Wingecarribee Shire Council

Fire Management Plan

For

The Greater Mount Alexandra Reserve

July 2004

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The Greater Mount Alexandra Reserve

July 2004

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TERMINOLOGY

PLEASE NOTE:

The bushfire terminology used in this plan can mean different things to different people. A glossary of key terms has been included at the end of this fire management plan.

Summary

This fire management plan for the Greater Mount Alexandra Reserve has been prepared for Wingecarribee Shire Council by AVK Environmental Management and Renaissance Forestry. The plan is compatible with the *Wingecarribee Bushfire Risk Management Plan*, and will ensure that Wingecarribee Shire Council is able to meet its responsibilities under current legislation. The plan is intended to cover a 15 year period (2004 to 2019).

The Greater Mount Alexandra Reserve has an area of approximately 2305 ha located to the north of Mittagong. The reserve is managed by Wingecarribee Shire Council with the assistance of the Mount Alexandra Reserve Management Committee. To ensure that management boundaries are practical and ecologically viable, they have been extended beyond the formal boundaries of the Greater Mount Alexandra Reserve, where required, to provide the most practical boundaries for management burning and fire suppression.

Wingecarribee Shire Council and landowners surrounding the reserve have a general legal responsibility to take all reasonable steps to minimise the risk of fires that originate on their property causing personal injury, damage to adjoining property, or damage to items of natural or heritage value protected by government legislation. Wingecarribee Shire Council also has specific responsibilities under various Acts of Parliament for fire management, fire hazard abatement, and the conservation and management of native flora and fauna.

Wingecarribee Shire Council does not currently have a bushfire management policy or strategy. The following draft policy has been developed for Council's consideration to provide a framework for this and other fire management plans.

Wingecarribee Shire Council will diligently exercise all its legislative responsibilities relating to fire management.

Wingecarribee Shire Council will implement current 'Best Management Practice' in fire management on all land under its control in order to fulfil its responsibilities as a landowner, and in recognition of its role in natural area management.

Fire management on property owned, or managed, by Wingecarribee Shire Council will be based on sound ecological principles, and will take into account the objectives and principles of Ecologically Sustainable Development.

Wingecarribee Shire Council recognises the importance of regular communication between fire management agencies, landowners, and the community at large, in raising awareness of fire management issues and ensuring broad understanding of the responsibilities of different sections of the community in reducing the risk of dangerous bushfires.

The last major wildfire to affect the reserve was in November 2002. This fire started in the reserve to the west of Willow Vale and moved into urban and rural areas to the east, where 5 houses and one warehouse were destroyed. About one third of the reserve was burnt by the wildfire and associated backburns.

It will not be possible to prevent wildfires occurring within the Greater Mount Alexandra Reserve. Although the recent wildfire and other hazard reduction burns have reduced fuel loads over a substantial portion of the reserve, there are areas with fuel loads sufficient to generate uncontrollable crown fires on days of high to extreme fire danger. Unless fires in the reserve are suppressed when small and accessible (close to trails), there is a risk that large destructive fires may develop. Depending on weather conditions, such fires may burn a substantial area of the reserve causing damage to assets and environmental values, and even loss of life. These fires may also travel onto adjoining lands, further threatening life and property. This plan aims to lessen these risks by minimising the risk of fires starting in the reserve, and minimising the risk of loss of life or damage to assets in and around the reserve.

Natural heritage assets include native flora and fauna, as well as scenic values. The Greater Mount Alexandra Reserve contains one plant species, *Persoonia glaucescens,* listed as endangered in the Threatened Species Conservation Act, 1995, one vulnerable species, *Phyllota humifusa,* and three species listed in ROTAP (Rare or Threatened Australian Plants) *Eucalyptus apiculata, Lissanthe sapida,* and *Persoonia mollis* subsp. *Revoluta,* a species endemic to the region. There are also four species uncommon in the area that have local conservation value, *Cryptandra amara, Dodonaea multijuga, Eucalyptus dendromorpha, and Eucalyptus oreades,* that is at the southern limit of its distribution (Benson & McDougall, 1998).

Five fauna species listed as vulnerable in the Threatened Species Conservation Act, 1995, have been recorded in the reserve; Powerful Owl (*Ninox strenua*), Glossy Black-Cockatoo (*Calyptorhynchus lathami),* Yellow-bellied Glider (*Petaurus australis*), Squirrel Glider (*Petaurus norfolcensis*), and Brown Treecreeper (*Climacteris picumnus*). There are also three "species of special concern" in the reserve; Platypus (*Ornithorynchus anatinus*), Greater Glider (*Petauroides volans*), and Peregrine Falcon (*Falco peregrinus*). There are several records of Koalas around Bowral and with several key feed trees within the reserve, Koalas may visit from time to time.

Wildfires can pose a risk to flora and fauna habitats and fire sensitive vegetation in the Greater Mount Alexandra Reserve, as burning of large areas in one high intensity fire event could remove species, and even whole plant communities, from the area. Extensive, frequent, and indiscriminate hazard reduction burning can have a similar effect. The potential risks to flora and fauna habitats from wildfire can be managed by minimising the risk of ignitions, maintaining adequate fire trails and other control lines, and by burning suitable areas of vegetation at different times to create a

mosaic of vegetation units at different stages of recovery from fire. The approach taken in this fire management plan is to prescribe fire regimes that aim to conserve existing plant community distribution, structure and floristics, unless there is a legitimate reason to change the vegetation. Prescribed burns will be of low intensity to limit canopy scorch, and not so frequent as to prevent the existing tree cover regenerating.

No sites of Aboriginal or European cultural heritage value likely to be at risk from fire have been identified the reserve. However some sites, such as Aboriginal axe grinding groves and the old tramway formations in the reserve, may be damaged by fire management and fire control activities, such as bulldozing fire control lines.

Infrastructure in the reserve includes: power lines; two dams and a disused water treatment plant which were formally part of the Mittagong water supply system; and a former landfill at Welby which is still used for storage of recyclable materials. Most of the Mittagong Golf Course is included in the reserve. There are timber seats and picnic facilities along the Box Vale Walking Track and at Lake Alexandra. Smaller items at risk from fire include signs on the roads and walking tracks, perimeter fencing, steps on tracks, timber barriers at parking areas and along the public roads, and regeneration plantings. The main built assets at risk from fire are the buildings and infrastructure in the residential areas of Welby, Mittagong and Willow Vale that adjoin the southern boundary of the reserve. The fire risk to major assets and infrastructure in the reserve, and surrounding property, has been addressed by ensuring that there are adequate Asset Protection Zones around infrastructure and buildings, and that fire trails and hazard reduction burns are strategically located to provide the best opportunity of containing wildfires within the reserve.

To implement the management burning program the reserve has been divided into fire management units where burning will be used primarily for hazard management (strategic hazard management), or for habitat management (ecosystem management). These units also allow other management activities, such as weed control, to be co-ordinated with the burning program for maximum benefit. The strategic hazard management units will be burnt primarily to maintain relatively low fuel loads (less than 10 tonnes per hectare) to strengthen fire control lines (fire trails and asset protection zones). The ecosystem management units will be burnt at the optimal fire frequency for the vegetation in the unit.

Except for the north-western boundary, the reserve perimeter is easily accessible from roads, fire trails, or across cleared paddocks. There is an extensive network of trails in the portion of the reserve south of the Hume Highway, more than is required for fire management. The remainder of the reserve has a reasonable network of trails, though many are dead ends, which can make them hazardous during a major fire. A number of new fire trail links are recommended to

improve access and fire-fighter safety. Water for fire fighting is available from fire hydrants on streets close to the reserve in Mittagong and Colo Vale, and from farm dams on adjoining rural properties. Water sources within the reserve are limited to a number of creek crossings which may be dry during droughts.

A number of fire management objectives have been set for the reserve. These objectives, and the management actions recommended to achieve them, are summarised below. Some of the recommended actions have been referenced to a series of generic Management Procedures (MP) in the appendix to this plan. A number of management actions recommended in the draft of this plan have already been implemented, including the establishment of some Asset Protection Zones around assets adjoining the reserve.

Fire Management Objective		**Recommended Actions**
1	Minimise the risk of wildfires starting in the reserve.	a) On total fire ban days, erect fire ban warning signs and regularly patrol the area to ensure that no fires are lit. b) Remove wood-fired barbecues from picnic areas along the Box Vale walking track. Replace with gas or electric barbeques if necessary. c) Implement a community education program to request residents near the reserve to report any smoke or suspicious persons on days of total fire bans.
2	Minimise the risk of fire to users of the reserve and the general public.	a) Erect appropriate signs on tracks and roads to warn reserve users of management burns. b) Ensure that smoke from burns does not cause accidents on the Hume Highway, or other roads, by preparing and implementing a traffic management plan for any burns close to the highway. c) Implement the recovery procedures in Management Procedure (MP) 13 following fires.
3	Minimise the risk of wildfire damaging built and cultural heritage assets in and surrounding the reserve.	a) Implement the fire protection measures listed in Table 3, including the establishment and maintenance of Asset Protection Zones. b) Ensure properties surrounding the reserve are inspected at the beginning of the bushfire danger period and Section 66 notices are issued as required. c) Ensure that authorities planning wildfire control operations in the reserve are aware of built and cultural heritage assets and ensure they are not damaged by machinery movement or other activities. d) Following fires implement the recovery procedures in MP 13.
4	Minimise the impact of fire and fire management activities on water quality.	a) Minimise the risk of wildfires starting and spreading. b) Maintain a minimum 20 m unburnt buffer along flowing watercourses and a 5 m wide unburnt buffer along dry watercourses during management burning wherever possible. c) Implement the recovery procedures in MP 13 following fires. d) Do not spray fire fighting foams or retardants onto water courses during prescribed burning or wildfire suppression operations.

Fire Management Objective		Recommended Actions
5	Implement planning controls on new developments within and adjoining the reserve to ensure they incorporate adequate bushfire protection measures.	a) All new buildings in the reserve must be constructed in accordance with the relevant construction level in Australian Standard 3959 - 1999 *Construction of Buildings in Bushfire Prone Areas*. b) All new buildings in the reserve should be surrounded with an Asset Protection Zone as detailed in MP 5. c) All new developments within 100 m of the reserve boundary should meet the requirements of the RFS document *Planning for Bushfire Protection*.
6	Maintain existing emergency vehicle access points and fire trails shown on Figure 5 in a trafficable condition.	a) Carry out fire trail repairs and maintenance listed in Table 4. b) Ensure all fire trails shown on Figure 5 are inspected and maintained in a trafficable condition at all times according to MP 2. c) Maintain the helipad at the northern end of the Box Vale Fire Trail.
7	Provide additional fire trails to ensure adequate vehicle access for fire control and to eliminate dead ends.	a) Provide new fire trail links (as shown on Figure 5) between: • Joadja Lane and Bowral Street, Welby, and the fire trail system. • Fire trail GMA2 from Iron Mines Oval through the former Mittagong sewage treatment works. • Drapers Road, Welby, and the existing fire trail off Badgery Street, along the unformed portion of Parkes Road. • The junction of Cordeaux and Gascoigne Streets, Willow Vale, and Fire Trail GMA19 to the west of the Mittagong Golf Course. b) Investigate the feasibility of linking the northern end of Wonsons Fire Trail (GMA4) with the road to The Crags.
8	Minimise damage to the fire trail system by preventing unauthorised vehicle access.	a) Implement a security lock system (keys that can't be copied without permission) to control access to fire trails in the reserve. Issue copies of the key to the NSW Fire Brigades, the Rural Fire Service and other emergency services. Each brigade to be provided with a key for each vehicle likely to be used to respond to a fire in the reserve. b) Install additional gates as recommended in Table 4 and shown in Figure 5. c) Inspect gates regularly to ensure that locks are in place and functioning.
9	Signpost all fire trails at their access points, and at trail intersections.	a) Erect appropriate signage at all vehicle access points, and at fire trail intersections, to guide emergency service vehicles. Signs should include commonly used names and/or codes. Dead end trails should be marked as such on the signs. b) Consult with the Rural Fire Service, and the Wingecarribee Bushfire Risk Management Committee, on the most appropriate form and location for the signs.
10	Close and rehabilitate all vehicle trails not designated as fire trails in Figure 5, and not required for other management purposes.	Rehabilitate any vehicle trails not designated as fire trails in Figure 5, and not required for other purposes, using the procedure in MP 3.
11	Construct any future foot tracks so as to maximise their use for fire management.	Locate any new foot tracks along the boundaries of fire management units wherever possible, and construct to MP 4.

Fire Management Objective		Recommended Actions
12	Ensure an adequate and accessible water supply for fire fighting.	a) Ensure fire hydrants within and surrounding the reserve are clearly marked and maintained to Australian Standard AS 2419.1 - 1996. b) Encourage residents in areas with poor mains pressure' or no mains supply to install stored water supplies for fire fighting that are accessible by fire brigade vehicles. c) All stored water supplies should be identified with special markers available from the NSW Fire Brigades.
13	Apply the appropriate fire regime to populations of flora and fauna of conservation value in the reserve that require periodic fire for their long-term survival.	a) Consult with the NPWS Threatened Species Unit when planning prescribed burns in units containing populations or communities listed in the Threatened Species Conservation Act, 1995. b) Avoid burning the whole of any population of a threatened or rare plant species in a single management burn. c) Monitor the recovery of any populations of threatened or rare flora and fauna burnt by wildfires or prescribed burns.
14	Exclude fire from the simple rainforest (riparian) plant communities in the Mount Alexandra Reserve.	Avoid burning simple rainforest (riparian) plant communities wherever possible.
15	Implement a mosaic burning program in selected forest plant communities to maintain and enhance existing habitat diversity, and reduce overall fuel loads in bushland areas.	a) Carry out prescribed burning according to the schedule in Table 6 using the procedure in MP 8. b) Regularly revise burning prescriptions to ensure they incorporate the most recent information on the fire ecology of flora, fauna and plant communities of conservation value in the reserve.
16	Control of unwanted plant species through coordinating fire management and weed control activities.	a) Treat any weeds in areas to be burnt under this fire management plan according to MP 9. b) Coordinate fire management and weed management activities using the procedure in MP 10. c) Integrate the prescribed burning program and its associated weed control activities into any weed management program for the reserve. d) Ensure that all vehicles involved in fire management activities in the reserve (excluding emergencies) are washed to remove any mud, soil or plant material prior to entering the reserve, particularly vehicle underbodies, in order to control the spread of weeds and plant diseases. This is the responsibility of the owner of the vehicle.
17	Coordination of fire management activities in the reserve amongst the various stakeholders.	a) Implement the procedures for coordinating fire management activities in MP 10. b) Preparation of pre-fire season map updates and distribution to the NSW Fire Brigades and Rural Fire Service. c) Approach all landowners who have works or activities recommended on their land in this fire management plan and obtain their cooperation in implementing the relevant activities on their land. d) Units scheduled for burning should be inspected by representatives of Council, the reserve committee, and the person who will be in charge of the burn approximately 3 months prior to the burn to determine if the scheduling is suitable and if any works need to be carried out prior to the burn.

