2,7 or 9 fire tankers in a very short space of time.</i>

<b>Soil Dryness Index (SDI)</b>	See Drought Index
<b>Southern Oscillation Index (SOI)</b>	Calculated from the monthly or seasonal fluctuations in the air pressure difference between Tahiti and Darwin. Sustained negative values of the SOI often indicate El Niño episodes. Positive values of the SOI are associated with stronger Pacific trade winds and warmer sea temperatures to the north of Australia, popularly known as a La Niña episode.
<b>Spot Fire</b>	Isolated fires started ahead of the main fire by sparks, embers or other ignited material, sometimes to a distance of several kilometres.
<b>Strategic Fire Advantage Zone (SFAZ)</b>	Strategic Fire Advantage Zones (SFAZ) assist in the containment of wildfires to provide safe access to bush fire fighters and to assist with the achievement of a fire regime which is consistent with reserve management objectives. The zone is located in an area which is effective in reducing wildfire intensity and spotting potential and is therefore proven to be effective in assisting with the containment of wildfires within a defined area
<b>Striker</b>	A small four wheel drive fire tanker capable of carrying from 400 to 600 litres of water for fire fighting purposes. Also known as a Category 9 Fire Tanker.
<b>Structure Fire</b>	A fire burning part, or all of any building, shelter, or other human made construction.
<b>Tanker</b>	A mobile firefighting vehicle equipped with a water tank, pump, and the necessary equipment for spraying water and/or foam on wildfire's. <i>Under NSW Dept. of Rural Fire Service guidelines, bush fire fighting tankers have been designated into nine 'Categories' delineating water carrying capacity and whether the unit is two or four wheel drive capable.</i>
<b>Topography</b>	The surface features of a particular area or region, ie the lay of the land, and includes mountains, rivers etc.
<b>Unplanned Fire</b>	<i>see Wildfire</i>
<b>Urban/Rural Interface</b>	The line, area, or zone where structures and other human development adjoin or overlaps with undeveloped bushland. Also known as the urban/bush interface, urban interface or just the interface.
<b>Wildfire</b>	An unplanned fire. A generic term which includes grass fires, forest fires and scrub fires.



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**NATIONAL  
PARKS AND  
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**43 Bridge Street  
Hurstville NSW  
Australia 2220**

**Map 2.1 Bushfire Risks – Property, Infrastructure, Visitor Sites, Historic Heritage Values**

**Map 2.2 Bushfire Risks – Endangered Ecological Communities**

**Map 2.3 Bushfire Risks – Threatened Flora & Fauna**

**Map 2.4 Bushfire Risks – Erosion hazards, Acid Sulphate Soils**

**Map 2.5 Bushfire Risks – Fire Regime Analysis**

**Map 3.1 Fire Management Strategies – Zonation**

**Map 3.2 Fire Management Strategies – Fire Breaks, Trails**

**Map 3.3 Fire Management Strategies – Bushfire Behaviour Potential**



Map 2.1 Bushfire Risks - Property, Infrastructure, Visitor Sites, Historic Heritage Values



