Angophora Reserve Bush Fire Management Plan

Supporting Document

Report prepared by Pittwater Council 2014

Disclaimer

Amendments to current information, legislation and schedules identified in this Plan are made on an ongoing basis and readers should obtain up to date information. This Plan is based on best practise management.

Although Council aims to implement this Plan in its entirety, it may not be possible due to availability of resources. Council will endeavour to work with the NSW Rural Fire Service and Fire and Rescue NSW to implement the provisions of this Plan, however because of events out of Councils control and other potential constraints and considerations, achieving the objectives and strategies of this Plan may not always be possible.

Pittwater Council accepts no liability or responsibility of the use of this Plan by any third party. This Plan is not intended to substitute the necessary environmental assessments required prior to undertaking any hazard reduction works including prescribed burning. It must be noted that this Plan applies to the management of the Angophora Reserve only, this Plan does not apply to adjoining private property.

The Map Based Plan and supporting document may be amended on an ongoing basis. Please visit Councils website for the most up to date version.

If changes to the proposed burn schedule are to be implemented, Council will consult and advise adjoining residents as soon as reasonably possible.

Contents

1. INTRODUCTION

1.1 Scope and Objectives

This Bush Fire Management Plan (Plan) describes the objectives, strategies and activities for bush fire management within Angophora Reserve for the next 5 years from 2014 to 2019. This Plan will also provide the framework for continued management beyond 2019.

The aim of this Plan is to provide a working management plan to reduce bush fire fuel loads in a Council reserve as specified in the Vegetation Strategy of the *Pittwater Council 2020 Strategic Plan*.

The Plan addresses both the life and property protection to adjoining landowners and conservation management within a natural reserve. The Plan also provides guidance on fire prevention and fire suppression. This Plan is consistent with the fire management objectives and actions of the *Angophora Reserve Plan of Management 2002*.

Four primary objectives of the Plan have been identified for the reserve. These are set out below:

1. Protect life and property from unplanned fire;
2. Protect significant environmental values from inappropriate fire regimes;
3. Protect aboriginal and cultural heritage from damage by fire and hazard reduction activities;
4. Cooperate with neighbours, visitors and other agencies in managing the risk of fire in the reserve and adjoining areas.

1.2 Report Structure

The Bush Fire Management Plan for Angophora Reserve is comprised of two separate documents. First and foremost an A1 sized map based plan showing a series of relevant maps and tables, illustrating fire and environmental management outcomes. Secondly, this report, which is intended as a supporting document to the map based plan. It identifies and provides further information on the background to the project, major issues affecting the site, and some specific details to complement the map based plan where required.

1.3 Limitations of the Plan

Establishing appropriate bush fire mitigation measures in areas of existing development is often complicated. There are many difficulties in upgrading existing developments to achieve construction standards such as those required for new buildings built in accordance with Australian Standard *3959-2009 - Construction of buildings in bush fire prone areas*. In line with *Planning for Bush Fire Protection (2006)*, where an Asset Protection Zone (APZ) is established in an adjoining Council bushland reserve to achieve appropriate bush fire mitigation, modifying vegetation to the extent required to create an appropriate APZ is often restricted by significant environmental constraints such as; steep lands with possible geotechnical problems, threatened species, Endangered Ecological Communities (EECs) and other environmental considerations (Kearnes *et al*. 2012). Also the application of such APZs, often contradicts the environmental conservation objectives for Councils bushland reserves. Where appropriate, Council has provided areas of Defendable Space where an APZ cannot be achieved on private property.

1.4 Residual Risk

Residual risk is defined in the *Warringah Pittwater Bush Fire Risk Management Plan 2010* as the bush fire risk that remains after the implementation of bush fire risk reduction measures. It is acknowledged that despite the implemented bush fire protection measures, some bush fire risk to life and property will remain and fire may continue to threaten life and property to some extent. It is simply not possible, without major environmental and/or financial impact, to provide complete protection for life and property located in bush fire prone areas. It should also be noted that adjoining vegetation on private property also poses a potential bush fire risk. Asset protection on private property is the responsibility of each property owner.

As outlined in Section 3.5, the risk assessment process documented that risk in this instance is generally low. Given this, and that it is considered good practice, education and extension programs for the neighbouring community are discussed later in the report.