Fire Management Objective		Recommended Actions
18	Ensure all personnel carrying out fire management activities in the reserve are suitably trained and equipped.	a) Ensure all personnel engaged in prescribed burning activities in the reserve have the appropriate level of training and equipment as outlined in Section 6.4, and the minimum equipment listed in MP 8. b) Ensure all personnel engaged in fire management activities in the reserve, including fire trail maintenance, are provided with appropriate instruction in the recognition and protection of items of natural and cultural heritage value, or are supervised by a person with this knowledge.
19	Develop community information and education programs for fire hazard management and bushfire protection.	Prepare an information sheet as outlined in Section 6.1 and Appendix F of this plan, and distribute to adjoining residents, reserve users and other interest groups.
20	Encourage the setting up of Community Fire Units in moderate and high risk urban areas adjoining the reserve.	Consider setting up Community Fire Units at Darch Place, Mittagong; Badgery and Carlton Streets, Willow Vale; and Short and Joadja Streets, Welby (NSW Fire Brigades).
21	Maintain up-to-date information on location of dwellings, fire trails and their condition, water supply points, Asset Protection Zones, and areas burnt in prescribed fires and wildfires.	a) Record fire management activities and wildfires using the procedures in MPs 11 and 12. b) Enter details of each management burn and wildfire in the Bushfire Risk Information Management System (BRIMS).
22	Monitor the impact of fire management activities in the reserve. Adjust practices to achieve relevant objectives, and periodically review the fire management plan.	a) Monitor the impacts of fires carried out as outlined in Section 6.5. b) Review this fire management plan at regular intervals using the procedures in Section 6.5.4. and Table 7. c) Regularly revise burning prescriptions to ensure they incorporate the most recent information on the fire ecology of flora, fauna and plant communities of conservation value in the reserve. d) Carry out further research on the impacts of fire on the reserve.

1. Introduction

This fire management plan for the Greater Mount Alexandra Reserve has been prepared for Wingecarribee Shire Council by AVK Environmental Management and Renaissance Forestry. This plan is designed to be a working document, containing all the maps and information necessary for its immediate implementation. This fire management plan is compatible with the *Wingecarribee Bushfire Risk Management Plan*, and will ensure that Wingecarribee Shire Council is able to meet its responsibilities under current legislation.

The fire management plan considers private property adjacent to the reserve, and, where necessary, identifies works to reduce the threat to life and property in these areas. To ensure that the boundaries of fire management units are practical and ecologically viable, they have been extended beyond the formal boundaries of the Greater Mount Alexandra Reserve, where required, to provide the most practical boundaries for management burning and fire suppression. This fire management plan covers all the environmental issues required for the issuing of a *Bush Fire Environmental Assessment Code* certificate for the hazard reduction works recommended in the plan.

To help overcome the lack of information on the long-term responses of indigenous vegetation to fire, this fire management plan has adopted the principles of 'adaptive management'. The plan contains a monitoring and evaluation component which will provide the information required to progressively refine the plan to ensure it is achieving its desired outcomes. In view of this, the scheduling of management burning in the fire management plan covers a 15 year period. This will allow sufficient time to implement the recommendations in the plan, and to collect enough information for an informed assessment and review. However, the plan also includes procedures to ensure that key components of the plan are continuously updated.

1.1 Reserve Overview

The Greater Mount Alexandra Reserve has an area of approximately 2305 ha located to the north of Mittagong along the Nattai River Valley (Figure 1). The Hume Highway cuts through the reserve with about 450 ha on the southern side, and the remainder extending along the Nattai River gorge to the north-west. The most prominent feature in the reserve is Mount Alexandra (780 m) on the outskirts of Mittagong. The reserve includes a number of popular lookouts, picnic areas and walking tracks. The reserve forms the scenic background on the northern side of Mittagong.

The Greater Mount Alexandra Reserve is managed by Wingecarribee Shire Council with the assistance of the Mount Alexandra Reserve Management Committee.

Figure 1 - Location of the Greater Mount Alexandra Reserve

1.1.1 Vegetation

Details of the vegetation in the Greater Mount Alexandra Reserve are in the ecological investigation undertaken as part of this fire management plan by Kevin Mills and Associates (see Appendix E). The distribution of the plant communities in the reserve is shown in Figure 2. The vegetation in the reserve is strongly influenced by topography with dry forest/woodland communities on the ridges and plateau tops, wet forest along the lower slopes of the gorges, particularly on south facing slopes, and gallery (simple) rainforest along the Nattai River and its main tributaries. Soils are generally shallow and sandy. The vegetation in the reserve is linked to extensive bushland along the Nattai River and its tributaries to the north and east.

There is no comprehensive plant list for the Greater Mount Alexandra Reserve. A plant species list was compiled from existing information and observations during fieldwork for this project (see Appendix E). A total of 242 native species and 17 exotic species are listed, but is by no means a comprehensive list for the reserve.

1.1.2 Reserve Usage

The reserve borders residential developments in Welby, Mittagong, and Willow Vale to the south, farmland to the east and south-west, and bushland in private ownership to the north-east and north-west. The only public road in the reserve is a short section giving access to a lookout on Mount Alexandra from Lake Alexandra. Recreational usage is concentrated in the southern portion of the reserve close to Mittagong. There is a network of walking tracks in the southern and south-western portion of the reserve including the very popular Box Vale Track. There are lookouts on top of Mount Alexandra, and at the end of the Box Vale Track. The lookouts and walking tracks are popular with visitors to the region. There are picnic facilities at Lake Alexandra and at a number of points along the Box Vale Track.

The reserve includes the old Welby landfill, and two dams that were formerly part of the Mittagong water supply but are no longer in use. The reserve also includes the fairways of the Mittagong Golf Club.

Activities within the reserve that are of particular relevance to this fire management plan are:

- recreation activities that could result in people being injured by fires (eg, walking, picnicking)
- infrastructure that would be adversely affected by wildfire (eg, Hume Highway)
- activities that can cause damage to fire trails (eg, four wheel drive vehicles and trail bikes)
- activities that increase the risk of fires starting (eg, picnicking, car dumping).

Figure 2 – Vegetation in the Greater Mount Alexandra Reserve

1.2 Aim

The aims of this fire management plan are to:

"a) Provide recommendations for maintenance and operational procedures to minimise the fire threat to:

- life and property
- ecological diversity
- sustainability of natural systems
- cultural and aboriginal values
- threatened species

b) Provide Council with recommendations on policy and best management practice for development of fire hazard management strategies."

It must be noted that it will not be possible to prevent wildfires occurring within the Greater Mount Alexandra Reserve. Unless these fires are suppressed when small and accessible (close to trails), there is a risk that large destructive fires may develop. Depending on weather conditions, such fires may burn a substantial area of the reserve causing damage to assets and environmental values, and even loss of life. These fires may also travel onto adjoining lands, further threatening life and property. This plan aims to lessen these risks by minimising the risk of fires starting in the reserve, and minimising the risk of loss of life or damage to assets in and around the reserve. The works required to protect life and property in areas adjacent to the reserve will mostly need to be carried out on land adjoining the reserve, rather than within the reserve.

This plan also provides for the use of fire as a management tool to:

- reduce fire hazard to protect assets from wildfires
- maintain plant communities and individual species of conservation value within the reserve that require fire in order to ensure their long-term viability
- assist in the removal of weeds within the reserve and the regeneration of degraded bushland.

1.3 Structure of the Fire Management Plan

SECTION 1 of this plan covers the aim, scope and structure of the plan, current management responsibilities within the reserve, and the necessity and advantages of fire management planning.

SECTION 2 outlines the fire management responsibilities of Wingecarribee Shire Council and private landowners, and how they apply to fire management within and surrounding the reserve. This section also includes a fire management policy for consideration by Council, and broad fire management strategies.

SECTION 3 assesses the fire history of the reserve, causes of wildfires, and fire risk to built, cultural and natural heritage assets that may be at risk from fire.

SECTION 4 provides an overview of fire management issues in the reserve including current fire management practices and community concerns.

SECTION 5 states the fire management objectives for this plan, based on the overall aims of the plan and specific fire management issues.

SECTION 6 covers plan implementation, including prescribed burning, training, community awareness and involvement, and evaluation and review.

SECTION 7 outlines further research that could improve fire management in the reserve.

SECTION 8 summarises the management activities required to achieve the objectives of the plan in the form of an action table. This action table references the tables, maps and other parts of the plan needed for on-ground implementation. It should therefore be used as the primary document for implementing the plan.

In Appendix A (separate document) are a series of generic management procedures to assist in implementing the plan. The appendices also include a methodology explaining the approach used in preparing the plan, assessment references and standards used in the plan, and fieldwork and consultation procedures. These details will be required when revising the plan.

Mapping of information relevant to fire suppression and fire hazard management has been done on a Geographic Information System (GIS). This will assist the Rural Fire Service and other emergency services during wildfire events. The GIS maps and data fields can be updated regularly so that emergency services operating within the reserve during a wildfire have access to the latest fire management information.

Use of a GIS system to record the basic information for the plan will allow it to be easily updated and revised. This is essential to the adaptive management approach used in this plan, as there will be a need to modify the plan in response to:

- new information on the fire ecology of the flora and fauna species in the reserve
- the results of implementation monitoring and performance evaluations
- unplanned incidents, such as major wildfires
- changes in Council and government policy affecting fire management in the reserve.

1.4 Fire Management

Wildfires are a threat to life and property, as well as to natural heritage and cultural assets. The wildfires in January 2001, and November 2002, showed the extent of the damage that can be caused by wildfires in Wingecarribee Shire. Fire has also been found to be a useful tool for managing native bushland reserves to maintain biodiversity.

1.4.1 Fire Hazard Reduction

As the intensity of a bushfire increases it becomes progressively more difficult to contain and suppress the fire. Very high intensity (> 4000 kW/m) fires with flame heights greater than 10 m are generally uncontrollable (NSW Rural Fire Service, 1997). The threat from a bushfire therefore increases as its intensity increases. Fire intensity is directly related to the quantity and distribution of fine fuel (live and dead plant matter less that 6 mm diameter) available to the fire. Other factors, such as slope and moisture content of the fuel, also influence fire intensity, but the only factor that can be effectively controlled to limit fire intensity is fine fuel load (usually expressed in tonnes per hectare).

The fire threat to infrastructure and built assets, such as dwellings, can be reduced by creating an Asset Protection Zone around the asset where fine fuel loads are maintained at low levels. Generally, these buffers consist of an Inner Protection Area (IPA) around the asset with minimal fine fuel loads, and an Outer Protection Zone (OPA) with reduced fine fuel loads. The purpose of the OPA is to reduce the intensity of any bushfire approaching an asset. The purpose of the IPA is to protect the asset from flame contact and intense radiant heat. Slashing, mowing, or hand cutting of vegetation are generally the most effective methods for establishing and maintaining small defendable spaces around isolated assets, or long, narrow, defendable spaces along urban/bushland perimeters.

Protection of other assets and values, such as water quality, views, and threatened species, is generally more difficult, and requires strategies that minimise the risk of wildfires starting and spreading. The main strategies are to:

- minimise the risk of wildfires igniting by removing or limiting as many potential causes of fire as possible
- maximise the ability of fire suppression agencies to detect and control any wildfires that do start.

Maintaining fuel loads at a low level will limit the intensity and rate of spread of wildfires, and make it easier for fire brigades to control and suppress them. Prescribed burning is generally the most effective way to reduce fuel loads over relatively large areas, or where other methods of fuel management, such as slashing, are not feasible. However, there is always a risk of prescribed

burns escaping control lines and becoming destructive wildfires. In addition, some vegetation types accumulate fuel very rapidly and therefore require frequent burning to maintain fuel reduced conditions. Frequent burning can have adverse side affects, such as loss of plant communities and fauna habitat, increased erosion, and loss of visual amenity.

1.4.2 Use of Fire in Sustainable Management of Bushland

Inappropriate fire regimes (season, intensity and frequency of fires) can cause progressive and sometimes irreversible changes in indigenous plant communities, including a loss of biodiversity (the variety of life). On the other hand, identification, prescription and implementation of an appropriate fire regime can be used to:

- manage indigenous flora and fauna habitats in a sustainable manner
- maintain biodiversity
- control selected weed species and promote natural regeneration in dry forest communities.

Wildfires can pose a risk to fire sensitive vegetation in Mount Alexandra Reserve as burning of large areas in one high intensity fire event could remove species, and even whole plant communities, from the area. Extensive, frequent, and indiscriminate hazard reduction burning can have a similar effect. The potential risks to flora and fauna habitats from wildfire can be managed by minimising the risk of ignitions, maintaining adequate fire trails and other control lines, and by burning suitable areas of vegetation at different times to create a mosaic of vegetation units at different stages of recovery from fire. Adoption of a mosaic burning pattern would have the following advantages:

- increased habitat diversity
- reduced overall fuel loads
- help in the suppression of wildfires
- reduced risk of a single, high-intensity wildfire burning the whole of the reserve.

Within the mosaic of burning units the fire regime (frequency, season and intensity of fire) can be manipulated to achieve some or all of the following objectives:

- removal of woody and herbaceous weeds, and weed seeds from mid-storey, leaf litter, and soil surface
- reduction in the levels of plant nutrients, such as phosphorus and nitrogen, which may be contributing to weed invasion
- manipulation of ecological processes such as; species composition (via the promotion of selected species or communities), regeneration of senescent vegetation, and the creation of suitable conditions for native seed germination

- protection of species of conservation value by maintaining habitat elements that are critical for their survival.