**Assets and Historic sites**

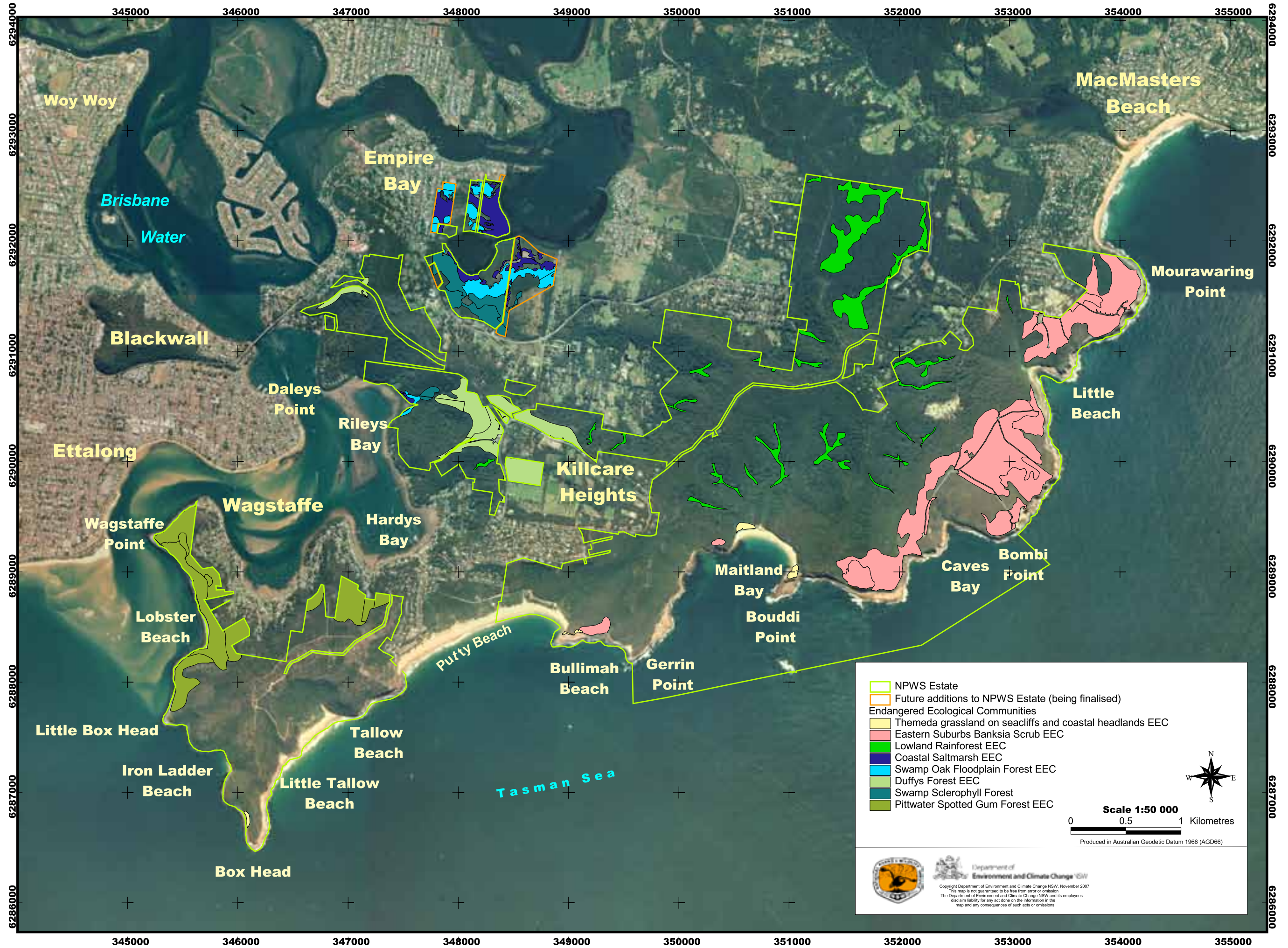
- Asset
- Historic Site
- Campground
- Day Use Area
- Lookout
- Coastal walk
- NPWS Estate
- Future additions to NPWS Estate (being finalised)

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 Produced in Australian Geodetic Datum 1966 (AGD66)

