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Fire Management Plan  
McKay Reserve & Dark Gully Park  
for  
Pittwater Council

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**Adopted June 2005**

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## Acknowledgements

Under contract this Bushfire Management Plan was prepared for Pittwater Council by Brian Parry & Associates Pty Ltd. The assistance of Karin Nippard, Mark Turnbull, Mark Beharrell and Chris Wright, staff of Pittwater Council, together with advice from Deputy Fire Control Officer, Community Safety George Sheppard of the NSW Rural Fire Service was both practical and informative, enabling us to produce a very practical and workable document. Thank you.

For the research, field assessment and document preparation, the major component within the project was carried out by Elizabeth Mann, Vic Walker, Carol Quilter and Brian Parry. The combined skills of this team include extensive fire management experience combined with a strong appreciation of ecological values.



## **1.0 Executive Summary**

### **1.1 Planning Background**

The Fire Management Plan has been developed for Pittwater Council as direction for the fire management activities within the McKay Reserve and Dark Gully Park. For the purposes of this Plan, references to McKay Reserve include reference to Dark Gully Park. A total area of 16.6 hectares comprises the two reserves which are located on the western side of the Barrenjoey Peninsula, north of Whale Beach Road.

Throughout the length of the Reserve the land is quite steep, falling from the top of the escarpment adjacent to the development down to the rear of the properties that front Barrenjoey Road. The Reserve is of significance environmentally with spectacular rock formations and numerous other natural features within the Reserve. Many of the people who venture into the reserve do so to look down on the beautiful views of Pittwater. However, as pedestrian access improves, the visitation level will increase with people venturing deeper into the bush.

From the Plan of Management for the Reserve, the following objectives are considered relevant to the development of the fire management plan;

- Protect life, property and community assets from any adverse impact of fire.
- Manage fire regimes within the Reserve in order to restore, maintain and enhance biodiversity to ensure viability of the reserve's natural heritage.
- Encourage cooperative and coordinated fire management arrangements between the NSW Rural Fire Service, NSW Fire Brigades, Council and the community adjacent to the Reserve.
- Minimise the risk of fire to aboriginal sites, historic places and culturally significant features known to exist within, or adjacent to McKay Reserve.
- Encourage nearby residents to implement suitable fire mitigation strategies on their own property to complement the work undertaken within the Reserve.

In preparing this fire management plan we have sought to produce a document of a practical nature that is complementary to the "McKay Reserve and Dark Gully Park Plan of Management". This is a very special environmental asset that benefits the local



residents, the Pittwater community and visitors to the area. Although rugged in nature, it is a fragile area environmentally and fire is one of the major threats. It is incumbent upon everyone who benefits by way of use of the Reserve and those charged with the responsibility for preservation of the area to be mindful of the need to effectively manage fire on the Reserve for future generations.

## **1.2 Life and Property Protection**

Throughout the development of the fire management plan a major emphasis has been placed upon the safety of residents and structural assets elevated above the Reserve throughout its entire length. With due regard for the environment, 15 separate zones have been identified within which various fire management strategies can be implemented with a major focus on the eastern perimeter of the Reserve.

There is a lack of detail in regard to the use of fire as a prevention measure and the impact of unscheduled fire on the Reserve. There is also a lack of record of the influence of weather on fire management within the Reserve. The effect of fire in the area has been minimal for an extended period of time except for some hazard reduction activity, along with or in close proximity to the eastern perimeter of the Reserve. Apathy about the potential for fire must be avoided.

## **1.3 Possible Fire Ignition Sources**

The major fire influence within the Reserve has been that resulting from the implementation of hazard reduction burning near the upper (eastern) portion of the Reserve. Additionally, there have been some minor instances of small isolated fires which appear to have been the result of arson activity.

The potential exists for a fire of accidental nature to commence in the vicinity of the residences that front on to Barrenjoey Road. A fire commencing along this strip would tend, under dry conditions, to quickly ascend towards the top of the Reserve. Some delay may occur due to the extensive rock outcrops within the area. Should such a fire occur it is anticipated that the head of the fire, on arriving at the eastern perimeter of the



Reserve, would be on a very narrow front and reasonably controllable by the local fire authority.

Of more concern is the potential for fires in the National Park to the west of Pittwater to create an ember shower that would have the potential to start one or a number of fires in various parts of the Reserve. A possible combination of fuel availability at 10 t/ha and weather conditions in the “very high” to “extreme” rating could cause the ember shower at McKay Reserve. The development of this combination of conditions rates more so as a probability than a possibility. Despite this, there is not any historical evidence of this having previously occurred.

#### **1.4 Strategies for Fire Management**

The Reserve has been divided into 15 fire management zones as a practical means of dealing with a range of environmental factors and the physical problems associated with fire management when working in such difficult terrain. The more intense work centres upon the eastern perimeter and it is proposed that so as to obtain maximum effectiveness, the removal of exotic vegetation from that area should be carried out in conjunction with fire fuel management strategies. The removal of the exotic species in many cases will provide the discontinuity of fuel required to reduce the fire hazard. A combination of environmental factors together with the practicalities of working in this difficult terrain were major considerations in identifying the 15 fire management zones.

Within the Plan, special strategies have been identified for the management of fuel along the western boundary of the Reserve, the rear of the properties facing Barrenjoey Road. Extreme caution and concern is required in contemplating the use of fire in this zone because of the existing depth of fuel and the propensity for a resulting ‘ground fire’ to develop excessive heat and cause permanent damage to the root structure of some of the large native trees in the area, perhaps causing them to fall. Additionally, complete removal of the ground fuel at any location along this western edge could render the area exposed for soil erosion during any major rainfall event following a fire. Such a situation could impact upon the residences of Barrenjoey Road.



Although fire activity within the Reserve has been minimal to date, the potential does exist. The fire management strategies identified within the Plan will limit the availability of fine fuels and subsequently, fire intensity. The strategies do not prevent unscheduled fire within the Reserve, but within the prescribed works, any fire should be manageable within the resources of the Fire Service.

There are four major factors involving the implementation of the Plan that require ongoing commitment from Council and the community.

1. Commitment to the fire regime for hazard reduction burning with the flexibility to adjust this around any wildfire event. This also requires the support of the Rural Fire Service and NSW Fire Brigades for the implementation of the program.
2. The construction and annual maintenance program for the strategic fire advantage zone around the perimeter of the development above the reserve.
3. The continued resourcing of a weed management program over an extended period.
4. Promote the involvement of the community in all aspects of the maintenance and usage of the reserve.

## **1.5 Cultural & Heritage Protection**

Within the Reserve there are a number of cultural sites that potentially could be damaged by either wildfire or scheduled hazard reduction. Council staff have managed this situation up until now and should continue to be extensively involved in all aspects of fire management within the Reserve to limit the potential for future damage to these value assets.

## **2.0 Project Status**

This Fire Management Plan has been prepared under contract to Pittwater Council. The Fire Management Plan (the Plan) applies to the McKay Reserve and includes the Dark Gully Park. References to McKay Reserve within this Plan also apply to the Dark Gully Park. The Plan contains suggested fire management activities for implementation for the period 2004 – 2009.



In so far as it is practical, this Fire Management Plan should be considered in union with the 'McKay Reserve and Dark Gully Park Plan of Management' and the 'Warringah / Pittwater Bush Fire Risk Management Plan'.