1.5 Legislative requirements

Legislation

- Local Government Act 1993 & Crown Lands Act 1989
- Rural Fires Act 1997
- National Parks and Wildlife Act 1974
- Environment Protection and Biodiversity Conservation Act 1999
- Environmental Planning and Assessment Act 1979
- Threatened Species Conservation Act 1995

Other policies and procedures

- Warringah Pittwater Bush Fire Risk Management Plan 2010 (BFRMP)
- Planning for Bush Fire Protection 2006
- Bush Fire Environmental Assessment Code for NSW 2006
- Pittwater LEP 2014
- Pittwater Bush Fire Prone Lands Map 2013
- Pittwater Council Geotechnical Risk Management Policy 2009
- State Environmental Planning Policy 19 (SEPP 19) – Bushland in Urban Areas
- Angophora Reserve Plan of Management 2002

1.6 Warringah Pittwater Bush fire Risk Management Plan

The *Warringah Pittwater Bush fire Risk Management Plan 2010* was prepared in line with Section 52 of the *Rural Fires Act 1997*. The aim of the BFRMP is to minimise the risk of adverse impacts of bush fires on life, property and the environment (RFS, 2010). The BFRMP identifies the bush fire risk in Angophora Reserve and the surrounding area as;

- Bush fire hazard risk – extreme
- Likelihood – likely

- Consequence – catastrophic

The BFRMP identifies broad bush fire management zones to determine the fire management intent for a specific area. Angophora Reserve has been mapped as a Strategic Fire Advantage Zone with an Asset Protection Zone bordering the Reserve.

Under the BFRMP, developing a Bush fire Management Plan for a council reserve is considered a Bush Fire Management Committee (BFMC) Wide Treatment forming the basis for operational planning on public land within the BFMC area (RFS, 2010).

1.7 Statutory Roles

Angophora Reserve occurs within the Fire and Rescue NSW district. Fire and Recuse NSW are the lead combat authority, however there is a high level of cooperation with the NSW Rural Fire Service, this joint involvement has been formalised under the 'Memorandum of Understanding' agreed to by the NSW Rural Fire Service Commissioner and Fire and Rescue NSW Commissioner.