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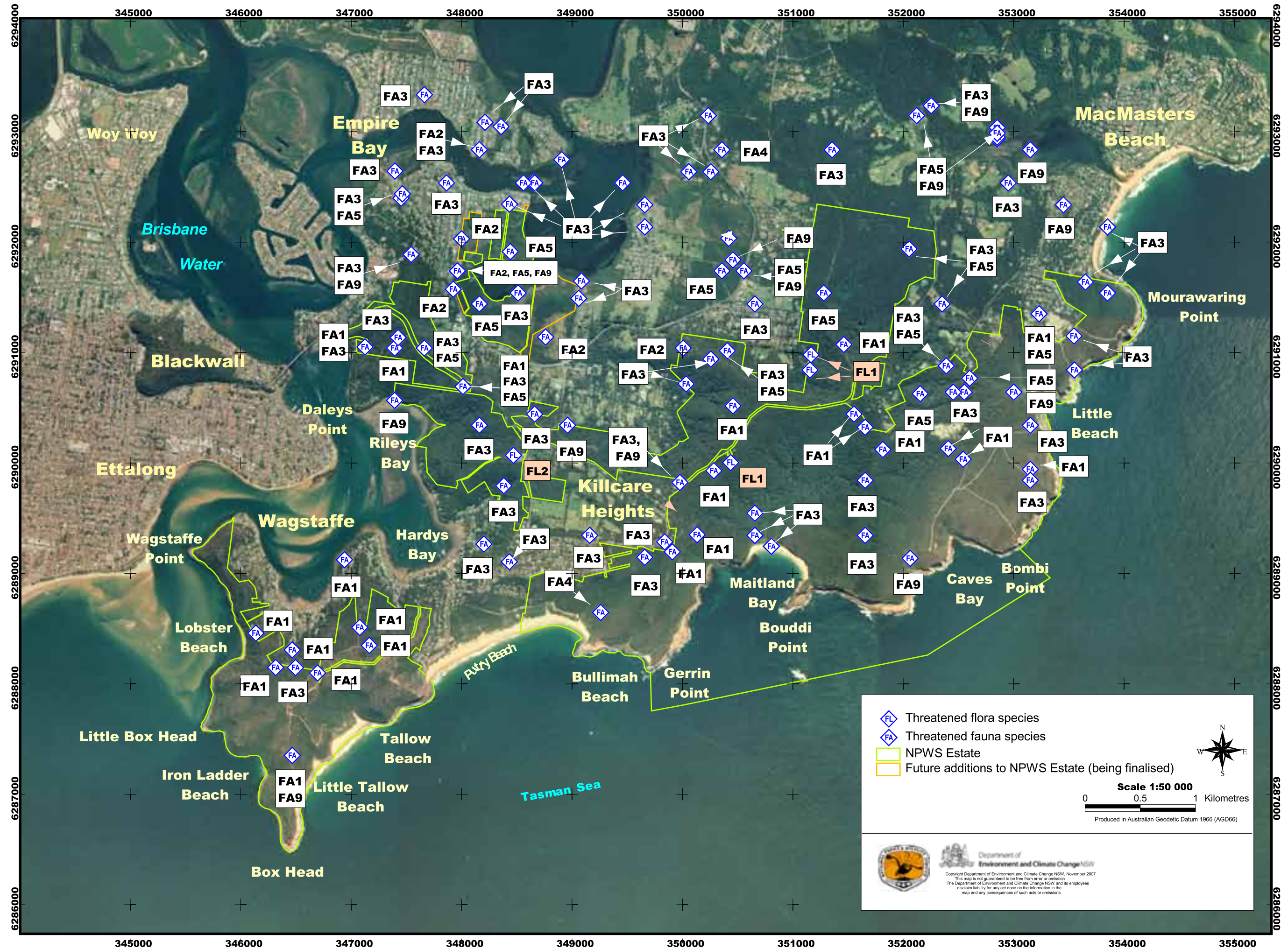