### **3.0 Major Legislative & Policy Documentation Relative to McKay Reserve**

The following pieces of legislation and other documents as listed have been taken into consideration in the formulation of this Fire Management Plan.

- Threatened Species Conservation Act 1995
- Rural Fires Act 1997
- Local Government Act 1993
- Heritage Act 1977
- Warringah / Pittwater Bushfire Risk Management Plan
- State Environmental Planning Policy No. 19 – Bushland In Urban Areas

The management objectives for the Reserve are detailed at '4.0 Management Objectives' in the 'McKay Reserve and Dark Gully Park Plan of Management'. The development of this fire plan touches on a number of those objectives, hence the importance of that document being considered in conjunction with the Fire Management Plan.

In 2001 the Warringah / Pittwater Bushfire Risk Management Plan was prepared as a requirement under the Rural Fires Act 1997. The objectives of that plan are two-fold in that it seeks to effectively manage the availability of fuel to a level that reduces the intensity of any unscheduled fire to a controllable level. The plan also has an operational component for when wildfires do occur.

Within the Bush Fire Risk Management Plan, the area in and around the Reserve is identified as follows;

- bushfire hazard classification – high
- environmental risk – major
- community risk classification – minor



- bushfire hazard management zone – ‘land management zone (environmental)’

While the McKay Reserve is totally within the Sydney Fire District with the NSW Fire Brigade as the lead combat authority, there is a high level of cooperation between that service and the Rural Fire Service, this joint involvement being formalised under the ‘Memorandum of Understanding’ agreed to by the Commissioners of both Services.

The McKay Reserve is an important asset within the local community and its value was acknowledged back as far as 1957 when separate parcels were first entrusted to Warringah Shire Council for management as a reserve. Subsequently, responsibility for the management of the Reserve was transferred to Pittwater Council.

Having regard to the location of the Reserve and its proximity to development, together with the objectives of the ‘McKay Reserve and Dark Gully Park Plan of Management’, the following fire management objectives are deemed to be appropriate for this fire management plan;

- Protect life, property and community assets from the adverse impact of fire.
- Manage fire regimes within the Reserve in order to restore, maintain and enhance biodiversity to ensure the continued viability of the reserve’s natural heritage.
- Encourage cooperative and coordinate fire management arrangements between the NSW Rural Fire Service, NSW Fire Brigades, Council, the community and land owners with assets in close proximity to the Reserve.
- Minimise the risk of damage by fire to aboriginal sites, historic places and culturally significant features known to exist within, or adjacent to, the McKay Reserve.

## **4.0 Physical Description of Reserve**

### **4.1 Location**

McKay Reserve and Dark Gully Park are located on the steep western slopes above Pittwater and Palm Beach in Sydney’s northern beaches. The reserve and park have a combined area of 16.6078ha and are located between Bynya Rd to the south, and the



Pacific Rd/ Ralston Rd junction in the north. There are a number of properties located adjacent to the reserve and several properties back on to the reserve.

McKay Reserve: Lots 49 and 50 in DP 6746; Pts Lots 1C and 2C in DP 13374; Part of drainage reserve between Lot 6C in DP 13374 and Lot 2 in DP 568036; Lots 49 to 65, Pts Lots 66 and 67, Pts Lot 69 and 70, Pts Lots 72 to 76, Pt Lot 78 and Pt Por 18 in DP 8595; Reserve in DP 29354; Lots 456 to 493 in DP 20204; Lot 1 in DP 821374; Lot 1 in DP 790731; Lot 1 in 100194; and Drainage Reserve in DP 14630

Dark Gully Park: Lot 89, Pt Lot 30, Lots 31 and 32 in DP 13620.

The location of McKay Reserve and Dark Gully Park is shown in Map 1.

## **4.2 Terrain**

McKay Reserve and Dark Gully Park predominately consist of sandstone terrain. Sectors of the reserve are very steep with slopes up to 25° with a maximum elevation of 100m. A contour map illustrating terrain is shown in map 2.

The Reserve incorporates a number of watercourses including Dark Gully Creek, the major watercourse towards the southern end of the Reserve and a number of smaller non-perennial watercourses.

The aspect of the McKay Reserve and Dark Gully Park varies slightly, generally west to southwest, with some areas north/westerly. This generally westerly aspect results in the reserve being a relatively dry environment. Steep, northwest and exposed locations have a higher erosion risk than those areas with a southeast and sheltered aspect.

## **4.3 Flora**

The floristic communities of McKay Reserve and Dark Gully Park identified by P & J Smith<sup>8</sup> in 1992 include: Red Bloodwood- Scribbly Gum Woodland, Hawkesbury Sandstone Open Forest, Spotted Gum Forest and Newport Bangalay Woodland. The distribution of these major communities is shown in Annexure 2a.

Given the terrain, climate, prevailing wind and aspect, it would be expected that the area would support a dry sclerophyll open forest (Read, 1987). This forest community



has an upper stratum dominated by eucalypts and a substratum with a distinct shrub (sometimes a tree) layer including Banksia's, wattles, hakeas etc. These forests are flammable in most seasons with many species being fire tolerant and the trees seldom die as a result of fire (Luke and McArthur, 1978). Altered fire regimes and introduced herbaceous species have changed the dry sclerophyll forests' substrata in many places (Read, 1987). This is evident in the Reserve as P & J Smith reported "medium density shrub". During the recent survey of this area it was noted that parts of the reserve had dense substrata with "alien" species and natural species outside of their normal habitat, for example blueberry ash and *pittosporum undulatum*. It is reasonable to assume that the lack of fire in this area has had an influence on the proliferation of both weed species and natural species outside of their normal range.

The following prominent weed species were observed in the Reserve. The ones marked with an asterisk (\*) are mentioned in the document "McKay Reserve and Dark Gully Park Plan of Management".

<b>Botanical Name</b>	<b>Common Name</b>
<i>Asparagus sprengeri</i> *(1)	Asparagus Fern
<i>Cinnamomum camphora</i>	Camphor Laurel, Camphor Tree
<i>Erythrina spp</i> (2)	Coral Tree
<i>Ipomoea indica</i> *	Morning Glory
<i>Lantana camara</i> *	Lantana
<i>Ligustrum lucidum</i> *	Large-leaved Privet
<i>Ligustrum sinense</i> *	Small-leaved Privet
<i>Lonicera japonica</i> *	(Japanese) Honeysuckle
<i>Nephrolepis cordifolia</i>	Fish-bone Fern
<i>Ochna serrulata</i>	Mickey Mouse Plant, Ochna
<i>Phoenix canariensis</i>	Canary Island Date Palm
<i>Raphiolepis indica</i>	Indian Hawthorn
<i>Senna pendula</i> *(3)	Cassia
<i>Strelitzia nicolai</i>	Blue Strelitzia, Wild Banana
<i>Tecomaria capensis</i>	Tecoma, Cape Honeysuckle
<i>Thunbergia alata</i>	Black-eyed Susan

Notes:

1. This is probably now known *Protasparagus aethiopicus* as listed in the Plan of Management.
2. Exact species identification is uncertain.
3. Formerly known as *Cassia bicapsularis*



There are many herbaceous weed species present around the edges of the reserve. Most of them will be garden escapes due to the past practices of dumping garden waste outside the boundaries of properties that back onto the reserve. Some of the species identified in these areas include; *Bidens Pilsoa* Cobblers Pegs, *Sonchus Oleraceous* Milk Thistle and *Rumex SP* Dock.