In bushland fire can be used to stimulate germination of indigenous plant seeds. She-oaks, most Eucalypts, Acacias, members of the pea family (*Fabaceae*) and many species from other families frequently germinate prolifically in areas which have been burnt. However, the burnt area will also be open to weed invasion and must be carefully monitored.

In rural areas frequent burning is sometimes used to control woody weeds, and this method can also be helpful in native grasslands. However, in native bushland fire will generally increase an existing weed problem. Many woody weeds re-sprout rapidly from rootstock after fire, often coppicing densely (hawthorn, gorse). Herbaceous species (including many grasses) respond in a similar way, regenerating from growth buds on a network of robust underground rhizomes (pampas grass). Seed germination is usually prolific after fire, a response which necessitates prompt control measures, on-going monitoring, and site maintenance (gorse, broom).

Therefore, where weeds are already a problem, prescribed burning should only be carried out after weeds have been treated, and follow up weed control can be carried out. In general, weed infested bushland areas should not be burnt if resources for post-fire weeding are not available. The exception to this is high fire hazard areas close to dwellings where burning is the only feasible method of hazard reduction.

2. Fire Management Framework

2.1 Fire Management Policy and Strategies

Wingecarribee Shire Council does not currently have a fire management policy or strategy. The following draft policy has been developed to provide a framework for this and other fire management plans. It has not been formally adopted by Council.

Wingecarribee Shire Council will diligently exercise all its legislative responsibilities relating to fire management.

Wingecarribee Shire Council will implement current 'Best Management Practice' in fire management on all land under its control in order to fulfil its responsibilities as a landowner, and in recognition of its role in natural area management.

Fire management on property owned, or managed, by Wingecarribee Shire Council will be based on sound ecological principles, and will take into account the objectives and principles of Ecologically Sustainable Development.

Wingecarribee Shire Council recognises the importance of regular communication between fire management agencies, landowners, and the community at large, in raising awareness of fire management issues and ensuring a broad understanding of the responsibilities of different sections of the community in reducing the risk of dangerous bushfires.

The recommended strategies for implementing this draft policy are:

1. Maintain up to date maps of bushfire prone areas within the shire to provide a basis for planning, and to ensure that development and building applications incorporate fire protection measures appropriate to the level of bushfire risk.
2. Prepare detailed fire management plans for all bushland areas under Council's control which include provisions for the protection of life and property, fire hazard reduction, protection of threatened species and their habitats, and conservation of biodiversity.
3. Facilitate control and suppression of wildfires on Council property through provision of adequate resources for the construction, inspection and maintenance of fire trails, fire breaks, water supply points, and asset protection zones.
4. Develop and maintain a fire management data base for recording and monitoring fire history, fire hazard levels, vegetation condition, and fire management actions.
5. Monitor Council managed bushland areas during periods of high and extreme fire danger to quickly detect wildfires, notify the appropriate fire service (NSW Fire Brigades or Rural Fire Service) through the "000" emergency system, and provide assistance in containing and

suppressing the fire (assistance would not include active fire fighting as Council has neither the resources or appropriately trained personnel).

6. Consult with the Rural Fire Service and NSW Fire Brigades during development of fire management plans, and assessment and reduction of fire hazards.
7. Consult with the Rural Fire Service during assessment of development applications in bushfire prone areas.
8. Consult with affected landowners and the wider community during the development of fire management plans, and education of the community about Council's fire management practices, procedures and future directions.

2.2 Statutory Responsibilities

Wingecarribee Shire Council, and landowners surrounding the reserve, have a general legal responsibility to take all reasonable steps to minimise the risk of fires that originate on their property causing personal injury, damage to adjoining property, or damage to items of natural or heritage value protected by government legislation. Wingecarribee Shire Council also has specific responsibilities under various Acts of Parliament for fire management, fire hazard abatement, and the conservation and management of native flora and fauna.

2.2.1 NSW Government Legislation

Rural Fires Act, 1997

Section 63(1) of the Act requires; "a public authority to take the notified steps (if any) and any other practicable steps to prevent the occurrence of bush fires on, and to minimise the danger of the spread of a bush fire on or from:

(a) any land vested in or under its control or management, or

(b) any highway, road, street, land or thoroughfare, the maintenance of which is charged on the authority.

Section 63(3) states that: "A public authority or owner or occupier is liable for the costs incurred by it in performing the duty imposed by this section.".

Section 63(4) states that: "The Bush Fire Co-ordinating Committee may advise a person on whom a duty is imposed by this section of any steps (whether or not included in a bush fire risk management plan) that are necessary for the proper performance of the duty."

"Notified steps" in this section of the Act mean:

"(a) any steps that the Bush Fire Co-ordinating Committee advises a person to take under subsection (4), or

(b) any steps that are included in a bush fire risk management plan applying to the land."

Section 66 of the Act requires local authorities to: "by notice in writing, require the occupier or owner (not being a public authority) of any land within the area to carry out bush fire hazard reduction work specified in the notice on the land". By agreement with the Rural Fire Service, notices under Section 66 of the Act within Wingecarribee Shire are now issued by the Rural Fire Service.

Section 66 of the Act also states that: "A notice requiring the establishment of a fire break cannot require an occupier or owner to kill or remove any trees that are reasonably necessary:

(a) for shade, shelter, windbreak or fodder purposes, or

(b) for the protection of threatened species, populations, communities or critical habitats within the meaning of the Threatened Species Conservation Act, 1995".

Section 69 of the Act states that: "A fire control officer, or an officer or member of a fire brigade or other person authorised by a local authority, may for the purpose of forming an opinion as to:

(a) whether the local authority should serve a notice under section 66 on the occupier or owner of any land, or

(b) whether or not such a notice has been complied with,

enter during the daytime any part of the land (other than a dwelling-house) that it is necessary to inspect in order to form that opinion."

Section 70 (2) of the Act states that: "If within the time specified in the relevant notice the owner or occupier to whom it is given fails to comply with any requirement of the notice, the local authority or any officers or members of any fire brigade or rural fire brigade or other persons authorised by the local authority may, without prejudice to the liability of the owner or occupier, enter on the land and carry out the bush fire hazard reduction work the owner or occupier was required to do under the notice."

Section 70 also allows the cost of the works to be recovered from the landowner.

Section 73 (1) of the Act allows the Commissioner of the Rural Fire Service to carry out bush fire hazard reduction work on land:

"(a) if the work has not been carried out on land by a public authority or owner or occupier of land when, or in the manner, required by a bush fire risk management plan, or

(b) if, in the opinion of the Commissioner, a public authority or owner or occupier of land has not properly performed a duty under section 63 to take notified steps, or any other practicable steps, that is imposed on the public authority or owner or occupier, or

(c) if the work has not been carried out by a public authority when, or in the manner, required by the Commissioner under section 74F."

Section 100C of the Act states that "bush fire hazard reduction work may be carried out on land despite any requirement for an approval, consent or other authorisation for the work made by the *Native Vegetation Conservation Act 1997*, the *Threatened Species Conservation Act 1995*, the *National Parks and Wildlife Act 1974*, or any other Act or instrument made under an Act if:

(a) the work is carried out in accordance with a bush fire risk management plan that applies to the land, and

(b) there is a bush fire hazard reduction certificate in force in respect of the work and the work is carried out in accordance with any conditions specified in the certificate, and

(c) the work is carried out in accordance with the provisions of any bush fire code applying to the land specified in the certificate."

Section 100D states that; "A bush fire hazard reduction certificate is a certificate that authorises the carrying out of bush fire hazard reduction work on land in accordance with:

(a) a bush fire risk management plan that applies to the land, and

(b) the provisions of any bush fire code applying to the land specified in the certificate, and

(c) any conditions specified in the certificate.

Wingecarribee Shire Council is the certifying authority for bushfire hazard reduction activities within reserves under its management. Section 100G of the Act states that:

"(1) Before a certifying authority carries out any bush fire hazard reduction work on land, the certifying authority must certify:

(a) that a bush fire risk management plan applies to the land, and

(b) that the certifying authority has taken into consideration the provisions of any bush fire code applying to the land and determined which of them should be complied with in carrying out the work and whether any conditions should be imposed having regard to any provisions of that code, and

(c) if the certifying authority is a local authority or a public authority, that the notice will be given to the fire control officer for the district in which the land is situated before the work is carried out and to any other person prescribed by the regulations.

(2) A bush fire hazard reduction certificate certified by a certifying authority must:

(a) specify the provisions of any bush fire code applying to the land that the certifying

authority has determined should be complied with in carrying out the work, and

(b) specify any conditions that have been imposed by the certifying authority having regard to that bush fire code."

The Bush Fire Environmental Assessment Code for use under this section of the Act was gazetted in July 2003.

The Rural Fires Act, 1997, requires all parties involved in fire suppression and prevention to have regard to the principles of ecologically sustainable development when exercising their functions, and when preparing Plans of Operations and Bush Fire Risk Management Plans. Consideration of these principles must include the conservation of biological diversity and ecological integrity.

Fire Brigades Act 1989

Section 6(1) of the Act states that: "It is the duty of the Commissioner to take all practicable measures for preventing and extinguishing fires and protecting and saving life and property in case of fire in any fire district."

However Section 10A of the Act states that: "The Commissioner is to have regard to the principles of ecologically sustainable development described in section 6 (2) of the Protection of the Environment Administration Act, 1991, in carrying out any function that affects the environment."

Section 21 of the Act states that the Commissioner of the NSW Fire Brigades is authorised to:

"(a) plough, burn, clear or otherwise establish or maintain fire breaks on any land (whether or not within a fire district), and

(b) remove, burn or destroy any flammable matter or other material on any land (whether or not within a fire district) if satisfied that the action is necessary to prevent the outbreak, spread or extension of a bush fire or other fire.

The power conferred by this section must not be exercised except:

(a) for the purpose of controlling or extinguishing a fire or protecting persons endangered by fire from injury or death or property endangered by fire from damage, or

(b) with the permission of the person apparently in occupation or control of the land.".

Local Government Act, 1993

The Greater Mount Alexandra Reserve is classified as community land under this Act. The Act requires councils to have regard for the principles of ecologically sustainable development. Included in Section 8(1) of this Act is a principle requiring a council to manage, develop, protect, restore, enhance and conserve the environment of the area for which it is responsible in a manner

that is consistent with, and promotes the principle of, sustainable development. This includes the integration of biodiversity considerations into the decision-making process. The Act also requires councils to have regard for the content of Recovery Plans for threatened species when preparing plans of management for community land.

Threatened Species Conservation Act, 1995

This Act provides for the protection of flora, fauna, plant communities and populations of particular species listed in the schedules of the Act. The Act requires recovery plans to be prepared for threatened species and plant communities, and threat abatement plans for threatening processes. Section 69 of the Act requires public authorities "to take any appropriate action available to them to implement those measures included in a recovery plan for which they are responsible and must not make decisions that are inconsistent with the provisions of a recovery plan."

There is a general exemption from the provisions of the Act for any emergency fire fighting activities within the meaning of the Rural Fires Act, 1997.

"High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition" is listed as a key threatening process in Schedule 3 of the Act. High frequency fire is defined as two or more successive fires close enough together in time to interfere with, or limit, the ability of plants or animals to recruit new individuals into a population, or for plants to build up a seed bank sufficient in size to maintain the population through to the next fire.

"Removal of dead wood and dead trees" has recently been listed as a key threatening process in Schedule 3 of the Act. Examples given in the determination report by the Scientific Committee include: "illegal or poorly regulated firewood collection from forests and woodlands and unsustainable loss of fallen woody debris, which may be stacked, burnt, mulched or otherwise removed from the site". There is no specific mention of hazard reduction burning in the committees determination.

National Parks and Wildlife Act, 1974

Aboriginal and European cultural heritage sites are protected under this Act, as well as threatened flora, fauna and plant communities. Section 118A prohibits "harming or picking threatened species, endangered populations or endangered ecological communities" except with the appropriate licence or certificate, or a development consent under the Environmental Planning and Assessment Act, 1979. However, "this section does not apply in relation to any thing authorised to be done by or under the Rural Fires Act 1997 in relation to any emergency fire fighting act within the meaning of that Act."

2.2.2 Wingecarribee Bushfire Risk Management Plan

This plan was prepared by the Wingecarribee Bushfire Management Committee under Section 52 of the Rural Fires Act, 1997. It was approved by the Bushfire Coordinating Committee in September 2001. The Bushfire Risk Management Plan has classified the bushfire threat to community assets bordering the Greater Mount Alexandra Reserve in Welby, Mittagong and Willow Vale as "high", and the bushfire risk as "major". The bushfire threat to environmental/ecological assets has been classified as moderate in the portion of the reserve to the south of the Hume Highway and along the Nattai Gorge, and low over most of the remainder of the reserve, except for a few small areas of "high" threat. There is no indication in the risk management plan as to what the areas of high threat represent. The level of bushfire risk to environmental/ecological assets is classified as "low" over most of the reserve.

The Bushfire Risk Management Plan has designated the southern boundary of the reserve bordering Welby, Mittagong and Willow Vale as an Asset Protection Zone. The stated objective for this zone is to: "protect human life, property and highly valued public assets" by providing "Inner Protection Areas (IPA) and Outer Protection Areas (OPA) around assets or groups of assets which are adjacent to bush fire hazard areas." The risk management plan also states that "whilst Asset Protection Zones are most commonly applied in residential developments, they also have application for many other asset types."

The remainder of the reserve is part of a Strategic Fire Advantage Zone. The stated objective of this zone is to: "To provide strategic areas of fire protection that will reduce the speed and intensity of bush fires, and reduce the potential for spot fire development." The functions of this zone as stated in the Wingecarribee Bushfire Risk Management Plan are to:

"• To provide fuel reduced areas which enable the protection of assets by firefighters when Asset Protection Zones are not in place.
- To complement Asset Protection Zones where these do not provide adequate protection.
- To provide fuel reduced zones in areas of high ignition potential (eg along roads, rail lines, power lines etc) to slow the development of fires, reduce their spread, and provide for safe suppression.
- To provide strategically located fuel reduced zones (eg across known fire paths) to reduce the potential for fires to become campaign fires and to provide advantageous areas for fire suppression.
- To provide strategically located fuel reduced areas to reduce the vulnerability of assets which are susceptible to fire."