Map 2.2 Bushfire Risks - Endangered Ecological Communities







Map 2.3 Bushfire Risks - Threatened flora and fauna



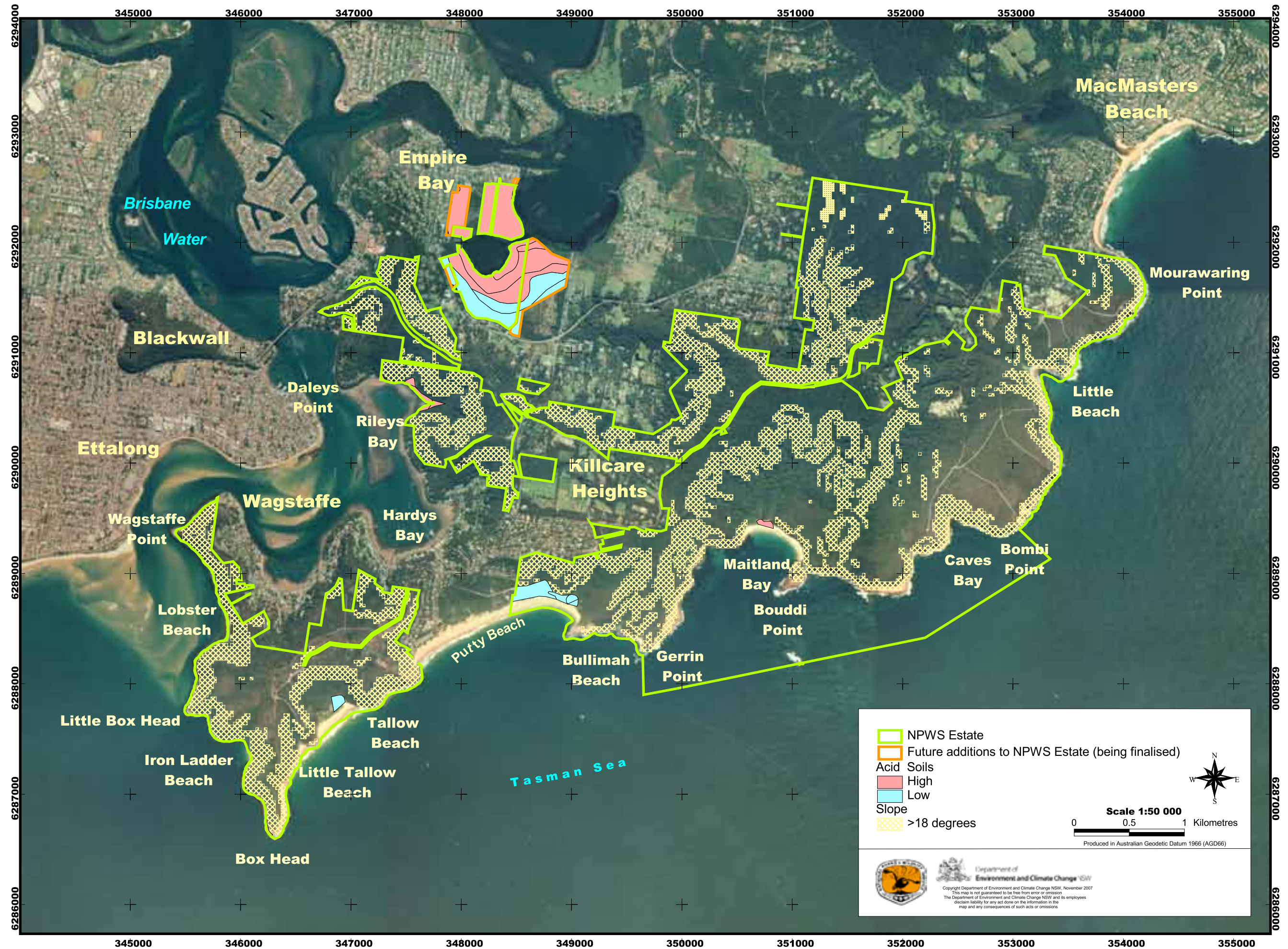
◆ FL Threatened flora species  
◆ FA Threatened fauna species  
 NPWS Estate  
 Future additions to NPWS Estate (being finalised)