The greatest threats are *Ochna serrulata* and *Strelitzia nicolai*. Neither of these species are mentioned in the Plan of Management. As both are extremely distinctive, stand out from the surrounding vegetation and are easily identified, it must be assumed that neither variety existed in great numbers when the survey of weeds was done prior to drawing up the Plan of Management. If this is the case the spread of these two plants has been exponential. There are large numbers of both scattered throughout the Reserve, regardless of type of habitat. There are numerous mature samples of both species as well as many more juvenile plants.

The following native plants have increased their population and spread outside what would be considered their normal habitat probably due to the absence of fire over a long period

<b>Botanical Name</b>	<b>Common Name</b>
<i>Elaeocarpus reticulatus</i>	Blueberry Ash
<i>Livistonia australis</i>	Cabbage Tree (Palm)
<i>Morinda jasminoides</i>	Morinda
<i>Pittosporum undulatum</i>	Native Daphne/Pittosporum
<i>Smilax glycyphylla</i>	Sarsaparilla

The spread of *Elaeocarpus reticulatus*, in particular, from its normal habitat of rain forest and wet sclerophyll forest threatens the integrity of various plant communities, especially the remanent *Corymbia maculata* forest at the northern end of the Reserve.

During the recent survey it was noted that there was a lack of sapling growth throughout the reserve. P & J Smith<sup>8</sup> noted that there was dieback of eucalyptus species. It is reasonable to assume that the lack of fire has had an influence on sapling growth, and less significantly on dieback. Following fires, epicormic buds buried beneath the bark of eucalypts will germinate. Even if fire torches the crown, a new canopy will rapidly



emerge and clumps of epicormic sprouts will clothe the bole and major branches like moss (Pyne, 1991). The fire intervals (regimes), which are described further in this report, are important in regard to the retention of species.

#### **4.4 Fauna**

P & J Smith<sup>8</sup> noted a low number of fauna species during their survey in 1992, identifying four mammal species, 37 bird species, one frog species and three reptile species. The floristic communities of the Reserve should support a range of birds, insects, spiders, mites and millipedes. During the recent site appreciation a lack of fauna species was observed, however, this would have been affected somewhat by the climate during the survey. It is reasonable to assume that the lack of young saplings and regeneration of species as a food source has affected the numbers of fauna species in addition to the urban development surrounding the reserve.

The proliferation of weed species and native species (in particular *Elaeocarpus reticulatus*) will have ramifications for the balance of fauna. It will encourage large aggressive seed eating birds, for example Pied Currawong, to move into these areas in greater numbers. This leads to a reduction of numbers of smaller native birds that would normally live in these habitats. The removal of weed species and a concerted effort to reintroduce native flora species should help somewhat to encourage native fauna back into the reserve, particularly bird species.

#### **4.5 Heritage and Cultural Issues**

Within the McKay Reserve and Dark Gully Park there are no known items of European Heritage. There are a number of aboriginal sites located within McKay Reserve and Dark Gully Park including a rock shelter with hand stencil and shell middens, including one with a stone axe.

#### **4.6 Usage of the Reserve**

Presently, the “Lookout” is the most visited area of the Reserve by the public. A lack of (marked) trails is probably having a negative effect on the usage of the reserve by the general public. With the construction of the track from Ralston Rd to Barrenjoey Rd,



public usage of the reserve should increase. Should the proposed track following the general line of Ralston Rd, McKay Rd, Cynthea Rd and Bynya Rd be developed, the access to the reserve, and consequently its usage, should increase. This proposed track is shown in map 4.

## **5.0 Fire History**

Limited fire history data is available for McKay Reserve and Dark Gully Park. According to the Plan of Management, a wildfire occurred in McKay Reserve in 1965. In addition, a fuel reduction burn occurred in 1991, the extent of which is shown in map 5. A high intensity arson burn occurred in the “triangle” between McKay Rd and Ebor Rd in 1991. Recently, a high intensity hazard reduction burn occurred at the rear of the properties along Cynthea Rd and Bynya Rd.

The detail by way of location and extent for the wildlife events of 1965 and 1991 are not available. In regard to the 1991 hazard reduction burning, it seems that this was a ‘cool burn’ which achieved a mosaic effect with very limited evidence being visible on the trees at this time. (see Annexure 2b)

## **6.0 Fire Weather Data**

The Bureau of Meteorology has recently established an automatic weather station at Terrey Hills, but at this point in time, information on fire weather of an historic nature is not available. The Rural Fire Service has been recording weather details at the Fire Control Centre at Terrey Hills for in excess of 10 years, but the data is not readily accessible in a suitable format for this plan, more to the point however, its relevance to the Palm Beach area is limited.

The Barrenjoey Peninsula is flanked to the east by the Pacific Ocean and to the west by Pittwater. There can be little doubt that the influence to the land of these two bodies of water would be quite substantial, probably leading to higher humidity, lower temperatures and a higher rainfall average than the remainder of the local government area. There will however, be some days when, despite the proximity to water, the reserve will be quite volatile.



Local residents have commented about the amount of burnt material that was deposited in Palm Beach area during the 1994 fire on the western side of Pittwater. It seems that most of this resulted from the backburning operations that took place in the cooler part of the day. Under the influence of the severe weather conditions that prevailed at times during that incident, if the main fire front had been permitted to approach the foreshore without the benefit of backburning, it would have the potential to cause spot fires throughout the Barrenjoey Peninsula including the McKay Reserve.

Regardless of the source of ignition the reserve does hold the potential to sustain a relatively severe fire that could impact upon the private residences elevated above the reserve.

The weather conditions cannot be controlled, hence the availability of fuel will play a major part in determining the intensity of any fire within the reserve.

## **7.0 Factors likely to influence fire behaviour**

There are a number of physical factors which influence fire behaviour. These include: topography and fuel characteristics. Topography can be analysed by considering aspect, slope and surface characteristics.

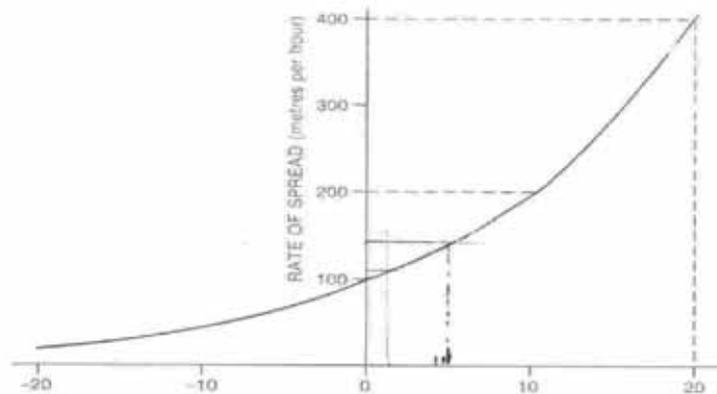
### **7.1 Aspect**

Overall McKay Reserve has a westerly aspect. Due to the sinuous nature of the reserve this aspect will vary slightly from northwesterly through to southwesterly. This exposes the reserve to potential ember showers from across Pittwater should there be bushfires in Ku-ring-gai National Park. The westerly aspect also leads to the Reserve being a relatively dry environment, especially during extreme fire weather. As a consequence it may be susceptible to ember ignition and could sustain wildfire quite readily. Even the slopes with a more southerly aspect may be dry and susceptible to fire during the warmer months, but quite damp with a low level of flammability during the remainder of the year.