The Bushfire Risk Management Plan also states that: "In accordance with the principles of Ecologically Sustainable Development, and Bush Fire Coordinating Committee Policy, the use of inappropriate fire regimes is to be avoided wherever possible." The plan explains 'inappropriate fire regimes' as follows:

> "An inappropriate fire regime is considered to be one where (usually through the decisions or actions of humans) one or more of the fire attributes is occurring outside its historic range of variation for the area. Where such a change is allowed to continue, changes to the environment are likely to result. Examples of this include areas where prescribed fire is applied too frequently, areas where fire occurrence is reduced (through wildfire suppression and cessation of prescribed burning) such that fires are less frequent and more intense, and areas where the season of burning is changed."

This is not a helpful explanation for fire management planning purposes as there are generally insufficient records to determine the 'historic' fire regime, and it also assumes that all historic fire regimes were 'appropriate'.

The Bushfire Risk Management Plan notes that there may be areas where asset protection and biodiversity conservation objectives conflict. In these areas priority is to be given to the protection of life and property.

2.3 National Standards and Guidelines

The following documents prepared by Standards Australia deal with bushfire protection issues at a national level:

- Australian Standard 3959 - 1999, Construction of Buildings in Bushfire Prone Areas
- Standards Australia Handbook 36 - 1993, Building in Bushfire Prone Areas.

Australian Standard 3959 is referenced in the Building Code of Australia and provides construction techniques to improve building resistance to varying levels of bushfire attack by wind-blown burning debris, radiant heat and direct flame contact. The NSW Rural Fire Service and Planning NSW publication *Planning for Bushfire Protection* (2001) contains instructions on how this standard is to be used in NSW. The Standards Australia Handbook 36 (Ramsay and Dawkins, 1993) provides general advice on siting, landscaping, design and construction of buildings in bushfire prone areas.

3. Bushfire Risks

Extreme fire conditions occur in Wingecarribee Shire when dry winters and springs are followed by hot summers. Under these conditions, fuels are very dry and fires that start during periods of strong, dry north-westerly to westerly winds can be expected to move quickly downwind, and then move more or less at right angles on a broad front when the subsequent southerly wind change arrives. Fires that start under these conditions can reach a very high intensity in a short time, even in areas with relatively low fuel loads, and are very difficult to control until the weather conditions abate.

3.1 Bushfire History and Causes

The last major wildfire to affect the whole of the reserve was in 1939. Since that fire the Wingecarribee Bushfire Risk Management Plan records a major fire burning up the Nattai River valley to the northern side of Mount Alexandra in 1980. The last major wildfire in the reserve was in November 2002. This fire started near the Hume Highway and, together with backburns, burnt approximately one third of the reserve. Between these two fires there have been numerous small wildfires and hazard reduction burns in the reserve. Information on the recent incidence of fires in the reserve was taken from Rural Fire Service and Wingecarribee Shire Council records, supplemented by information from local fire brigades and field observations in July 2004. The area covered by the known larger fires in the reserve since 1980 is shown in Figure 3.

Arson has been the most common cause of wildfires in the portion of the reserve to the south of the Hume Highway. In the remainder of the reserve lightning has been the most common cause of fires. The major wildfire in November 2002, which resulted in the loss of 5 dwellings and a warehouse, appears to have been accidental. This fire started on a day of extreme fire weather with a Total Fire Ban in force, and took approximately a week to be fully contained.

3.2 Current Hazard Levels

The higher the intensity of a wildfire the greater its destructiveness and the more difficult it is to control. Fire intensity is a function of the heat content of the fuel, the quantity of fuel (fuel load), and the rate of spread of the fire. The heat content of vegetation fuels is roughly constant, so fire intensity is largely determined by slope and weather conditions (wind speed and relative humidity), and fuel loads.

Figure 3 – Recent fires in the Greater Mount Alexandra Reserve

Fine fuels are the main factor influencing fire behaviour, (larger fuels burn during a fire but do not contribute significantly to the spread of a fire). Fine fuels consist of live and dead plant matter (including grasses, bracken, leaves, bark, and twigs and branches) less than 6 mm in diameter. This measure normally includes any fine fuel in the understorey as well as litter on the ground. Fine fuel load (measured in tonnes per hectare) is therefore used as a convenient measure of the underlying fire hazard in a particular area. The fine fuel load at any given time is a balance between the rate of fuel build up, and factors that remove fuel, such as litter decomposition and fire. In the absence of fire, fuel loads build up to a maximum level where the rate of fuel production equals the rate of decomposition. This theoretical maximum varies for different vegetation types, however it is rare for dry eucalypt forests and woodlands to reach their maximum fuel loadings due to relatively frequent fires.

Fuel loads can be roughly categorised in terms of the potential threat they pose as follows:
Low - < 5 tonnes per hectare
Medium - 5 to 15 tonnes per hectare
High - >15 tonnes per hectare.

Fine fuel loads in the various vegetation types in the reserve were assessed using the visual method in Appendix B. Fuel loads in the portion of the reserve burnt in November 2002 are still very low. Fuel loads are generally medium in the portion of the reserve to the south of the Hume Highway, and close to Colo Vale, where there has been relatively frequent hazard reduction burning. In other parts of the reserve fuel loads are generally high. It should be noted that even the lower levels of medium fuel loads are sufficient to generate uncontrollable fires on days of high to extreme fire danger, particularly if the fire is running upslope.

3.3 Assets at Risk from Fire

Assets potentially at risk from fire include; dwellings, infrastructure, and other items, such as ornamental plantings, which would cost money to replace; and items of scenic, cultural and natural heritage value which could be damaged or destroyed by fire, or fire suppression activities. Each landowner in the area, including Wingecarribee Shire Council, has an obligation to reduce a fire hazard where it is a threat to neighbouring properties. However, even with extensive hazard reduction burning, the risk of high intensity wildfires occurring in the reserve cannot be eliminated. Therefore consideration must be given to protection measures that will reduce the risk of fire damage to assets in and surrounding the reserve. The main assets adjoining the reserve that are at risk from fire are the surrounding rural and residential properties. Assets within the reserve that are considered at risk from bushfires are shown in Figure 4.

Figure 4 – Assets at risk from fire in the Greater Mount Alexandra Reserve

3.3.1 Bushfire Risk to Natural Heritage Assets

Natural heritage assets include native flora and fauna, as well as scenic values. This plan minimises the risk of fire damaging these assets through measures to minimise the risk of wildfires in the reserve, and ensuring that any prescribed burns are of low intensity to limit canopy scorch, and not so frequent as to prevent the existing tree cover regenerating. The Greater Mount Alexandra Reserve contains one plant species, *Persoonia glaucescens,* listed as endangered in the Threatened Species Conservation Act, 1995, and one, *Phyllota humifusa,* listed as vulnerable. *Persoonia glaucescens* is common in scribbly gum heathy woodland near Welby, and close to the reserve boundary along Drapers Creek near Colo Vale. A small population of this species near the Mittagong Sewage Treatment Works was burnt in the November 2002 wildfire. The reserve also includes three species listed in ROTAP (Rare or Threatened Australian Plants) *Eucalyptus apiculata, Lissanthe sapida,* and *Persoonia mollis* subsp. *Revoluta,* a species endemic to the region. There are also four species uncommon in the area that have local conservation value, *Cryptandra amara, Dodonaea multijuga, Eucalyptus dendromorpha, and Eucalyptus oreades* that is at the southern limit of its distribution (Benson & McDougall, 1998).

Five fauna species listed as vulnerable in the Threatened Species Conservation Act, 1995, have been recorded in the reserve; Powerful Owl (*Ninox strenua*), Glossy Black-Cockatoo (*Calyptorhynchus lathami),* Yellow-bellied Glider (*Petaurus australis*), Squirrel Glider (*Petaurus norfolcensis*), and Brown Treecreeper (*Climacteris picumnus*). There are also three "species of special concern" in the reserve; Platypus (*Ornithorynchus anatinus*), Greater Glider (*Petauroides volans*), and Peregrine Falcon (*Falco peregrinus*). There are several records of Koalas around Bowral and with several key feed trees within the reserve, Koalas may visit from time to time. The likely response to fire of the flora and fauna species of conservation value known to occur in the reserve is given in Table 1.

The tall valley forest and associated riparian habitats in the Greater Mount Alexandra Reserve are important for local fauna, both in terms of their intrinsic habitat value as well as their role in providing a habitat corridor for forest species. The reserve as a whole provides a significant habitat link, in terms of its size and location between the NPWS reserves of the lower Blue Mountains and the bushland around Mittagong, including Council's two other reserves, and the water catchment land further to the east.

The small area of Tea Tree Swamp Shrubland on Drapers Creek in the north-east of the reserve is rare in the area, although such sandstone swamps are common in the Blue Mountains and along the Illawarra Escarpment. This small swamp could be threatened by inappropriate fire regimes and use of off-road vehicles.

Table 1 – Fire Management Requirements of Flora and Fauna of Conservation Value.

A fairly simple rainforest community dominated by Coachwood (*Ceratopetalum apetalum*) occurs as a narrow stand along the Nattai River and some of its tributaries. Rainforest is quite rare in this part of the shire, and is sensitive to fire. Further details on the flora and fauna assets in the reserve can be found in the ecological investigation report by Kevin Mills and Associates in Appendix E.

The main fire risk to natural heritage assets in the reserve is from fire regimes that are outside the thresholds within which a particular plant community, or habitat for flora and fauna species, has viability in the long-term. Fire regimes within the thresholds of a particular plant community will help maintain its long-term viability, whereas fire regimes outside the thresholds are likely to lead to progressive changes in the structure and floristics of the plant community, and loss of habitat for the fauna favouring that plant community. Management burning of the plant communities in the reserve at the optimum frequency for their long-term viability is considered the best way to conserve habitat in the reserve. Management burning in a mosaic pattern along with maintenance of fire trails is the best way to minimise the risk of high intensity wildfires burning the whole of the reserve. The fire management requirements of the different plant communities/habitats in the reserve is given in Table 2.

This fire management plan is based on current knowledge of the effects of fire on the flora and fauna species known, or considered likely, to occur in the reserve. Where there is a lack of information about the fire ecology of a particular threatened species or plant community, a fire regime has been applied that aims to conserve their habitat by maintaining the structure and floristics of the particular plant community in which they occur. It should be noted that the flora and fauna in the reserve have persisted in an environment that has been burnt in the past at varying frequencies. The continued presence of these species in the reserve suggests that they have the capacity to at least survive a number of fires.

Additional species of conservation value may occur in the reserve. If any such species are discovered this plan may need to be modified to incorporate the fire management requirements of the new species.

Although the management burns prescribed in this plan may kill some individuals of particular threatened species, the management prescriptions should have an overall beneficial effect on species of conservation value by ensuring the long-term conservation of their habitats, and reducing the risk of large wildfires eliminating isolated populations. The monitoring and review procedures in the plan will allow fire regimes to be modified as new information on the ecology of any of the flora and fauna species of conservation value in the reserve becomes available.

Table 2 - Fire management requirements of the vegetation types in Mount Alexandra Reserve

3.3.2 Bushfire Risk to Built and Cultural Assets

A number of Aboriginal heritage sites have been recorded in the reserve, none of which are likely to be directly affected by fire. However, some sites, such as axe grinding groves, could be damaged by some fire management activities, particularly bulldozing of control lines during fire suppression operations.

The main cultural heritage sites in the reserve are associated with previous coal mining operations. These include the tramway formation to the Box Vale Mine in the Nattai River valley, which is now a popular walking track, the Mount Alexandra Mine on the northern side of Mount Alexandra, and the "open cut" on the eastern side of the Nattai River at Mittagong. All that remains of these mining operations are cuttings, embankments and tunnels, which would not be directly affected by bushfires but could be damaged by fire management activities such as bulldozing of fire control lines.

Infrastructure in the reserve includes: power lines; two dams and a disused water treatment plant which were formally part of the Mittagong water supply system; and a former landfill at Welby which is still used for storage of recyclable materials. Most of the Mittagong Golf Course is included in the reserve. There are timber seats and picnic facilities along the Box Vale Walking Track, and at Lake Alexandra. Smaller items at risk from fire include signs on the roads and walking tracks, perimeter fencing, steps on tracks, timber barriers at parking areas and along the public roads, and regeneration plantings. The main built assets at risk from fire are the buildings and infrastructure in the residential areas of Welby, Mittagong and Willow Vale that adjoin the southern boundary of the reserve.

The degree of fire threat at any particular time is a combination of fine fuel quantity, slope, and the prevailing weather conditions. The actual risk of a fire causing damage to an asset is a function the degree of threat, the probability of a fire igniting, and any measures taken to prevent the fire causing damage.

The four major modes of attack by bushfires that can cause damage to assets are:

1. wind-blown burning debris
2. radiant heat which can ignite flammable materials ahead of the fire front and shatter glass
3. flame contact
4. strong winds generated or intensified by the fire.

The potential for damage to buildings in the path of large fires burning out of the reserve will depend largely on:

- whether the fire will approach upslope or downslope
- the quantity and distribution of fuel surrounding the building

- whether they are defended during the fire
- their design
- the materials from which they are constructed
- how well they have been maintained.

The fire risk to the built and cultural heritage assets within and surrounding the reserve has been assessed using a procedure developed from Australian Standard 4360 – 1999 Risk Management. This procedure combines established risk factors in order to rank the level of fire risk so that implementation of fire risk reduction measures can be prioritised.

There is insufficient data available to assess the likelihood of a high intensity fire starting in the reserve, so the likelihood of ignition has been taken as constant in the analysis, i.e. it is certain to occur at some time in the future. The analysis is restricted to fires burning within the reserve, or approaching surrounding assets from the direction of the reserve. Where there are a number of possible fire approaches from bushland in the reserve, the approach with the highest threat has been used in the analysis.

The analysis is based on three main factors:

1. fire threat in terms of fuel loads and fire approach
2. vulnerability to damage of the asset
3. potential consequences of a fire damaging or destroying the asset.

The analysis is carried out by assigning each factor a relative score, and multiplying the scores to determine a relative level of risk.