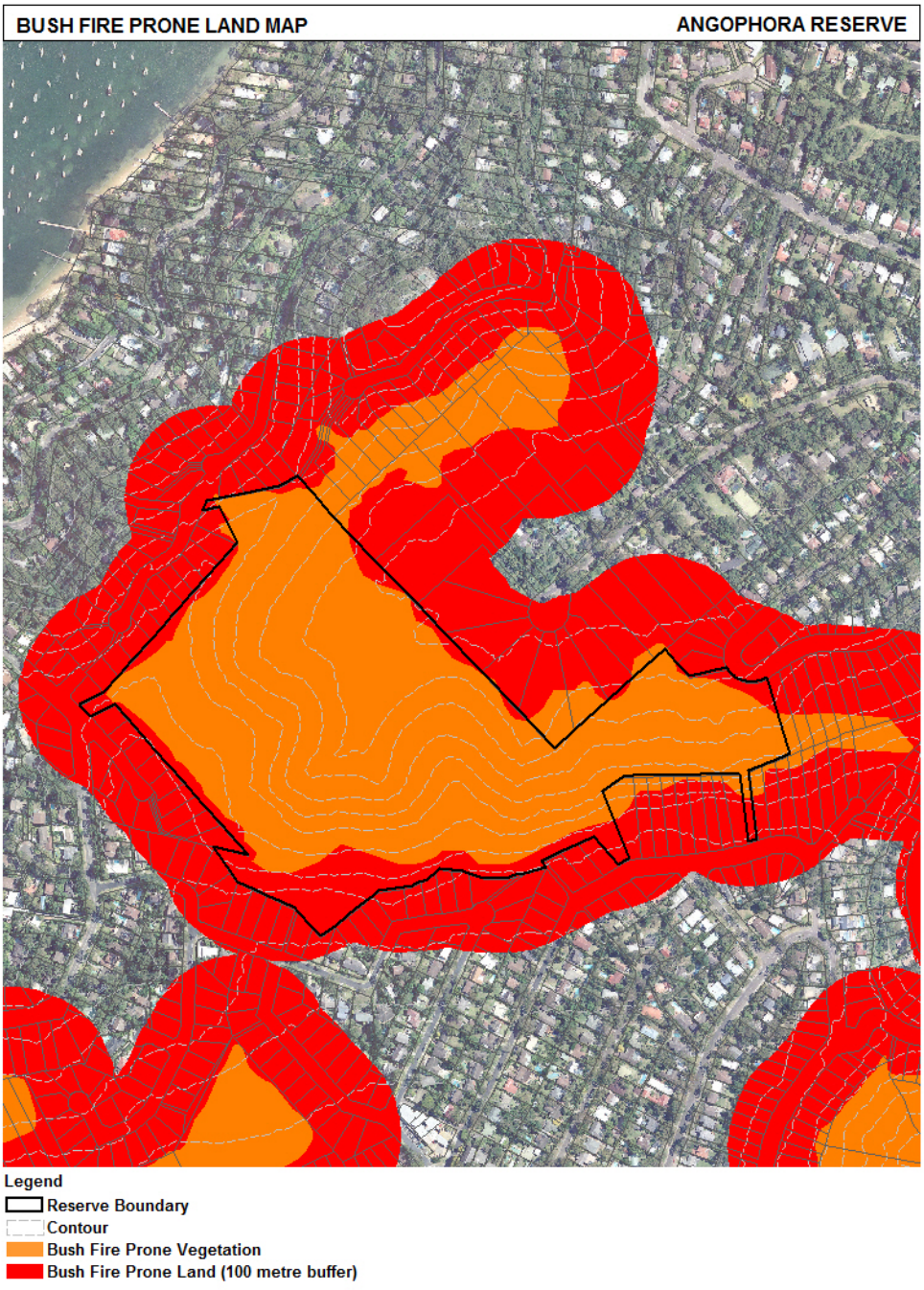
1.8 Development Control Planning

Control B3.2 Bushfire Hazard of the Pittwater 21 Development Control Plan 2014 applies to land identified on the Pittwater Bush Fire Prone Land Map 2012. Angophora Reserve and the adjoining private property is identified as being bushfire prone, see Figure 1. All development is to be designed and constructed to manage the risk due to the effects of bushfire throughout the life of the development.

Anyone purchasing a property on bush fire prone land receives a Section 149 Certificate which includes a notification to inform them of the bush fire threat on their property and their requirements to comply with the NSW Rural Fire Service document *Planning for Bush Ffire Protection 2006* when preparing a development application. This document also determines the extent of an Asset Protection Zone to occur on private property.

Development can still occur within an Asset Protection Zone on private property provided the requirements of *Australian Standard 3959-2009 - Construction of buildings in bushfire prone areas* is met in accordance with the determined Bushfire Attack Level. It must be noted, Council is not required to provide an Asset Protection Zone on Council land to meet requirements on Private Property.

Figure 1 Bush Fire Prone Land - Angophora Reserve and surrounds



2. DESCRIPTION OF THE RESERVE

2.1 Location

Angophora Reserve is located in the core of the Barrenjoey Peninsula bordering the suburbs of Avalon, Clareville and Bilgola Plateau. As a significant urban reserve of 18.5 hectares its location provides a refuge for urban wildlife and an important sample of the areas vegetation, geology and landscape. The Reserve is mostly bordered by residential development and can be accessed from Wandeen Road, Hilltop Road, Chisolm Avenue, Bilwarra Avenue, The Circle and Palmgrove Road. The Reserve and surrounding area is shown in Figure 2.

Figure 2 Reserve location and surrounds

2.2 Access and Recreation Use

Access within the Reserve is primarily by foot via the access points shown in Figure 3. The Reserve is mainly accessed by exercise walkers, bush walkers and bush regeneration workers. The rugged nature of the Reserve makes any access from vehicles nearly impossible.

Two main walking tracks extend through the reserve, firstly one from Palmgrove Road to Wandeen Road entrances and the second from Hilltop Road to Chisholm Avenue.

Figure 3 Reserve Access and walking Tracks

2.3 Topography

The Reserve forms part of the northern escarpment of Bilgola Plateau, occupying the steep slopes around the head of the north-east-facing valley down the centre of which runs Ruskin Rowe. The elevation ranges from 30 metres to 120 metres above sea level with slopes ranging from 5 to 35^{o} (Pittwater, 2002).

There are areas of extensive sandstone outcroppings throughout the Reserve in the form of a series of benches or steps. In a few places the bench-scarps are substantial cliffs but mostly they are only a couple of metres high.

Angophora Reserve contains two creeklines and 5 water outlets or small ephemeral creeklines.

2.4 Biodiversity

2.4.1 Vegetation Communities

Five (5) native vegetation communities occur in Angophora Reserve (ground-truthing, deLacey *et al*. 2012 & Pittwater, 2002). These vegetation communities and equivalent vegetation classifications shown in Table 1 are discussed below.