## 7.2 Slope

The Reserve slopes up to the east with some areas exceeding 25°. Above the Reserve there is extensive development. It is the slope in this reserve which will have the greatest influence on fire behaviour. As can be seen from the figure below, the rate of spread of fire increases exponentially with the increase in slope.



Fire travelling down a slope

Fire travelling up a slope

(Courtesy NSW Rural Fire Service)

This increase is caused by preheating of the fuels (through direct flame contact, radiation and convection). The rate of spread could be even greater under the influence of westerly winds. As the intensity of a bush fire increases so does the propensity for the fire to release airborne burning embers. The combination of uphill slope with westerly winds could be the catalyst for a fire in McKay Reserve to create an ember shower into the residential area above the reserve and even into the eastern side of the Palm Beach Peninsular. The damage potential for an ember shower was demonstrated during the 2003 Canberra fires, even though the slope was not as steep as it is in McKay Reserve.

## 7.3 Surface Characteristics

There are numerous sandstone outcrops throughout the length of the Reserve. These outcrops, together with the wet gullies that tend to align from east to west, create a



discontinuous flammable fuel bed. It must be noted that under extreme fire weather and/or during periods of drought, the gullies will be dry enough to sustain fire. The rocky outcrops will affect the passage of fire (both bushfire and hazard reduction). During bushfires, while offering some containment line potential, the outcrops also may cause directional changes to the upward passage of wildfire, to disperse the fire and create a broken fire front, somewhat different to that which would be expected from the influence of slope and wind alone. However, during hazard reduction by controlled burning the outcrops will provide containment lines and assist in creating a mosaic burn pattern which provides wildlife refuge during and immediately after the burn.

#### 7.4 Fuel Characteristics

Due to the long absence of fire throughout most of the Reserve, it could be assumed that the fuel has accumulated to the maximum level. The rate of accumulation of fuel is now matched by the rate of decomposition of the lower layers of detritus. Using the NSW Rural Fire Service's guides within their publication "Planning for Bushfire Protection"<sup>10</sup>, coupled with inspection of the Reserve, the following fuel loads have been calculated for the identified vegetation communities:

- *Corymbia gummifera* / *Angophora costata* forest - 40 t / hectare;  
(Red Bloodwood / Sydney Red Gum)
- *Eucalyptus botryoides* / *Corymbia maculata* forest) - 40 t / hectare;  
(Bangalay / Spotted Gum)
- *Corymbia gummifera* / *Eucalyptus haemastoma* woodland - 25 t / hectare;  
(Red Bloodwood / Scribbly Gum)
- *Corymbia maculata* - 40 t / hectare;  
(Spotted Gum)

Pockets of rainforest, such as exist in Dark Gully, behind some of the residences that front Barrenjoey Road and others scattered throughout the unnamed gullies which cross the Reserve are deemed to have a fuel load of 10t / hectare. An area of *Corymbia gummifera* / *Angophora costata* forest at the rear of properties which front Cynthea and Bynya Road was recently hazard reduced by fire and now has a negligible fuel loading.



## 7.5 Expected Fire Behaviour

Due to the demographics of the Palm Beach area, coupled with the currently limited access to the Reserve, the most likely source of bushfire ignition will be ember shower blown across Pittwater from a bushfire in Ku-ring-gai Chase National Park. This would only happen under extreme fire weather conditions: low humidity, high temperature and high winds.

As the majority of the Reserve has maximum fuel loading, it would under extreme fire weather, be highly combustible. Any fire under these conditions would quickly escalate in intensity, would travel uphill rapidly and present a significant threat to the properties on the urban interface. Even the rainforest pockets would carry fire. There also exists the potential for embers from the fire within the Reserve to cause spot fires in the surrounds of the developed properties east of the Reserve by igniting garden mulch or flammable plants such as conifers and various Genera within the Myrtle family, eg; Callistemon and Leptospermum species and cultivars.

A wind-fanned fire in this steep terrain would normally burn on a very narrow fire front. However, the rock outcrops have the potential to break up the fire front and cause it spread on a number of narrow fire fronts or fingers. As these fire fronts develop subject to location and fuel, there may be the likelihood that the fires may crown. Once the heads of the fires reach the summit of the Reserve, the fires will rapidly lose their intensity. The heel of any fire would creep slowly down hill toward the properties along Barrenjoey Road. Any such fire must be recognised as being capable of damaging the root structure around the base of the trees leaving them unstable. Complete extinguishment of the fire will be essential.

The flanks of the fire may spread slowly and unevenly to discontinuous pockets of fuel caused by the rocky terrain. There is the potential, under extreme fire weather, for multiple ignitions



## **8.0 Identify Assets at Risk**

Fire suppression activities on the McKay Reserve are primarily the responsibility of the NSW Fire Brigade. Strategies for the protection of assets, and the suppression of the fire, will generally be at the discretion of the senior officer of the NSW Fire Brigade in attendance at the incident.

Both the NSW Fire Brigade and the NSW Rural Fire Service are parties to a 'Memorandum of Understanding' that ensures a coordination of effort when the Rural Fire Service are requested to provide additional resources for incidents within the defined fire district. Both Services are also signatories to the Warringah / Pittwater Bush Fire Risk Management Plan and Operations Plan<sup>12</sup>.

Pittwater Council is also a signatory to the Warringah / Pittwater Bush Fire Risk Management Plan and this reserve is a Council asset. Apart from a vested interest in the protection of the reserve, Council also has a responsibility to take all reasonable steps to prevent the escape of fire from its property to that of other land owners. To achieve this, Council has an ongoing responsibility to manage the bushfire fuel upon the reserve so as to minimise the intensity of any fire that occurs, thus ensuring that from the vegetation there is not flame contact with the adjoining assets, radiant heat is minimised and by limiting the amount of burning debris (embers) that, during a fire situation, would be carried by the wind and lodged in the vicinity of the structural assets. A major step forward for new development would be compliance with the prescribed distances for asset protection zones as listed in the document "Planning for Bushfire Protection". With the area adjacent to the reserve being almost fully developed, this is not an option available to Council.

As reported elsewhere within the body of this report, in most instances when a fire occurs within the McKay Reserve it can be expected, under severe weather conditions, to rapidly burn uphill, but with a fairly narrow head. Assuming that a rapid fire service response can be implemented, then control of the situation should be achievable. There will be considerable smoke resulting from the fire and impacting upon the structural assets above the fire, but both flame impingement and severe ember attack



can be avoided or minimised by the development of a 'strategic fire advantage zone (SFAZ)' immediately adjacent to the rear of the private land holdings that surround the reserve.

It would be totally impractical, and environmentally unacceptable, to set out to modify the vegetation along the higher level extremities of the reserve in compliance with the 'asset protection zone' recommendations contained in the "Building in Bushfire Prone Areas" document, to the dimensions identified for vegetation Group 1 species. This is the appropriate vegetation group for the fringe areas of the reserve, but for the reasons previously stated, protection should be prescribed specifically to meet the local concerns and objectives.