0 – minimal risk of fire damage

1 to 250 – low risk

251 to 1000 – moderate risk

1001 to 11664 – high risk.

Scores are weighted where it is considered that the factor would have a major influence on fire risk. This purpose of this analysis is to rank the risk to various assets so that risk reduction works can be prioritised. The score numbers are only multiplied so that assets that are not at risk from fire have a score of zero. The scores allow the level of risk to be placed in the broad risk categories of low, medium and high. These risk categories have the following general meanings:

LOW – low levels of burning ember attack, possible spotfires and/or asset is of low value.

MODERATE – asset likely to be impacted on by a high intensity fire front but has features that will reduce the intensity of the fire attack, or provide some protection from fires.

HIGH – asset likely to be impacted on by the high intensity fire front with few, if any, features that would reduce the severity of fire attack.

Fuel Loads

Vegetation type has been used as a surrogate for fuel loads as actual fuel loads vary with time after the last fire, but reach different maximum levels in different vegetation types.

(A) VEGETATION TYPE	SCORE
Wet forests with a dense shrub understorey	6
Dry forest & woodland, shrub or heath understorey	5
Heathland and shrubland	4
Forest, grass or fern understorey	3
Grassland and grassy woodland	2
Rainforest	1

Scores have been halved where the vegetation threatening the asset is less than 1 ha in area, or the potential fire run is less than 20 m.

Fire Approach

Fire approach has two aspects; slope and wind direction. Fires burning downslope generally have a lower intensity than fires burning upslope in the same fuel type. Extreme fire weather generally occurs with hot, dry, north-westerly to westerly winds. These winds are usually generated ahead of cold fronts which cause the winds to back round to the south-west and south as the front passes. This wind change can turn the previous flank of the fire into the headfire which can continue to burn with high intensity until the cooler temperatures and higher humidity associated with the change increase fuel moisture levels. The two fire approach factors have been scored as follows:

(B) FIRE APPROACH - SLOPE	SCORE
Up slopes greater than 10˚	5
Up slopes between 5˚ and 10˚	3
Across slopes – 5˚ to + 5˚	2
Down slopes greater than 5˚	1

(C) FIRE APPROACH - DIRECTION	SCORE
North-west through west to south-east	3
North, north-east and east	1

Vulnerability to Damage

Vulnerability to damage has been assessed using three factors; the combustibility of the asset, fire protection measures in place in the form of an Asset Protection Zone, and whether the asset is accessible by fire brigade vehicles. An Asset Protection Zone is a natural or managed area around an asset where there is insufficient fuel to carry a fire, even under extreme conditions. The width of the Asset Protection Zone determines the likely severity of bushfire attack. Where there is no Asset Protection Zone an asset can be subjected to flame contact, intense radiant heat, and wind-blown burning embers. With an inadequate Asset Protection Zone in terms of the recommended widths in the Rural Fire Service document *Planning for Bushfire Protection,* an asset could be subjected to intense radiant heat and wind-blown burning embers. With an adequate Asset Protection Zone the asset should only be subjected to attack by wind-blown burning embers.

(D) COMBUSTIBILITY	SCORE
Asset constructed of non combustible materials capable of maintaining structural integrity during a bushfire	0
Asset contains structural, or other essential elements, that are combustible, or may fail at the temperatures likely to be generated by a bushfire (all dwellings have been included in this category)	2
Asset is constructed primarily of combustible materials	3

(E) ASSET PROTECTION ZONE	SCORE
None (flame contact, intense radiant heat, burning embers)	3
Present but inadequate (intense radiant heat, burning embers)	2
Adequate (wind-blown burning embers)	1

Accessibility

This factor assesses the ability of the fire brigades to actively defend an asset during a bushfire. The assessment is in terms of the ability of fire brigade vehicles to access the asset, and assumes that there will be sufficient water available to at least extinguish spotfires on or around the asset. It should be noted that in a major fire where fire fighting resources are heavily committed it may not

be possible to provide crews to defend every dwelling in the path of a fire. It is also possible that in high intensity fires it may not be safe for fire fighters to actively defend an asset.

This factor also provides an indication of the likely danger and difficulty in evacuating residents during a major bushfire. It should be noted that in all areas near bushland evacuation becomes progressively more dangerous as the fire front approaches.

(F) ACCESSIBILITY	SCORE
No fire brigade vehicle access	4
Dead end, light tanker only	3
Dead end, light and heavy tanker/pumper	2
Through road or fire trail	1

Potential Consequences

The following potential consequences of fire were used in the analysis:

(G) CONSEQUENCES	SCORE
CATASTROPHIC; potential loss of life; loss of structures equipment and infrastructure; high financial loss.	6
MAJOR; potential serious injury, some loss or major damage to structures, equipment and infrastructure; medium financial loss.	4
MODERATE; localised damage; possible minor injury, total loss of structures, equipment and infrastructure unlikely; low financial loss if any.	2
MINOR; no injury, superficial damage to structures, equipment and infrastructure, if any; very low financial loss if any.	1
INSIGNIFICANT; no injury or damage likely.	0

The injury factor in the consequences assessment assumes that residents will be sheltering in their dwellings during a bushfire. Some assets, such as Aboriginal heritage sites, may not be directly damaged by fire but may be damaged by fire management and fire suppression activities, such as construction of fire control lines. These risks are noted under "Comments" in Table 3.

The management strategies recommended in Table 3 will reduce the existing fire risk but in most cases will not eliminate it. Active protection of an asset during a fire can greatly reduce the fire risk. From a planning point of view it is not possible to determine if this will be available, although the potential for active protection is incorporated into the analysis under Factor F "accessibility". Recommended Asset Protection Zone (APZ) widths are in accordance with the requirements of the Rural Fire Service's *Bushfire Environmental Assessment Code.* The whole of this APZ needs to be maintained as an Inner Protection Area. For all buildings within 100 m of bushland in the reserve, the fire risk could be further reduced if the owners bring the buildings up

to at least Level 1 construction requirements in Australian Standard 3959 – 1999 *Construction of Buildings in Bushfire-prone Areas,* and regularly maintain buildings to ensure there are no flammable materials (such as leaves in gutters) in contact with combustible parts of the building.

Assets at medium and high risk from damage from fire will need to be protected during management burns in the reserve.

Table 3 – Fire Risk Assessment for Built and Cultural Assets in Mount Alexandra Reserve

4. Fire Management Issues

4.1 Management Responsibilities

Management of the reserve is the sole responsibility of the Wingecarribee Shire Council, who is assisted by the Greater Mount Alexandra Reserve Management Committee. Council has a responsibility under the Rural Fires Act (1997) to prevent the spread of wildfires occurring in the reserve to adjoining property. This fire management plan will help to fulfil that "duty of care". The reserve is within a NSW Rural Fire Service district with Mittagong Brigade responsible for the southern portion of the reserve, Woodlands Brigade for the western portion, and Colo Vale Brigade for the eastern and northern portions.

4.2 Prescribed Burning

Hazard reduction burning has been carried out in the reserve for many years by the three Rural Fire Service brigades that have parts of the reserve within their areas (Woodlands, Mittagong and Colo Vale). There was no documented strategy for hazard reduction burning in the reserve and decisions appear to have been based on the local Rural Fire Service brigade captain's assessment of risk. The primary focus of past burning was hazard reduction near towns and villages, and creating control lines along key fire trails. Hazard reduction burning was concentrated in the dry forest areas in the southern portion of the reserve near Mittagong, and the north-eastern corner near Colo Vale. Some burning has also been carried out on private property adjoining the reserve.

The approach adopted in this plan is to divide the reserve into areas where burning will be used primarily for hazard management (strategic hazard management) or for habitat management (ecosystem management). This is supplemented by Asset Protection Zones maintained by other methods for protection of property. Habitat management burns will have the additional benefit of reduced bushfire hazard for a period following each fire.

4.3 Fire Trails and Foot Tracks

Except for the north-western boundary, the reserve perimeter is easily accessible from roads, fire trails, or across cleared paddocks. There is an extensive network of trails in the portion of the reserve south of the Hume Highway, more than is required for fire management. The remainder of the reserve has a reasonable network of trails, though many are dead ends which can make them hazardous during a major fire. Some strategic trail construction and repair of existing trails took place in the reserve during the last two years in response to two major fires, and this has improved access and eliminated some dead ends.

It was noted by some residents bordering the reserve that the new trails have also increased trail bike activity in the reserve. This is a cause for concern as it will increase maintenance costs on the fire trails, as well as reducing the amenity of the area for other users and nearby residents. Trail bike usage is concentrated around the old Welby landfill, but is also a problem near Colo Vale. It is recommended that trail bike riding in the reserve be banned, and that this be clearly sign-posted and enforced. Current signage stating "no trail bikes off road" is ambiguous and could be interpreted to mean that trail bike riding is allowed on fire trails. To allow for the legitimate use of trail bikes, Council should consider establishing an area where trail bike riding can be carried out with minimal disturbance. This could be in the reserve but would require further investigations to determine a suitable site.

The location of the trails within the reserve considered necessary for fire management are shown in Figure 5, and their condition assessed in Table 4. Any other vehicle trails within the reserve that are not required for other management purposes can be closed. No new fire trails are considered necessary for fire management, although a number of new links are recommended to improve access and fire-fighter safety. These include:

- A link to the fire trail system north of Welby from the ends of Joadja Lane and Bowral Street.
- A link to the new fire trail north of Sunset Point Drive from Iron Mines Oval through the former Mittagong sewage treatment works.
- A link to the fire trail to the north of dwellings along Drapers Road, Welby, along the unformed portion of Parkes Road. The current access to this trail from Badgery Street runs through private property which is likely to be developed in the future.
- A link to the fire trail to the west of the Mittagong Golf Course from the junction of Cordeaux and Gascoigne Streets, Willow Vale.

It would also be desirable to have a link between the northern end of Wonsons Fire Trail and the new trail from Mount Flora to The Crags. This link would allow vehicles to move in and out of the northern portion of the reserve without large detours, and would improve safety on both trails as fire fighters would have an egress from the Mt Flora to The Crags trail, and the dead end on Wonsons Fire Trail would be eliminated. However, the link would need to be constructed through difficult terrain, and could increase the unauthorised use of the trails by trail bikes. It is recommended that the feasibility of this link be investigated.

There are a number of minor service trails and a network of foot tracks in the southern portion of the reserve near Mittagong which, although not required for fire suppression, provide convenient control lines for management burning. Foot tracks which could be useful as control lines for management burning have been shown in Figure 5.

Figure 5 – Fire Trails and Foot Tracks in Mount Alexandra Reserve

Table 4 - Condition and maintenance of fire trails in Mount Alexandra Reserve

Fire trails have been given names where these are in common usage, or are obvious from their destination. It should be noted that the naming of Winters and Wonsons Fire Trails has been modified from what is shown on the Mittagong 1:25000 map sheet (first edition). These were originally separate fire trails but were linked some time ago to provide continuous access through the reserve. In this plan it is proposed that the fire trail starting at the Sheepwash Creek crossing on Drapers Road and running to the north-west corner of the reserve near The Crags be classified as a primary fire trail and named Wonsons Fire Trail. The name "Winters Fire Trail" has been retained for the portion of the original Winters Trail running west from the renamed Wonsons Trail to the Nattai River Gorge.

Access to most fire trails and service roads in the reserve is controlled by locked gates, however this has not completely eliminated unauthorised usage by four wheel drive vehicles. The location of the existing gates is shown in Figure 5. A number of trails do not have gates or locked chains, and installation is recommended at a number of locations on the existing trails to control access (see Figure 5). All gates on fire trails should include a sign stating that they should not be blocked at any time. Of concern is the persistent tampering with locks on the gates on Mount Alexandra and near the Mittagong Recreation Centre by person or persons unknown. Damaged locks on gates can cost the fire brigades valuable time when responding to fires, and any damaged locks, or persons seen damaging locks should be reported to Council.

Guidelines for the construction, repair and maintenance of fire trails in the reserve are given in Management Procedures (MP) 1 and 2 in Appendix A. Trails in the reserve that are closed should be rehabilitated properly to ensure they do not erode and affect water quality in nearby watercourses. Guidelines for rehabilitating fire trails are given in MP 3 in Appendix A. The helipad constructed at the end of the Box Vale Fire Trail during the 2001 bushfires should be regularly maintained.

Any new foot tracks in the reserve should be constructed according to the guidelines in MP 4 (Appendix A), and should be routed along the boundary of fire management units wherever possible.

The existing trails and foot tracks provide adequate access to the reserve for fire management, and have been used as fire control lines for the prescribed burning recommended in this plan. All fire trails in the reserve need to be clearly signposted to avoid confusion when out of town fire brigades and other emergency services are operating in the area.

4.4 Asset Protection Zones

The higher the intensity of a bushfire approaching a building, or other asset, the greater the risk of ignition. Fire intensity is controlled by a number of factors including temperature, humidity, wind

speed, slope, and quantity of fine fuel (fuel load). The only one of these factors that we can control is fuel load. It is therefore desirable to reduce the risk of damage to a building or other asset by creating a zone around the building where the amount of flammable fine fuel is kept at a low level. These are called Asset Protection Zones and consist of an Inner Protection Area immediately adjacent to the asset at risk from fire, and an Outer Protection Area between the Inner Protection Area and bushland. The width of both these zones must be increased as slope increases in order to maintain a reasonable degree of fire protection.

The main aim of these two zones is to ensure that there is a reduction in the intensity of a bushfire as it approaches an asset at risk from fire, and the asset is not exposed to intense radiant heat or flame contact. Asset Protection Zones also provide:

- relatively safe access for fire-fighters
- a control line for fire fighting operations
- a relatively safe refuge area for fire-fighters and residents.

Inner Protection Areas are normally established within individual lots and maintained by the landowner or resident. Outer Protection Areas may be required on large lots, and in some cases need to be maintained on adjoining private property, or in the reserve.

The existence and adequacy of defendable spaces on individual lots adjoining the reserve was not surveyed as part of this fire management plan, except where this could be easily observed without entering the property. Nevertheless it must be stressed that establishment and maintenance of Asset Protection Zones around residences bordering the reserve is essential for fire protection. Private landowners are responsible for establishment and maintenance of Asset Protection Zones on their properties where required to protect their dwellings, or neighbours' dwellings. Wingecarribee Shire Council is responsible for maintaining the portion of any Asset Protection Zone that falls within the reserve. The areas where portions of Asset Protection Zones around adjoining dwellings will need to be maintained within the reserve are shown on Figure 5. In some cases adjoining residents are already maintaining these areas.