  
**Scale 1:50 000**  
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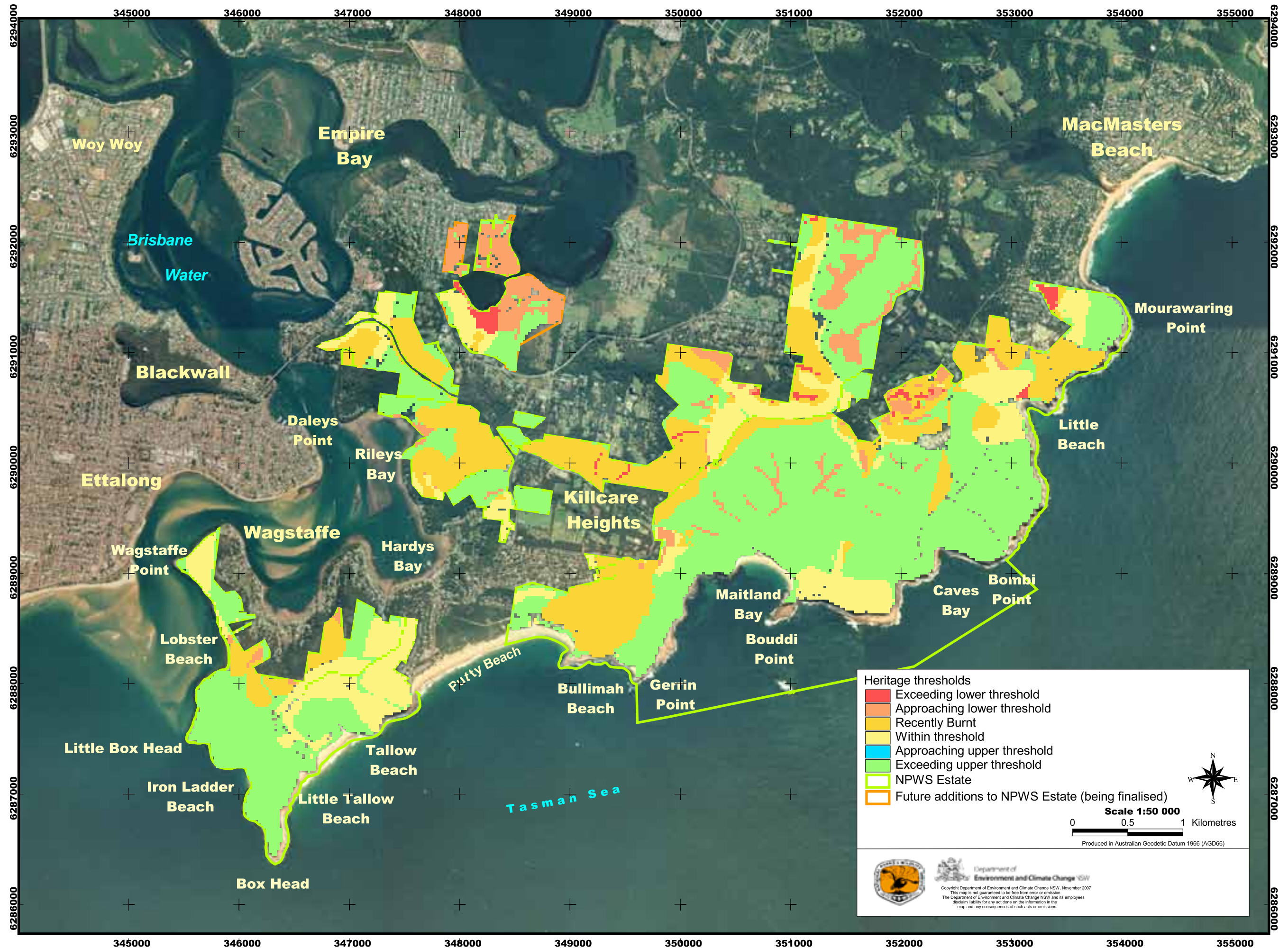


Map 2.4 Bushfire Risk - Erosion Hazards, Acid Sulphate Soils





Map 2.5 Bushfire Risks - Fire Regime Analysis




**Heritage thresholds**

- Exceeding lower threshold
- Approaching lower threshold
- Recently Burnt
- Within threshold
- Approaching upper threshold
- Exceeding upper threshold
- NPWS Estate
- Future additions to NPWS Estate (being finalised)