The premises considered to be most at risk from a fire within McKay Reserve are those immediately adjacent to the reserve in Bynya Road, Cynthea Road, the unformed portion of Ralston Road and properties with frontage to Canara Place and Pacific Road.

Due to the projected burning characteristics of a fire within the reserve, a strategic fire advantage zone immediately behind the properties as described above, of up to 20m width, would provide a high level of protection. In some specific locations there will be a need for variation due to terrain constraints, in some instances necessitating prescription of a setback from the structural assets rather than the boundary. This strip of land is currently extensively degraded by the presence of weeds and exotic plants that have intruded into the reserve from the perimeter development. Further spread of this vegetation is already impacting upon other sections of the reserve below the escarpment. It would seem that if action was taken to control the weeds and exotic plants along this 20m strip then this would represent a major step forward in providing fire protection in that area. Ideally the vegetation could be re-established as a mix of native grasses that can be maintained in a slashed state together with the re-establishment and maintenance of native trees and shrubs in accordance with the provisions of 'Planning for Bushfire Protection'<sup>10</sup>.

The impingement of the exotic plants deeper into the reserve, largely through storm water flow, would also need to be addressed in due course.



## 9.0 Fire Mitigation Considerations

### 9.1 Burning

Fire may be considered to be one of the most significant influences at work in Australian environments today. Virtually all fire management plans are developed with the management of ground fuels as the fundamental goal, commonly accomplished through the application of prescribed burning. Small, low-intensity fires can prevent the development of intensive fires that strip soil and nutrients dramatically. Fires that result in entire litter removal, including the decayed or decomposing layer should be avoided. The intense heat released by such fires has a damaging effect on surface material and is one of the major factors leading to the problems of erosion. Fire can also affect the physical and chemical characteristics of soil, indirectly influence the composition or growth rate of the protective ground flora and have some bearing on the ability of native fauna to continue life within the area.

Frequent fires can result in; proliferation of exotic plants and animals; destruction of mature and hollow-bearing trees; decrease of large logs and litter; a decline of understorey structure and plant species; and, increased predation of mammals.<sup>2</sup> These factors should be considered when setting prescribed burning intervals.

Mosaic pattern burning is most desirable as it creates an assortment of old, dense, unburned vegetation that provides shelter for local fauna species. In addition, newly burned patches provide sprouting leaves and shoots providing food sources for medium-sized mammals in particular. Wild fires effectively destroy the mosaic of variously aged plants necessary for the survival of the middle-sized mammals (Flannery, 1994)<sup>9</sup>.

Prescription burning should be focussed on low scorch and the temporary or permanent removal of some of the shrub layer in a given area. The Fire Management Plan incorporates this principle, but with a capability of assessing the results by comparison with unburnt fuel within the same zone.



## **9.2 Fuel Removal**

Fuel removal is required to reduce the density of the shrub layer and fine fuels including fallen leaves, bark and spindly shrubs, particularly in asset protection zones and strategic fire advantage zones. Clearing in or near the Reserve perimeter needs to be closely regulated and implemented by council staff to ensure that “view gaining” is controlled and that excessive and unnecessary clearing is avoided. Some species of young trees may need to be thinned out so that mature trees are well spaced with limited shrub layer growing in between. To limit the speed and spread of unscheduled fire within the Reserve, undergrowth may need to be removed, thinned and species managed. It is essential to keep some large trees as windbreaks to absorb radiant heat and screen the houses from flying embers.

All exotic species of plants should be targeted when clearing to halt their proliferation and colonisation of areas particularly following prescription burns. If native shrubs, litter and ground cover are removed completely, the reduction in complexity of the forest structure may lead to a reduction in abundance and species diversity of native fauna<sup>2</sup>.

## **9.3 Sensitive Areas**

Fire management can cause damage to heritage and cultural areas through construction of fire trails and inappropriately placed control lines. Shell middens can be exposed to erosion after a fire.

Where the fire is intense enough, exfoliation of rock may cause irrevocable damage to Aboriginal art sites such as rock shelters and engravings. Trees burnt from a wildfire or prescription burn can collapse onto a site either damaging or destroying the site.

Burning around sensitive areas should be excluded where possible to ensure that damage doesn't occur. Selective clearing of shrub layers around the site should reduce potential damage should a wild fire occur in the Reserve.

Fire management zones have been identified within this Plan that should ensure that hazard reduction burning does not impact upon the identified sensitive areas within the reserve.



**The involvement of council staff in planning and implementation of all hazard reduction activities is essential for the protection of the environment and other features within the Reserve.**

#### **9.4 Biodiversity**

The vulnerability of the Pittwater Spotted Gum community has been recognised in the prescription of burning and the formation of hazard reduction compartments. The threshold for this species would normally require a minimum interval of 15 years to reduce sapling mortality. In McKay Reserve the exclusion of fire for in excess of this period may have led to a situation where there are minimal juvenile plants of this species, hence the use of fire may be required as part of a regenerative process. Moreso, than for any other species, there is a need for 'monitoring fire regimes and biodiversity' within the spotted gum community in accordance with Annexure 1 to this report.

The defining of fire zones have been determined with due regard to the advice in Section 5.3.4 "Use of Appropriate Fire Regimes" in the Warringah Pittwater Bushfire Risk Management Plan<sup>12</sup>. In order to maintain biodiversity, suitable fire frequencies for threatened species and vegetation communities need to be adhered to within their biodiversity thresholds. The ecological integrity of areas may be adversely affected when a lack of fire exceeds the biodiversity thresholds required. Prescription burns should only cover a section of each vegetation community at a time so as to retain a diversity of fire frequency and associated age classes within these communities.

In order to preserve biodiversity and prevent species extinction, there are some general principles to follow regarding fire regimes. According to the nature of their life history, groups of plant and animal species may react similarly to fire. Thus, individual species fire regimes are not usually specified. In general, the needs for most flora species can be summarised in broad groups. Where thresholds are unknown a precautionary approach should be applied. The interaction between fauna and flora is an important consideration in fire management as the habitats of many fauna species are reliant on the presence of flora and their communities. Initially in order to maintain native biodiversity, only low intensity fire has been prescribed. Some experimentation with medium intensity fire on sample areas should be considered after two burning cycles.



Where fire regimes of fairly rigid frequency, intensity and extent occur, extinction of species may take place. Frequent fires of less than 3 years will dramatically simplify understorey vegetation and must be avoided.

The effect of fire regimes and all fire management practices require evaluation and this may be achieved by mapping of the area and recording characteristics of all fire activity and the effect on flora and fauna species, both long and short term.

Delineation of all species within each zone is neither achievable, nor necessarily desirable. In selecting fire management zones within the reserve, wide scope has been provided to preserve and improve on the balance and retention of native species.

## **10.0 Establish a Fire Regime for Areas Suitable for Hazard Reduction Burning**

### **10.1 Fauna**

Native fauna populations are generally considered to be able to survive bushfires by moving beyond the fire edge or taking shelter. Ground dwelling species may burrow into the soil or damp litter or move beyond the fire edge and tree dwellers escape all but the most severe bushfires. In a severe wildfire event, some animals may not survive due to not finding adequate shelter.