It should be noted that, except for dwellings close to the reserve boundary, there will be little point in Council maintaining a portion of an Asset Protection Zone in the reserve unless the adjoining landowner has established, and is maintaining, an Asset Protection Zone between their dwelling and the reserve. A cooperative approach between Council and individual landowners is needed to maintain adequate fire protection. Where landowners are unwilling to cooperate, Council should request the Rural Fire Service to issue notices under Section 66 of the Rural Fires Act, 1997, to ensure that adequate Asset Protection Zones are established and maintained on adjoining private

property. Although Council has the power to issue notices under Section 66 of the Rural Fires Act, 1997, it currently has an agreement with the Rural Fire Service to issue these notices in the shire.

No specific fire protection measures are recommended for the smaller assets within the reserve such as board walks, foot bridges, signs, seats, picnic tables and timber steps. Some of these are already in cleared areas which will provide them with some protection, others are vulnerable to fire damage and will need to be protected during management burns. However, it is not considered cost effective to try to protect these items from wildfire as the cost of replacement will be far less than the cost of maintaining cleared areas around these assets.

4.5 Water Supply

Water for fire fighting is available from fire hydrants on streets close to the reserve in Mittagong and Colo Vale, and from farm dams on adjoining rural properties. The only water sources within the reserve that are accessible by fire brigade tankers are:

- A pool on an unnamed creek approximately 30 m downstream of where it is crossed by Wonsons Fire Trail. A portable pump is required to access this water supply.
- A small pool constructed on Kells Creek besides the Box Vale Track.
- The crossing of Nattai Creek just upstream of the lower dam.
- The Drapers Road crossing of Sheepwash Creek.
- A dam in the north-west corner of the Mittagong Golf Course. This dam is surrounded by golf course greens and should only be used during wildfires.

Some of these water sources may be dry during prolonged droughts. The location of fire hydrants and other water points are shown on Figure 5. Please note that Council has not finished logging the location of fire hydrants in Willow Vale on their GIS.

4.6 Fire Detection and Suppression

The portion of the Greater Mount Alexandra Reserve south of the Hume Highway is highly visible from the freeway and Mittagong, and it is likely that any fires would be promptly reported. This area is also easily accessible so fires can usually be contained before they get out of control. The portion of the reserve to the north of the Hume Highway is less visible from surrounding areas and has inaccessible gorges and gullies where direct attack is difficult and large wildfires could develop before containment lines can be established. The Wingecarribee Rural Fire Service does not currently have a remote area fire fighting capability. This means that it is not possible to mount a direct attack on fires in gorges and gullies where there is no vehicle access. These fires can only be controlled by backburning from existing fire trails or bulldozed control lines. In the more

rugged parts of the reserve this could result in quite large areas being burnt to control even relatively small wildfires.

4.7 Bushland Management

Introduced plant species are mainly confined to the southern border of the reserve adjoining urban areas of Mittagong and its suburbs. The portion of the reserve to the north of the Hume Highway is mostly free of introduced plants. Some of the introduced plant species in the reserve are declared noxious weeds, while others can be considered environmental weeds due to their ability to colonise native vegetation communities and displace indigenous species. A comprehensive survey of introduced species was not included in this study, however incidental observations were recorded and added to the species list in the Ecological Investigation report.

Fire can provide the disturbance that many introduced species need to spread to new areas, as well as to expand existing populations. Other fire management activities, such as construction and maintenance of fire trails, and bulldozing of fire breaks during fire suppression, can also provide opportunities for weeds to colonise native bushland. The likely response of introduced species in the reserve to fire is given in Table 5.

Fire can also be used as a tool to manage weed infestations. Some species are best controlled by herbicide application to regrowth following a fire. Other species can sometimes be controlled by the application of a fire regime that stimulates germination of seed but kills the regrowth before it has been able to flower.

The Mount Alexandra Reserve Management Committee is actively working with Council on regeneration and weed control projects in the reserve. The prescribed burning recommended in this plan can assist a weed control program, and it is recommended that weed control activities be integrated with the management burning program in this plan. Management Procedure (MP) 9 in Appendix A includes guidelines for integrating weed management with management burning, and for minimising the risk of weed invasion following wildfires. These guidelines should ensure that fires in the reserve do not worsen existing weed problems, or cause weeds to spread.

It should be noted that bush regeneration plantings in previously cleared areas may increase the fire hazard. Any proposals for bush regeneration in the reserve should be considered in the context of this fire management plan to ensure that they do not compromise fire protection measures proposed in this plan. In general plantings should not be allowed:

- in defendable spaces established around assets at risk
- on fire breaks
- within 1 m of the edge of fire trails.

In some cases it may be possible to landscape Asset Protection Zones and fire breaks to reduce their visual impact. Guidelines for landscaping in Asset Protection Zones are given in MP 6.

Table 5 - Response to fire of the main weed species in Mount Alexandra Reserve

4.8 Conservation of Biodiversity

Fire plays an important role in maintaining biodiversity in Australia. Changes in the fire regime (season, frequency and intensity of fire) can cause progressive changes in plant communities. Frequent fire and long-term exclusion of fire have both been shown to lead to progressive changes in plant community structure, and a reduction in biodiversity. Failure to use fire properly as a management tool can be considered a threat to the natural habitats in the reserve.

Frequent burning of native forests will generally reduce species diversity and make it more vulnerable to weed invasion. A high fire frequency (less than 5 years) will usually favour grasses in the understorey at the expense of shrubs, and severely restrict the re-establishment of canopy species. For this reason "high frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition" has been listed as a key threatening process on Schedule 3 of the Threatened Species Conservation Act, 1995.

Fire can adversely affect fauna by killing individual animals, removing their habitat, or removing specific elements in their habitats, such as nest sites and feeding areas. Extensive, high-intensity wildfires pose probably the major threat to fauna in the reserve, and so this plan includes measures to minimise the risk of wildfires burning the whole of the reserve. This fire management plan also aims to conserve the known habitats of fauna species of conservation value in the reserve by prescribing an appropriate fire regime to ensure the long-term viability of the species, and ensuring the critical habitat elements are protected as much as possible.

The wet forest and simple rainforest plant communities in some of the gorges and gullies in the reserve naturally have a low fire frequency and do not require management burning to ensure their long-term viability. These communities could be damaged and even eliminated from the reserve by frequent fires.

The drier forest plant communities in the reserve are considered to be dependent on fire to maintain their present structure and floristics in the long term. Periodic burning will help to maintain diversity in the understorey, and allow fire dependent species to germinate and establish. However, there is a need to minimise damage to important habitat elements (such as dead trees, old logs and stumps) during these burns, and to ensure adequate retention of unburnt patches of each forest type to act as refugia for recolonisation of burnt areas. The management procedure for prescribed burning in Appendix A of this plan includes the retention of dead trees, logs, and stumps as one of its prescribed outcomes.

Currently there is some debate over the optimal season for burning dry forests, grassy woodlands and grasslands. In fact, it is likely that they benefit from a varied fire regime. The season of

burning specified in this plan has therefore been deliberately varied, except where there has been a specific need, such as avoiding the flowering time of a threatened species.

4.9 Stakeholder and Community Concerns

At the commencement of the project Wingecarribee Shire Council sent a letter to all landowners adjoining the reserve informing them that the fire management plan was being prepared and inviting them to have input into the plans by sending in a written submission, attending a community "walk and talk" at the reserve, or by contacting the consultant team directly. The community "walk and talk" was held in the reserve in June 2003. A draft of the fire management plan was placed on public exhibition in March 2004. The main community comments and concerns about fire management in the reserve expressed during the walk and talks, and in written submissions were as follows:

Welby: 9:30 am 14/6/03

- Concern that a pile of tyres in the reserve is a fire hazard – residents have contacted Council but no action as yet.
- Concern that the recent blocking of trails in the area will restrict fire brigade access.
- Concern about dumping of cars and rubbish in this part of the reserve.
- A glossary of fire fighting terms in the plan or a brochure would help public understanding, eg HRB, backburning, high intensity/low intensity etc.
- Concern about use of trail bikes on fire trails – damage issues and legal issues – not clear if trail bikes are allowed in the reserve. If not, can a special area be provided for trail bikes.
- Concern about high fuel levels at the eastern end of Joadja St.
- Concern about lack of hazard reduction in bush at the western end of Colo Street.
- Concern about what is in dumped drums in the 'BMX track' area.

Willow Vale: 1:30 pm 14/6/03

- Concern about future hazard reduction on private lots between Willow Vale and the Hume Highway.
- Community needs to be educated about fire risks, particularly children.
- Concern about who will be responsible for fire management, and that complaints will be acted on.
- Concern about lack of access control to the fire trail behind the golf course.
- Local community needs information on the importance of habitat and ecosystem management, also the damage that can be caused by trail bikes.

- Concern about trail bikes, 4WD, & unauthorised access to private land on Colo Vale side of the reserve – exacerbated by new trails put in after the 2001 fires.
- Need new vehicle access to the fire trail off Gascoyne Street if private blocks are developed.
- Poor water pressure in the area during the last fire.
- Need somewhere for trail bikers to use.

Lake Alexandra: 1:30 pm, 21/6/03

- Concern that the mail out notice only went to residents adjoining the reserve, should have gone to all residents in Mittagong.
- Confusion between the areas of responsibility of the Rural Fire Service and NSW Fire Brigades, who to approach for assistance with hazard reduction?
- Concern about apparent lack of hazard reduction in the reserve.
- Concern that piles of weeds left by bushcare activities are a fire hazard – need to be burnt or removed.
- Concern that there are more noisy trail bikes in the area since the new fire trail to Welby was put in – trail bikes are driving walkers away – needs a gate or suitable barrier.
- Confusion about procedure for getting hazard reduction work done on private property; permission, burning restrictions, non burning solutions, disposal of cleared material. How can Council and fire brigades assist – haulage, mulchers, pile burning, cooperation between Council and landowners ("if they remove the blackberries, I will mow the grass"). Tip fees and only one green waste collection seen as disincentives - could Council waive tip fees for a week just before the fire season/for residents in fire prone areas? Alternatively, could Council provide a mulcher to remove cleared vegetation.
- Tree branches overhanging the loop of Sunset Point Drive - difficult for large vehicles to pass, need to be pruned. Albert Street also affected.
- Concern about rubbish dumping in the bush between Sunset Point Drive and the old sewage treatment works
- Concern that excessive tree planting on nature strips could increase the fire risk.
- Comment that Council requires hazard reduction on private property but does not do their own hazard reduction work.
- Concern about Council's commitment to implementing the fire management plan.
- Trees around Lake Alexandra might hamper helicopters filling their buckets.
- Need for residents to know what they can do to reduce bushfire risk and who is responsible for what aspects of fire management.

- Need a brochure of leaflet with relevant fire protection information, terms, and responsibilities (landowners, Rural Fire Service, Council, NSW Fire Brigades, Reserve Committee).
- Concern that street signs and house numbers are not prominent enough and could lead to problems in an emergency.
- This is a good opportunity to set up cooperative fire management schemes, Council should show more leadership.

Colo Vale community hall: 7:30 pm, 24/6/03

- Concern that the local fire brigade will still have a role in fire management in the Reserve, particularly hazard reductions.
- Warnings of planned burns to residents, particularly those who may be affected by smoke.
- Concern that there will be adequate resources for implementing the plan, and someone responsible for implementing it.

Written Comments

Six written submissions were received from surrounding residents and one from the Management Committee of the Mittagong Youth, Recreation and Community Centre. These are summarised below:

- Concern about lack of access controls on fire trails in the Colo Vale area constructed during the 2001 bushfires. No signs or gates restricting access to these trails. No indication of the boundary between the reserve and private property. Erection of gates in other parts of the reserve has greatly increased vehicle usage (trail bikes and 4WD) of the trails in the Colo Vale area, also illegal activities such as rubbish dumping and cutting fire wood. Concern that this will lead to dumping of cars and arson. Area needs similar access controls to the other parts of the reserve, and signs to inform users of activities that are prohibited in the reserve.

- Request for the fire management plan to include the area around Alice Street, which is used for dumping garden refuse (trees, logs, grass clippings) and general rubbish, which increases the fire hazard. The risk is particularly heightened when Alice Street is blocked by this rubbish.

- Concern about lack of recent hazard reduction in the reserve and consequent build up of fuel, particularly during the recent drought. Request for regular hazard reduction burning in the reserve, particularly the area below the scenic drive, around lake Alexandra and back to the old Welby tip (as the direction from which fire would be most likely to come into the reserve). Suggests that property owners adjoining the reserve be exempt from property size restrictions on burning off, and that Lake Alexandra should be cleaned out to increase its water holding capacity and the Highlands Golf Club dams should be enlarged so that they can be used by

water bombing helicopters. Also suggested the RFS prepare a data base of all large bodies of water eg. swimming pools/dams/lakes and of all fire fighting pump locations, and an fire evacuation plan be developed, documented and distributed.

- Concern about protection of the flora and fauna on Tearum Mountain as it is one of the few areas left unburnt by the recent fires. Sugar gliders, large gliders, goannas, wallabies, eastern grey kangaroos, Lyre birds and other fauna, possibly including koalas, inhabit this area. Flora including a stand of grey gums, stringy bark (mahogany), ferns, creepers and shrubs are also present.

- Concern about large pine trees on Council land adjacent to 35 Arthur Street, Mittagong, including large quantities of pine needles falling on the ground, roof and garden at this address and the potential for damage to life and property from these trees. Also concerned about an apparent lack of hazard reduction on the southern side of Mount Alexandra, and trail bikes on the fire trails in the reserve.

- Concern about the potential for loss of visual amenity and home and contents, most likely due to a westerly wind carrying fire around base of Mount Alexandra. This could have a devastating effect on the reserve and adjoining properties. Wants more hazard reduction burning in the reserve and in adjoining bushland on private property.

- Concern about fire risk to the Mittagong Youth, Recreation and Community Centre including:
    a) bushes growing out of the Centre's guttering;
    b) trees and shrubs growing up against the Centre walls;
    c) trees too close to the building;
    d) no fire hydrants;
    e) no water taps/outlets for fire fighting.