**Scale 1:50 000**  
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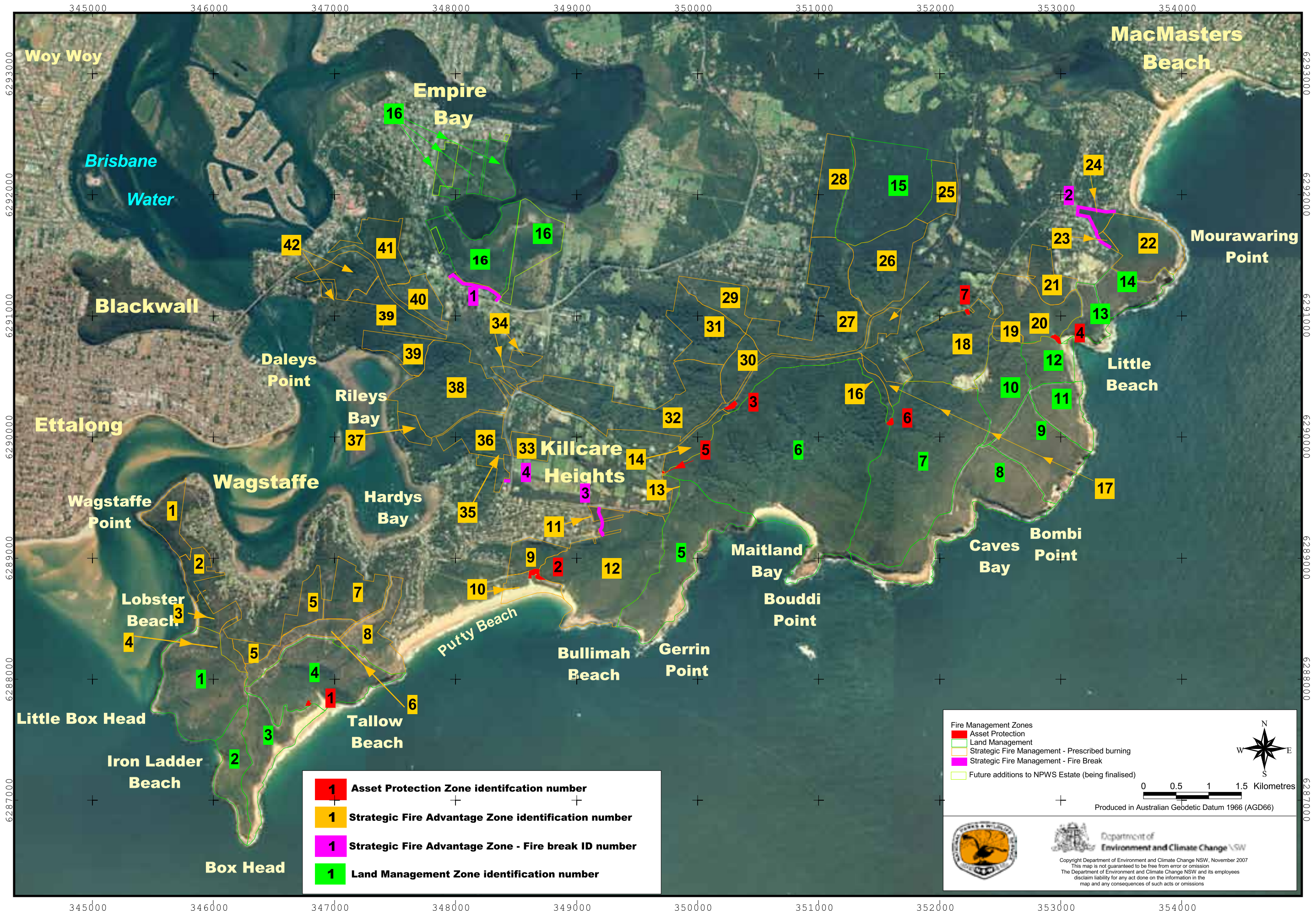
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Map 3.1 Fire Management Strategies - Zonation




<b>1</b>	<b>Asset Protection Zone identification number</b>
<b>1</b>	<b>Strategic Fire Advantage Zone identification number</b>
<b>1</b>	<b>Strategic Fire Advantage Zone - Fire break ID number</b>
<b>1</b>	<b>Land Management Zone identification number</b>

**Fire Management Zones**

- █ Asset Protection
- █ Land Management
- Strategic Fire Management - Prescribed burning
- Strategic Fire Management - Fire Break
- Future additions to NPWS Estate (being finalised)