Fires that occur during the breeding seasons of birds and arboreal mammals may detrimentally affect population numbers. It is expected that autumn burns at low intensity and high frequency may cause some reductions in population of forest mammals. A decline in abundance of native species, and an invasion of alien species is envisaged for spring burns at high intensity and low frequency. However, it is predicted that native species would recover quickly as the understorey recovers.<sup>2</sup>

Fires can directly affect the habitat of bird species by reducing available materials for nest sites, loss of shrubs for shelter and loss of food (invertebrates and nectar).



Immediately following a fire there may be a reduction in bird species abundance, however as the habitat recovers, bird species should recolonise the area.

Fires may affect reptiles as a loss of logs and litter for shelter may occur. In general, species should recover with post-fire revegetation, however it should be noted that frequent burning might result in degradation of the habitat that species rely upon.<sup>2</sup>

Prescription burning must take into account the provision of suitable unburnt areas of bushland for wildlife refuge. Low intensity fires create a mosaic of burnt and unburnt ground providing safe refuge and patches of food supplies for fauna. Continual evaluation of burning and its impact on wildlife should be undertaken to ensure appropriate fire regimes are being utilised.

These factors have been considered in the formulation of this Plan. It does seem as this time that due to the fuel levels within the Reserve, the range of faunal species may be somewhat depleted from what some people would consider as normal.

## **10.2 Flora**

Fires can have a considerable effect on flora regardless of whether it is a wildfire event or hazard reduction burning. Species richness can decline, increase or remain relatively constant with time following the initial post-fire recovery stage. In general, open-forests demonstrate a nominal change in species richness with time after a fire event. In dry sclerophyll forests it has been shown that species diversity declined when fire was excluded for a period of 38yrs, with little change following a fire after six years.<sup>1</sup>

Most eucalypts have significant ability to recover after defoliation, due to the presence of buds under the bark of stems and branches (Pyne, 1991). These buds are generally in a dormant state due to growth inhibitors produced in the tree. Epicormic shoots will emerge from undamaged buds when the tissues that produce the inhibitors are killed, for instance by fire. A new crown will eventually be developed from these shoots (Pyne, 1991). Epicormic shoots are not likely to be produced, nor increment lost, when less than half a trees' foliage is scorched. If the majority of foliage is scorched, epicormic



shoots will emerge along the lower branches with loss of growth unlikely. Considerable loss of growth is likely if all foliage is scorched, however epicormics may grow along the bole and in the crown. A tree may be left in a skeletal state if the crown is severely damaged and all of the inhibitor-producing tissue is killed. Epicormic growth will be limited to the trunk, diameter growth may be negligible for some years, and the replacement of the crown formation is a very slow process. In this circumstance a tree may take ten or fifteen years to recover to its pre-fire height, and a series of hot fires at frequent periods may ultimately create a mallee type of eucalypt noticeably lower than the original vegetation (Pyne, 1991)<sup>5</sup>.

It has been noted that frequent low intensity fires: enhance flammable species therefore increasing the forest flammability; eradicate the shrub layer allowing grasses and ferns to dominate the understorey; stop eucalypt regeneration; decrease volume and diameter growth of some eucalypts; and, favour lignotuberous eucalypts in regeneration at the expense of non-lignotuberous eucalypts.<sup>2</sup>

Spring fires in general enhance shrub regeneration, whilst autumn fires enhance herbaceous species. It has been noted that in a Spotted Gum forest (near Grafton) subjected to annual control burns over a six year period, diameter increment was 54% that of an unburnt stand.<sup>2</sup> The complexity of forest structure may be maintained with a long-term regime of spring burns at high intensity and low frequency.<sup>2</sup> Sites that are burnt frequently (less than every five years) will support a grass layer while those burnt less frequently will support a shrub layer.

Within McKay Reserve the long term exclusion of fire in the vicinity of the spotted gums could well have been detrimental to the development of new trees. Further research is required regarding the lack of young trees.

The Bush Fire Environment Code for asset protection zones and strategic fire advantage zones recommends a minimum hazard reduction fire interval of 5 years in dry sclerophyll shrub/ grass forest. This fire management plan complies with that recommendation.



### **10.3 Areas Infested by Exotic Plants and Weeds**

In areas close to the development above the reserve, various exotic plants and weeds have become established. As part of the fire management planning process this needs to be addressed. Weed management, primarily by hand removal, is currently being carried out by contractors. Hazard reduction burning could also be of assistance, though fire could exacerbate the weed problem.

Follow-up weeding should occur within 3 to 9 months after any fire event to take advantage of the clearing effect that fires produce. Following a prescription burn, or wildfire, a weeding program should be considered as a mandatory follow-up to limit the re-infestation of weed species.

Frequent low-intensity burns should be avoided as these may favour feral mammalian species by decreasing the density of the substrata vegetation, which allows easier access and reduces protective cover available for native species to avoid predation.

### **10.4 Smoke Management**

Smoke has the potential to affect local residents, schools and air quality as well as visibility for road, water and aviation traffic (although given the size of the reserve this would most likely be minimal).

Burning should be carried out during times of low fuel moisture content to minimise smoke emissions. Residents of the local area should be notified well in advance of prescription burns and be requested to assist with removing accumulated debris. As a general rule, hazard reduction burning under a westerly air stream should be avoided within this Reserve.

## **11.0 Identify Fire Management Zones**

### **11.1 General**

For the purpose of this Plan, McKay Reserve has been divided in fifteen Fire Management Zones (see Annexures 3 & 4). These zones are contained within a mix of established and proposed walking trails, geographic features (rocky outcrops and wet



gullies), temporary (handtool) lines and the urban interface boundary. All zones will be accessible from either permanent walking trails (as proposed) or streets and street easements along the eastern interface.

Zones one to fourteen will be subject to hazard reduction by fire. All burning should be carried out under relatively still conditions or the influence of easterly winds. Ignition should be implemented along the eastern (higher) containment lines of these compartments, but not as a continuous line of fire. As the fire moves down hill a mosaic burn pattern is expected to develop. A minimum of 40% of the fuel should be removed to render the burn effective. Maximum available ground fuel removal should not exceed 80% thus providing a mosaic within the zonal mosaic. Scorch height as distinct from flame height should not exceed an average height of 5 metres within any zone.

The preferred time for hazard reduction by burning will be from late summer through to winter. The exact time will be determined by weather conditions and fuel loadings. A downloadable fire danger meter is available from the CSIRO web site. This should be used to calculate weather required for lower intensity burns.

No two adjacent compartments should be burnt within the same year or in consecutive years. Some adjustment to the schedule may be necessary after wildfire events. The compartments which border the rainforest gullies should only be hazard reduced under conditions in which the fire is self-extinguishing as it approaches the rainforest. Also note that the boundary between sclerophyll forest and rainforest is not fixed, but recedes or advances with the presence or absence of fire.

Exotic vegetation needs to be manually removed along the urban interface to increase the barrier between proposed hazard reduction sites and adjacent properties.

Zones should be inspected for further exotic plant removal three to six months after completion of burns. Weed infested compartments may require ongoing manual weeding.