Meetings were held with the NSW Rural Fire Service brigades responsible for fire suppression in the reserve, Mittagong, Colo Vale and Woodlands, at which the recommendations of the plan were discussed. The brigades' comments and suggestions have been incorporated into the plan. The Wingecarribee Rural Fire Service, and some adjoining residents, have made written comments on the draft fire management plan. These comments have been addressed, where appropriate, in this final plan.

5. Fire Management Objectives

The specific fire management objectives recommended for the Greater Mount Alexandra Reserve for the 15 year duration of this fire management plan are as follows:

Fire Prevention and Asset Protection

1. Minimise the risk of wildfires starting in the reserve.
2. Minimise the risk of fire to users of the reserve and the general public.
3. Minimise the risk of wildfire damaging built and cultural heritage assets in and surrounding the reserve.
4. Minimise the impact of fire and fire management activities on water quality.
5. Implement planning controls on new developments within and adjoining the reserve to ensure they incorporate adequate bushfire protection measures.

Access and Water Supply

6. Maintain existing emergency vehicle access points and fire trails shown on Figure 5 in a trafficable condition.
7. Provide additional fire trails to ensure adequate vehicle access for fire control, and to eliminate dead ends.
8. Minimise damage to the fire trail system by preventing unauthorised vehicle access.
9. Signpost all fire trails at their access points, and at trail intersections.
10. Close and rehabilitate all vehicle trails not designated as fire trails in Figure 5, and not required for other management purposes.
11. Construct any future foot tracks so as to maximise their use for fire management.
12. Ensure an adequate and accessible water supply for fire fighting.

Conservation of Biodiversity

13. Apply the appropriate fire regime to populations of flora and fauna of conservation value in the reserve that require periodic fire for their long-term survival.
14. Exclude fire from the simple rainforest (riparian) plant communities in the Mount Alexandra Reserve.
15. Implement a mosaic burning program in selected forest plant communities to maintain and enhance existing habitat diversity, and reduce overall fuel loads in bushland areas.
16. Control unwanted plant species through coordinating fire management and weed control activities.

Coordination and Human Resources

17. Coordinate fire management activities in the reserve amongst the various stakeholders.
18. Ensure all personnel carrying out fire management activities in the reserve are suitably trained, equipped and supervised.
19. Develop, assist development of, or utilise existing education programs and materials aimed at:
    - reducing arson
    - informing residents adjacent to the reserve of fire safety issues, and measures to improve protection of themselves and their property
    - informing residents of adjoining properties about the potential impact of their fuel management activities on environmental and other values
    - interpreting fire management activities for the public, particularly the role of fire in maintaining biodiversity.
20. Encourage the setting up of Community Fire Units in moderate and high risk urban areas adjoining the reserve.

Monitoring, Records and Review

21. Maintain up-to-date information on location of dwellings, fire trails and their condition, water points, Asset Protection Zones, and areas burnt in prescribed fires and wildfires.
22. Monitor the impact of fire management activities in the reserve. Adjust practices to achieve relevant objectives, and periodically review the fire management plan.

The actions recommended to achieve these objectives are given in the management action summary table in Section 8.

6. Plan Implementation

6.1 Community Education, Awareness and Involvement

In order to inform key sectors of the community about fire management issues in the reserve, the text for an information sheet has been prepared that can be made available to residents living close to bushland (see Appendix F). The information sheet is designed to cover issues relevant to fire protection in Wingecarribee Shire that are not covered in general pamphlets available from the NSW Fire Brigades or the Rural Fire Service. Appropriate Rural Fire Service community education pamphlets should be distributed along with the information sheet.

A Community Fire Unit has recently been established for the Sunset Point Drive area. This will help to promote awareness of bushfire issues in this area and provide additional resources for fire fighting. This can provide a model for more Community Fire Units in the urban areas adjoining the Greater Mount Alexander Reserve. Possible areas include Darch Place, Mittagong; Badgery and Carlton Streets, Willow Vale; and Short and Joadja Streets, Welby.

6.2 Fire Management Units

In order to implement the prescribed burning component of the fire management plan, the plant communities in the reserve have been divided into a mosaic of management units which can be burnt at a frequency, season and intensity that is optimal for the plant communities within each unit (see Figure 6). These units allow for implementation of the most appropriate methods for managing fire hazard whilst ensuring the maintenance of biodiversity. A number of the units include private property and therefore successful implementation of this plan will require the cooperation of these landowners. Some units close to assets at risk have been designated as strategic hazard management units and should be burnt as required to maintain relatively low fuel loads (less than 10 tonnes per hectare).

Wherever possible existing roads, tracks, and suitable natural features have been used for fire management unit boundaries. This has required some of the boundaries to be located outside the boundary of the reserve. Use of these existing fire control lines will reduce the amount of preparation required prior to burning. In some instances plant community boundaries have been used as boundaries. Some of the recommended burns do not have control lines and can only be carried out when weather conditions will ensure that the fire will go out overnight.

Some areas of the reserve are steep and inaccessible and would be very difficult to burn. These areas are well away from any assets, and have been left out of the burning program as it is considered that the effort involved in burning them is far greater than any benefit in habitat management or hazard reduction. These areas generally contain wetter forest types which do not

require frequent burning for ecosystem management. In addition, vegetation within 5 m of minor (intermittent) watercourses, and 20 m of major (permanent) watercourses should not be burnt wherever possible. This will help to minimise the impact of the prescribed burning program on water quality.

6.3 Prescribed Fire Regimes

The general approach in this fire management plan is to manage areas close to urban areas, for strategic hazard management, and the remainder of the reserve primarily for ecosystem management. The strategic hazard management units will be managed primarily to maintain relatively low fuel loads (less than 10 tonnes per hectare) to strengthen fire control lines (fire trails and asset protection zones). Depending on the sensitivity of the area, the fuel in the strategic hazard management units can be managed by burning, or hand cutting and removal of fuel; or a combination of both. The ecosystem management units should be burnt at the optimal fire frequency for the vegetation in the unit.

Burning has not been scheduled in stands of riparian (simple) rainforest, or in tall wet forest, except where required for strategic hazard management close to dwellings. The tall wet forests are generally in deep gullies or gorges where access is difficult and there are no control lines available to contain the burn. These areas are generally too wet to burn in autumn and winter when conditions allow for open burning. These areas will consequently build up high fuel loads over time which could support high intensity wildfires.

Three different types of prescribed burn have been used in this plan:

1. Spot or line ignition within established containment lines (fire trails or previous burns). These burns can be easily controlled within the containment lines, and can be carried out under conditions that would be unsuitable for the other two types of burns.

2. Ignition along one side of a fire trail. In these open burns there is only a containment line on one or two sides of the burn. These burns must only be lit under calm conditions when forecast overnight weather will extinguish the fire, and the forecast over the next few days is not likely to cause any flare ups from burning logs or trees. These conditions are specified in Management Procedure 8 (see Appendix A). In most cases these fires will be moving downslope which will reduce intensity.

3. Line or spot ignition along ridge tops. These burns can be lit by crews on the ground, or by aerial incendiaries. For longer ignition lines a temporary vehicle access could be constructed and retained as a dormant fire trail. These open burns will slowly move downslope into the adjoining valleys, and must only be lit under calm conditions when forecast overnight weather will extinguish the fire, and the forecast over the next few days is not likely to cause

any flare ups from burning logs or trees. These fires require the same weather conditions as the second type of fire. Larger areas can be burnt out by using multiple line or spot ignitions.

The last two types of burns have a much higher risk of escape and should only be lit in autumn or winter. The extent of the area burnt by the uncontained fire can be controlled to some extent by the time of day the fire is lit. Ignition in the morning will allow the fire to move further before nightfall than a fire lit in the afternoon.

Minor reviews of the burning schedules are recommended every 5 years and a major review of the whole plan every 15 years. To allow for flexibility in budgeting and planning, burns have been scheduled within five 3-year periods as shown in Table 6. The burns can take place at any suitable time during the specified 3-year period. If a wildfire burns more than half of a unit, the whole of the unit should be considered to have been burnt and the schedule adjusted accordingly. In order to create a mosaic of native bushland with different fire histories, adjoining units should generally not be burnt in the same 3-year period.

The fire management units scheduled for burning should be inspected some months prior to the proposed burn to check that the scheduling and burning prescriptions are still appropriate, and to determine if there are weeds present that require treatment prior to burning. Where treatment of weeds is required, it should be carried out at least 3 months in advance of the burn to allow treated weeds to desiccate.

It should be noted that areas excluded from the prescribed burning program will still be vulnerable to wildfires. In fact wildfires in these areas are likely to be of higher intensity, and cause greater damage, than in areas included in the prescribed burning program due to higher fuel loads.

6.4 Administration

Management Procedure (MP) 10 in Appendix A was prepared to ensure effective coordination of fire management activities amongst the various stakeholders in the reserve. MPs 11 and 12 include forms for recording fire management activities in the reserve.

Successful implementation of the prescribed burns in this plan requires trained personnel and special equipment. The equipment and level of expertise required for the crews carrying out prescribed burns is given in MP 8 in Appendix A. Minimum crew strengths are also specified. Prescribed burns can be carried out by the Rural Fire Service, NSW Fire Brigades, appropriately trained and equipped Council staff, or by contractors. If the prescribed burning is contracted out, the contractor must be able to meet the required training, crew and equipment levels specified in MP 8, as well as provide evidence of experience in carrying out ecosystem management burns.

Weed management before and after prescribed burns will require personnel trained in bush regeneration techniques.

Figure 6 - Fire Management Units

Table 6 - Burning regimes for Mount Alexandra Reserve

6.5 Monitoring And Evaluation

Details of any prescribed burning or wildfires within the area covered by this fire management plan should be recorded according to MPs 11 and 12 in Appendix A, and entered in the Bushfire Risk Information Management System (BRIMS) operated by the Rural Fire Service.

6.5.1 Species of Conservation Value

It is important that fires in the reserve do not negatively impact upon known populations of species of conservation value, or endangered plant communities. In the absence of any specific information on the fire management requirements of a particular species or community of conservation value, this fire management plan aims to maintain the structure and floristics of the plant communities in which they occur. However, given the uncertainties in our knowledge of the fire ecology of many species, known populations of species of conservation value should be monitored for any changes in population size following wildfires and prescribed burns. Accurate mapping and estimation of existing population sizes followed by periodic recounts should be considered. The monitoring program should be developed in consultation with the National Parks and Wildlife Service Threatened Species Unit.

6.5.2 Plant Community Structure

A photographic record of the vegetation in each fire management unit should be set up to monitor major changes in plant community structure over time. Photos should be taken of a representative section of each fire management unit (burnt and unburnt) at the beginning of each 3-year period of the plan. Photos should be taken from the same location in each unit and show the same area of bushland. This will require a marked vantage point in each unit, and specifications as to the film type and camera settings to be used. Ideally the same focal length setting should be used throughout the monitoring period.

6.5.3 Performance Indicators

The management action summary in Section 8 includes performance indicators for actions, or groups of actions, recommended to meet the objectives of the fire management plan. Desired outcomes for prescribed burns are given in the prescriptions in MP 8 in Appendix A, and in Table 5. The performance indicators should be used to determine if the specific objectives of this fire management plan have been achieved. They should be monitored every 5 years during the operation of the plan. Where performance targets are not being achieved, a review of the relevant portion of the plan should be undertaken.

6.5.4 Review of the Fire Management Plan

Minor reviews should be undertaken approximately every 5 years, and when any of the triggers listed in Table 6 are encountered. A full review of the fire management plan should be undertaken after all the burns prescribed for the fifth 3-year period of the plan have been completed.

The review should include:

- an audit to ascertain if procedures have been properly carried out and performance targets have been achieved
- a review of contemporary fire management and fire ecology literature to incorporate the latest information into the plan
- comparison of the condition of burnt and unburnt fire management units
- assessment of any changes in plant community structure as a result of fire
- preparation of a revised fire management plan to cover the next 15 years.

Table 7 - Fire management plan revision procedures

ASSESSMENT	REVIEW TRIGGER	RECOMMENDED ACTION
Monitoring of wildfires in the reserve.	Wildfire burns more than half of any single fire management unit.	Consider the whole unit to have been burnt and reschedule the next prescribed burn according to the optimal fire frequency given in Table 2.
Monitoring of wildfires in the reserve	Wildfire burns more than 50% of the fire management units in any single year.	Completely revise the burning schedule.
Flora and fauna surveys or incidental recordings.	Threatened species considered sensitive to fire recorded in the reserve.	Revise the burning prescription and/or burning schedule to ensure that the newly identified threatened species is/are not adversely affected.
At the end of each 3-year period check that each burn has produced the desired outcomes.	Burning prescription not producing the desired outcomes.	Revise burning prescription based on information recorded during the burn to ensure outcomes can be achieved.
General weed monitoring.	Post-fire weed treatment has not been successful in controlling target weeds.	Carry out follow-up treatments until target weeds are under control.
Review of ecological literature.	Research shows that the optimal fire frequencies for particular plant communities or threatened species need revision.	Revise burning schedules for the fire management units containing the particular species or plant community.

6.6 Maintaining Records

6.6.1 Annual Update

The following items should be inspected annually at the beginning of the bushfire season (September) and the maps and information tables in the fire management plan updated if required:

- condition of vehicle access points and gates
- condition of fire trails and any new trails
- condition of fire hydrants and markers
- assets at risk from fires (delete assets no longer present and add new assets).

6.6.2 Update After Fires

After each prescribed burn or wildfire in the area covered by this fire management plan, details of the burn should be entered in the Bushfire Risk Information Management System (BRIMS), and the extent of the burn and the date should be entered in a data base maintained by Wingecarribee Shire Council (see Management Procedure 12 in Appendix A).

6.7 Adaptive Management

It is recommended that an 'adaptive management' approach be adopted for the implementation of this plan. Although this plan incorporates current knowledge on the impacts of fire on specific flora and fauna species and different plant communities, none of this knowledge is specific to Mount Alexandra Reserve. It is therefore difficult to predict the effect of the management actions recommended in this plan, particularly the prescribed burning program, on the ecosystems in the Greater Mount Alexandra Reserve, or on individual flora and fauna species.