0 0.5 1 1.5 Kilometres

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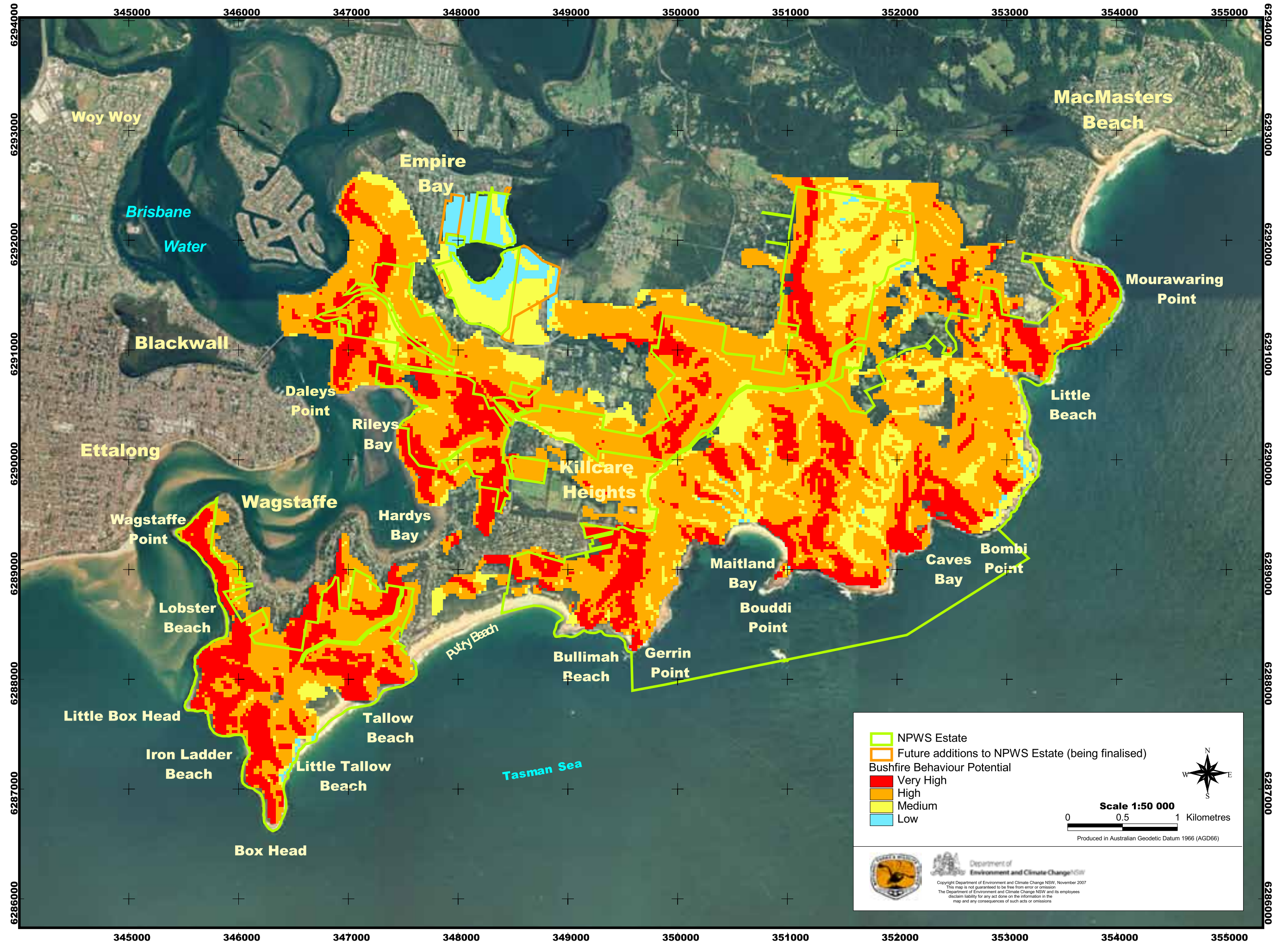




Map 3.2 Fire Management Strategies - Access Trails





Map 3.3 Fire Management Strategies - Bushfire Behaviour Potential





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