Zone fifteen which extends the length of the Reserve at the rear of properties facing Barrenjoey Road will be a fire exclusion area. This compartment is likely to become unstable as a result of any major fuel management initiatives (see below)

## 11.2 Zone Characteristics

Fire Management **Zones 1, 2, 4, 5, 9** and **11** comply with the general prescription for hazard reduction as outlined above. However the other compartments have certain characteristics which require special mention.

**Zone 3** - the western aspect of this area ensures that the vegetation and ground fuels will be drier, than in other zones, due to a higher level of exposure to sun and wind. This is seen as the key compartment for the protection of the southern portion of the Reserve.

**Zone 6** serves a critical role in protecting the water reservoir from fire from the south. The strategy should be based on burning within the many small sub-compartments that have been formed by the proliferation of tracks within this zone.

There is sufficient space within the reservoir compound for the Water Authority to undertake complementary and effective fuel reduction. This should be in the form of removal of the shrub layer and removal of lower branches on retained trees to the height of three metres above ground. Trees should be thinned out to create a discontinuous canopy, but sufficient left to satisfy aesthetic demands. These fire mitigation procedures are very important for the protection of the water facility from any fire west of the compound. It is believed that this facility is the key water supply for the areas abutting the Reserve. In the event of wildfire it is vital that the New South Wales Fire Brigade pumpers have an uninterrupted supply of water to the hydrant system, to enable them to protect the properties along the eastern urban interface.

**Zone 6A.** There has been a severe impact on this compartment due to excessive removal and thinning of the vegetation by some of the neighbouring residents. This proliferation of weed encroachment must be stopped and remedial re-vegetation commenced. The clearing work that has been previously undertaken by the residents,



for a degree of self protection, will now be negated by effective fuel management in zones 6 and 7.

**Zone 7** is critical to the protection of the water reservoir from fires travelling under the influence of northerly or northwesterly winds. Above ground electricity and telephone lines are particularly vulnerable to wildfire and at present, even to a hot hazard reduction. There needs to be urgent underscrubbing and branch removal in this powerline easement. (See above for comments about security of water supply)

This zone also contains a drainage retention basin. Due to its sensitive nature it would be advisable to exclude fire from this and the immediate surrounds.

In the north of this compartment there is a powerline easement running down to Barrenjoey Road. It may be may practical to use this easement as the zone boundary between this compartment and zones 8 and 9.

**Zone 8** has been subject to considerable disturbance behind the properties that front Pacific Road. On the positive side, the extensive grassy areas as currently maintained, assist in the protection of the Pacific Road properties and encourage passive recreation by local residents. On the negative side, it is an area where natural features of the vegetation have been destroyed or disturbed. Some restoration through appropriate re-vegetation is recommended. While the gradual and continuing encroachment into the bushland from properties fronting Pacific Road needs to be halted, removal of exotic plant infestations needs to be ongoing.

**Zones 10 and 12.** Neighbouring residents have converted Ralston Road easement into a wide grassed area. This should be maintained for both property protection and Fire Service access.

**Zones 12, 13 and 14** cover the major portion of the *Corymbia maculata* (spotted gum) community. The absence of fire for a very long period has resulted in major ecological degradation in this plant community. An immediately obvious manifestation of this is the abnormal proliferation of *Elaeocarpus reticulatus* (blueberry ash) and *pittosporum undulatum* (native daphne).



**Zone 15.** As mentioned above, this is a fire exclusion zone. Geotechnical work has shown that parts of this compartment are inherently unstable due to the steepness of the terrain and the underlying geology. As major fuel management initiatives have the potential to destabilise the slope, it is recommended that fire be excluded. However, extremely localised hazard reduction burning may be permitted along with sensitive underscrubbing to deal with problems which are raised by adjacent landholders. Damage to the root system of the major trees through inappropriate fire management activities could create a degree of safety concern to the neighbours.

The current heavy deposit of ground fuel (leaf, bark, twigs etc) is primarily a product of fire exclusion. In conjunction with a heavy tree canopy this is tending to inhibit weed growth though some exotic vegetative species are thriving.

The quantity and composition of the ground fuel is such that any fire within the fuel bed will become deep seated and the resulting intense heat may destroy the tree root system. Under those circumstances the area could become unstable.

Should it be considered essential to reduce fuel within this compartment by burning then extreme caution would be required to ensure that the stated concerns are not realised.

The immediate effect on structural assets by any wildfire ignition in this zone should be reasonably controllable due to the proposed fire management works in the above zones. As described earlier, any impingements of fire upon these compartments should be narrow across the head with a natural tendency to move upslope with minimal downslope travel.

### **11.3 Initial Fire Regimes**

As previously mentioned the interval between burning each compartment should be no less than five years, unless there is an overriding, ecologically based need to modify the existing plant community.

For Fire mitigation purposes, it is recommended that two complete cycles of hazard reduction be conducted with an eight-year interval between each zone burn.



During this period longitudinal studies of the Reserve should be conducted. On the basis of this monitoring, it will be possible to reassess, if necessary, the intervals at which the various compartments need to be hazard reduced. For the Forest / Woodland Zones the third burn will probably be more appropriate after a 12 year period.

The following table is the suggested initial cycle of zone hazard reduction.

Year	Zone to be burnt
1	7, 13
2	3, 10
3	6A, 14
4	1, 9
5	6, 8
6	2, 12
7	5, 11
8	4

## 12.0 Monitoring Fire Regimes & Biodiversity

The flora and fauna within the Reserve cannot be taken as natural in the present condition. Very little wildlife is evident within the Reserve and the various native species seem to be under challenge from probably 3 directions; invasion by exotic plants, concentrated storm water runoff and exclusion of fire. The resulting changes in biodiversity are probably the major contributing factor for the lack of wildlife.

Reference has been made within the body of the report to the need to address the exotic plants and weeds within the Reserve as part of the fire management process. It is also considered necessary to reintroduce fire within the Reserve in an attempt to bring the native vegetation back to its natural perimeters.



The mix of species within the fire management zones does make it very difficult to nominate a fire regime that will suit all of the plants within the zone. Provided that the prescription for minimum and maximum effectiveness of any hazard reduction burn is met, then with each of the fire management zones there will be, within the mosaic profile, the basis for comparison between the areas burnt during the hazard reduction process and those left in their current state. It must be realised that the monitoring of the impact of fire on biodiversity is an essential part of the fire management process. Every opportunity should be taken to exercise ecological research as a means of broadening the knowledge of the type and quantity of flora within the Reserve, much of it being hidden under the present environmental conditions. The fire regimes proposed within this Plan may suit the existing conditions, but need some modification to the projected burning plan dependent upon the observation and research over at least a five year period.

# Refer to Annexure 1, Research & Monitoring Schedule

### **13.0 Visitor Safety in the Event of Fire**

Up until recently most of the public access into the Reserve was at the higher levels, in reasonably close proximity to the eastern boundary of the area. This situation is expected to change with a new walking track now developed, that links from near Canara Place down through the Reserve to Barrenjoey Road.

In some cases the boundaries that have been identified for the fire management zones within this Plan may be suitable for public access into the Reserve at a later date.

On days of very high to extreme fire danger it would be advisable for people to restrict their access to the perimeter areas above the escarpment. This should also be the case when there is reason to believe that there may be a fire within the Reserve.