Adaptive management utilises an experimental approach to land management where full scientific knowledge is lacking but where immediate management actions are required. For the adaptive management approach to work, the management plan will have to be run as an experiment with the following steps:

Model (hypothesis)

This is the aim of the experiment and can be stated as:

- To apply a specific fire regime to the various plant communities in the reserve that will maintain their distribution, structure and floristics, as at 2003, in the long-term.
- To maintain the populations of indigenous fauna in the reserve.
- To reduce the distribution and abundance of introduced species in the native plant communities in the reserve.

Test

The test is the implementation of the plan.

Collect Relevant Data

The performance indicators in the summary table in Section 8 of this plan are designed to monitor the effectiveness of the implementation of the plan, rather than its impacts. However, it should be noted that if the plan is not being implemented effectively it will be more difficult to analyse and draw useful conclusions from the monitoring program.

It order to run this 'experiment', baseline data of sufficient accuracy for resampling and statistical analysis must be collected. This could be expensive and it is suggested that the assistance of the University of Wollongong be sought for the detailed design of the 'experiment', including data collection and analysis. Data collection could be undertaken by students and/or interested community groups, if properly supervised.

Analyse

Data collected will need to analysed in such a way that it will indicate where changes in the plan are required.

Feed back

Use of the monitoring results to improve the plan is the essential component of adaptive management. This will allow the plan to be progressively improved so that it is more closely linked to the actual conditions in the reserve.

7. Further Research

Apart from the adaptive management approach used in this plan there are also opportunities to use the fire management activities recommended in the plan as the basis for specific research projects. There has been a great deal of research into bushfires in Australia over the years. Initially the emphasis was on understanding fire behaviour, but recently more emphasis has been placed on fire ecology, and particularly the effects of fire on native flora and fauna, and native ecosystems. However, most of these studies have only been short-term, and Whelan (1995) states that: "There are very few long-term experimental studies of the effects of fire on any level of organisation - individual organism, population or community". Whelan goes on to state that: "The need for validation of models of long-term change based on short-term studies is becoming urgent". Valid models of long-term change will obviously contribute greatly to effective fire management in bushland reserves. However, even if new studies are begun today, useful results may not be available for decades, and even then may not be applicable to the situation in the Greater Mount Alexandra Reserve.

The fire management activities in this plan are based on current scientific knowledge, however, they also provide an opportunity for research into the problems of managing fire hazard while at the same time maintaining the aesthetic, nature conservation and recreational values of the reserve. The results of any such research would be directly applicable to the management of the Greater Mount Alexandra and similar reserves.

Potential research topics that could be based on the fire management activities recommended in the plan include:

- effects of fires on weeds in different native plant communities
- methods of controlling specific weeds using fire, or incorporating fire into an overall weed control strategy
- comparison of the effects on particular ecosystems of low intensity verses high intensity burning
- methods for creating Asset Protection Zones which minimise environmental impact, and to what extent natural environments can be retained in these zones

The monitoring program outlined in this strategy should provide good data for many of these studies.

8. Management Action Summary

The management actions recommended in this plan have been summarised and classified using the following criteria:

URGENT - Actions required to reduce a very high risk to life or property.

ESSENTIAL - Actions required to improve safety, or inadequate fire protection measures in high risk areas.

- Actions that are essential for control & suppression of wildfires, and/or conservation of threatened species.

RECOMMENDED - Actions required to improve inadequate fire protection measures in moderate risk areas.

- Actions required to ensure on-going effective fire management, or conservation of biodiversity.

ROUTINE - Maintenance of fire control resources and protection measures.

Urgent actions need to be undertaken as soon as possible.

Where applicable the desirable timing of other actions has been coded as follows:

A - Inspect and maintain annually, or as specified in the relevant MP

A/S - Timing as specified in the fire management plan

1, 2, etc - Carry out action within the time period specified (years)

1A, 2A etc - Construct within the next 1, 2 etc years and then inspect and maintain annually, or as specified in the relevant MP.

BIBLIOGRAPHY

Eco Logical Australia Pty Ltd (2003) *Wingecarribee Biodiversity Strategy, Phase 1.* Report prepared for Wingecarribee Shire Council, Moss Vale.

Adams R. and Simmons D. (1993) The Impact of Fire Intensity on Litter Loads and Understorey Floristics in an Urban Fringe Dry Sclerophyll Forest and Implications for Management. In *Proceedings of a Conference, Fire and Biodiversity: The Effect and Effectiveness of Fire Management*. Victorian National Reserves Association, Melbourne.

AFAC (1996) *Prescribed Burning 1.* Australian Fire Authorities Council and Longman, Melbourne.

Auld B. A. and Medd R. W. (1987) *Weeds: An Illustrated Guide to the Weeds of Australia.* Inkata Press, Melbourne.

Australian Standard 3959 - 1999 *Construction of Buildings in Bushfire-prone Areas.* Standards Australia, Sydney.

Benson D. and McDougall L. (1998). Ecology of Sydney plant species. *Cunninghamia* (5)4: 809-983.

Bradstock R. A., Keith D. A., and Auld T. D. (1995) Fire and conservation: imperatives and constraints on managing for diversity. In *Conserving Biodiversity: Threats and Solutions*. (Eds) R. A. Bradstock, T. D. Auld, D. A. Keith, R. T. Kingsford, D. Lunney and D. P. Sivertsen, pp323-333, Surrey Beatty and Sons, Sydney.

Buchanan R. A. (1989) *Bush Regeneration - Recovering Australian Landscapes*. TAFE Learning Publications and Inkata Press, Sydney.

Campbell A. J. and Tanton M. T. (1981) Effects of Fire on the Invertebrate Fauna of Soil and Litter of Eucalypt Forest. In Gill A. M., Groves R. H. and Noble I. R. (Eds), *Fire and the Australian Biota*, pp 273-310, Australian Academy of Science, Canberra.

Conroy B. (1988) Bushfire management planning in natural areas. In proceedings of the conference - *Caring for Warringah's Bushland*. Warringah Council, Dee Why, NSW.

Driessen M. M., Taylor R. J. and Hocking G. J. (1991) Trends in abundance of three marsupials after fire. *Australian Mammalogy*, **14**, 121-4.

Forestry Tasmania (1996) *Fuel Reduction Burning; Course Notes.* Forestry Tasmania, Hobart.

Inions G. B., Tanton M. T. and Davey S. M. (1989) Effect of fire on the availability of hollows in trees, used by the common brushtail possum (*Trychosurus vulpecula*), Kerr 1792, and the ring-tailed possum (*Pseudocheirus peregrinus*), Baddaerts, 1785. *Australian Wildlife Research*., **16**, 449-458.

Kirkpatrick J. B. (1985) The viability of bush in cities - ten years of change in an urban grassy woodland. *Australian Journal of Botany*, **34**, 691-708.

Lunt I. D. and Morgan J. W. (1998) *Second Generation Management of Grassland Reserves: Lessons from First Generation Reserves*. A report to the Victorian Grassy Ecosystem Reference Group. Unpublished Draft Report.

Maxwell S., Burbidge A. A. and Morris K. (1996) *The Action Plan for Australian Marsupials and Monotremes*. Australasian Marsupial and Monotreme Specialist Group, IUCN Species Survival Commission. National Reserves and Wildlife Service, Canberra.

NSW Rural Fire Service (1997) *Prescribed Burning Course Manual.* NSW Rural Fire Service, Sydney.

NSW Rural Fire Service (2001) *Planning for Bushfire Protection, A Guide for Councils, Planners, Fire Authorities, Developers and Home Owners.* NSW Rural Fire Service, Sydney.

Parsons W. T. and Cuthbertson E. G. (1992) *Noxious Weeds of Australia.* Inkata Press, Melbourne.

Ramsay C. and Dawkins D. (1993) *Building in Bushfire-prone Areas - Information and Advice.* CSIRO and Standards Australia, SAA HB 36-1993.

Specht R. L., Roe E. M. and Boughton V. H. (1974) Conservation of major plant communities in Australia and Papua-New-Guinea. *Australian Journal of Botany Supplement*, **7**, 1-667.

Tasmania Fire Service (1984) *Guidelines for Fuel Reduction Burning Under Dry Forests.* Tasmania Fire Service, Hobart.

Tolhurst K. (1993) Effects of fuel reduction burning on flora in a dry sclerophyll forest. In Proceedings of the Conference, *Fire and Biodiversity: Effects and Effectiveness*, Victorian National Reserves Association, Melbourne.

Victorian National Reserves Association (1996) Proceedings of the Conference, *Fire and Biodiversity: The Effect and Effectiveness of Fire Management* held in Melbourne 8-9 October 1993.

WBFMC (2001) *Wingecarribee Bush Fire Risk Management Plan.* Wingecarribee Bush Fire Management Committee, Bowral.

Whelan R. J. (1995) *The Ecology of Fire.* Cambridge University Press, Melbourne.

Glossary

The following descriptions of bushfire related terms used in this plan are taken or adapted from:

Australian Fire Authorities Council (1996) *Glossary of Rural Fire Terminology*

Forestry Tasmania (undated) *Fuel Reduction Burning; Course Notes*.

NSW National Reserves and Wildlife Service (2002) *Fire Management Manual.*

NSW Department of Bushfire Services (2001) *Planning for Bushfire Protection.*

Ramsay C & Dawkins D (1993) *Building in Bushfire-prone Areas - Information and Advice.* CSIRO and Standards Australia, SAA HB 36-1993.

Warringah/Pittwater Bush Fire Management Committee (1994) *Draft Fuel Management Plan.*

NSW Rural Fire Service (2001) *Planning for Bushfire Protection.*

Asset Protection Zone

An area of managed fuel around a dwelling or asset at risk that reduces the risk of damage by fire. It consists of an Inner Protection Area and an Outer Protection Area.

Backburning

A fire started intentionally along the inner edge of a fire control line to consume the fuel in the path of a wildfire. This is usually the only method for controlling large wildfires, or fires of high intensity.

Bushfire

A fire burning in plantations, forests, mallee, grasslands and other vegetation types. Usually classified as either a 'wildfire' or a 'prescribed fire'.

Bushfire Hazard

Synonymous with static risk, a relative assessment of the potential intensity, and therefore the difficulty of controlling and suppressing a bushfire in an area. Bushfire hazard is a function of slope, and vegetation type.

Bushfire Prone

Refers to the potential for the vegetation in an area to carry a bushfire at reasonable frequencies.

Bushfire-Prone Area

Defined as areas within, or within 100 m of, high or medium bushfire hazards, or within 30 m of low bushfire hazards, but are not existing urban areas or waterbodies (other than wetland vegetation).

Bushfire Risk

Bushfire risk is the probability of a wildfire starting, spreading and causing damage to an asset.

Fine Fuel

Live and dead plant matter (including grasses, bracken, leaves, bark, and twigs and branches) less than 6 mm in diameter. Fine fuel is what burns at the fire front and contributes directly to fire behaviour. Increasing fine fuel loads increases the rate of spread and intensity of fire fronts.

Fire Break

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

Fire Control Line

A natural or constructed barrier, or treated fire edge, used in fire suppression and prescribed burning to limit the spread of a fire. Fire control lines can include constructed trails, roads, cleared areas and environmental features such as watercourses and rock outcrops.

Fire Danger Rating (FDR)

A relative number denoting an evaluation of rate of spread, or suppression difficulty for specific combinations of fuel, fuel moisture and wind speed. FDRs range from 1 (low danger) to 100 (extreme danger). The FDR is used for general fire danger forecasting and is based on the expected behaviour of fires burning in eucalypt forest carrying a fuel loading of 12.5 tonnes per hectare and travelling over level to undulating ground.

Fire Intensity

The rate of energy output per unit length of fire perimeter, usually measured in kilowatts per metre. It is a function of the heat yield of the fuel (H), the weight of the fuel consumed (W), and the rate of spread of the fire (R) i.e. I = HWR.

Fire Regime

The pattern of fire occurrence within an area described by the frequency, intensity, and season of fire occurrence.

Fuel Load

The quantity of fine fuel in an area, usually measured in tonnes per hectare of dried fine fuel.

Outer Protection Area

A zone between an Inner Protection Area and a bushfire hazard that is maintained in a fuel reduced condition. Provision of an Inner and Outer Protection Area will ensure that there is a progressive reduction of fine fuel between a bushfire hazard and any combustible structures.

Fuel Reduced Condition

A condition where fine fuel is maintained below a maximum height of 100 mm in grasslands, or below 8 tonnes per hectare in other fuel types.

Hazard Reduction

Reduction of the average fuel load over an area by burning (prescribed burn or wildfire), chemical, mechanical, or manual means.

Indigenous Vegetation

A term used to describe the plant species and/or plant communities which occur naturally in a locality. The term 'indigenous' excludes Australian species from another locality or region, as well as non-native species, that have been introduced to a locality.

Inner Protection Area

An area between buildings, or other assets, and bushland, where fine fuels are maintained in a minimum fuel condition to ensure that there is insufficient fuel to carry a fire from the bushland to the asset (see minimal fuel conditions)

Introduced Species

Species of plants or animals that have been deliberately, or accidentally, brought to an area in which they did not naturally occur.

Minimum Fuel Conditions

A condition where fine fuels are minimised to the extent that the passage of a fire will be prevented or severely restricted. This generally requires the removal of dead fine fuel and control of live fuel, breaks in the continuity of any fuel, maintenance of a high moisture content in vegetation, or replacement of vegetation with roads, paths, etc.

Outer Protection Area

A zone between an Inner Protection Area and a bushfire hazard that is maintained in a fuel reduced condition. Provision of an Inner and Outer Protection Area will ensure that there is a progressive reduction of fine fuel between a bushfire hazard and any combustible structures.

Prescribed Burn

(Synonymous with prescribed fire, controlled burn, prescription burn, scheduled fire or management burn) The controlled application of fire under specified environmental conditions to a predetermined area, and at the time, intensity, and rate of spread required to attain planned resource management objectives. It is undertaken in specified environmental conditions.

Spotting, Spot Fire

Isolated fires started ahead of the main fire by sparks, embers, or other ignited material carried by the wind, sometimes to a distance of several kilometres.

Wildfire

A bushfire which is not burning according to management prescriptions or requirements.