At the entrance to any pathway that leads into the Reserve below the first escarpment, it would be prudent for Council to display a warning sign regarding the risk of fire.



## **14.0 Review of Fire Management Plan**

This fire management plan has been developed to provide for community safety during fire events, while enhancing the health and well being of the native fauna and flora within the Reserve.

At the commencement of the Plan there is a severe shortage of detail relating to previous scheduled and unscheduled fires within the Reserve. During the life of this plan, various works have been programmed and it is essential that the effects of this activity be monitored and recorded to assist in the fine tuning of the document.

This Plan should be reviewed in 2010.

## **15.0 Community Fire Involvement**

The fire history records only seem to register 'hazard reduction burning' within the Reserve, indicating that any previous unscheduled or wildfire event must have been relatively minor. The potential remains though and those living in close proximity to the Reserve need to be mindful of this fact.

The Reserve provides a wonderful environmental setting for near neighbours. With this in mind residents have a vested interest in participating in protecting themselves and the reserve from the effects of fire.

Firstly, they are well placed to take note of any person acting in a suspicious manner, particularly a day of very high or extreme fire danger.

Secondly, they should report to Council any incidence of rubbish dumping, more so garden waste, within the reserve.

Thirdly, there are well publicised bushfire maintenance procedures for home owners to implement for their own protection at the commencement of the Bush Fire Danger



Period. These include what action should be taken if there is a likelihood of a bushfire impacting on their property.

Fourthly, there are other self help initiatives that are available to help protect the premises during any fire event. These include making use of the water in the swimming pool, the application of fire fighting gels and other chemical treatments. These approaches could be considered in conjunction with neighbouring properties, perhaps even formalising the arrangements through the 'Community Fire Units' promoted by the NSW Fire Brigades, or the 'Community FireWise Program' promoted by the NSW Rural Fire Service.

Finally, fire brigade and Council personnel will be endeavouring to provide protection by carrying out hazard reduction burning in a prescribed manner to reduce the intensity of any fire that occurs within the reserve. The cooperation of residents is essential to the success of these programs.

## 16.0 References

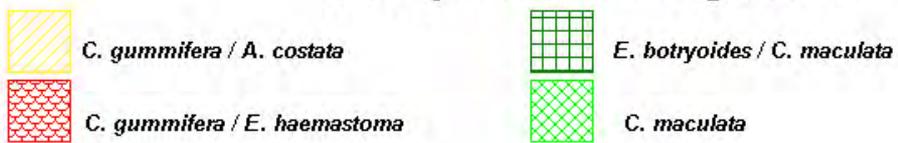
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### McKay Reserve - Vegetation



**NORTH**  
Scale 1:5000



Aerial photography - March 2002.  
This plan is not survey accurate.

### McKay Reserve- Fire History

- |  |   |
|--|---|
|  HR 1991    |  HR 2002 |
|  HR 1997-99 |  HR 2004 |

**NORTH**  
Scale 1:5000

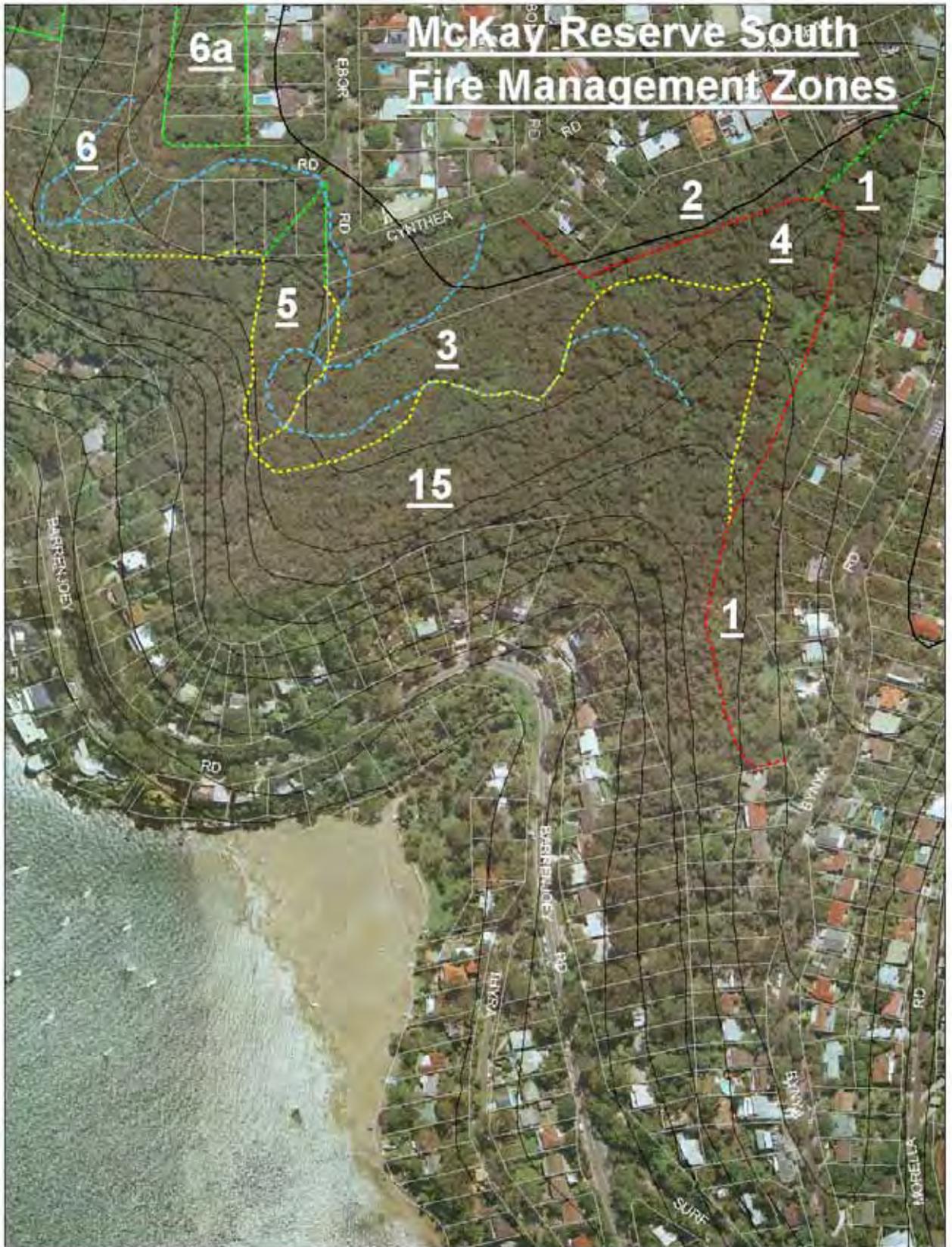


### McKay Reserve Fire Management Zones

- - - - - Existing Containment Line
- - - - - Proposed Containment Line
- - - - - Proposed Fire Zone Boundary Containment Line
- - - - - Existing Formal Track

Aerial photography - March 2002.  
This plan is not survey accurate.

**NORTH**  
Scale 1:5000



Aerial photography - March 2002.  
This plan is not survey accurate.

- - - - - Existing Containment Line
- - - - - Proposed Containment Line
- - - - - Proposed Fire Zone Boundary Containment Line
- - - - - Existing Formal Track

**NORTH**  
 Scale 1:2000