Table 1 Angophora Reserve Vegetation Communities

Pittwater Vegetation Community	**Keith (2004) Equivalent**	**Endangered Ecological Community Equivalent**	**Total Area of Vegetation Type (ha)**
Coastal Dry Spotted Gum Forest	Hunter-Macleay Dry Sclerophyll Forests	Pittwater Spotted Gum Forest EEC (Dry)	2.3
Coastal Moist Spotted Gum Forest	Southern Lowlands Wet Sclerophyll Forest	Pittwater Spotted Gum Forest EEC (Moist)	5.9
Coastal Escarpment Littoral Rainforest	Littoral Rainforest EEC	Littoral Rainforest EEC	3.8
Hawkesbury Sandstone Exposed Bloodwood Woodland	Sydney Coastal Dry Sclerophyll Forests	N/a	5.9
Coastal Upland Damp Heath Swamp	Coastal Heath Swamp	Coastal Upland Swamp	0.02

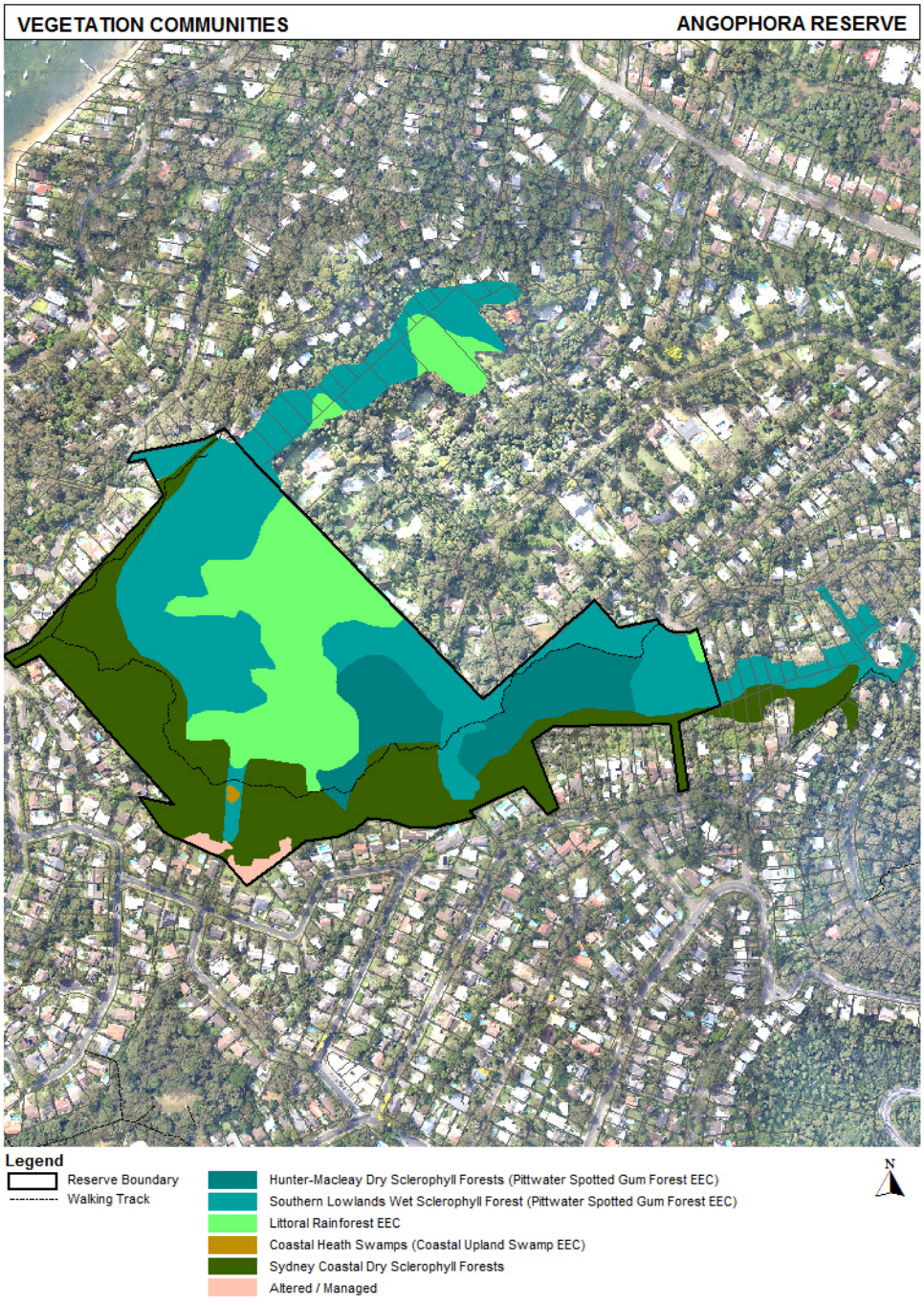
The Keith (2004) Equivalent as used in *NSW Rural Fire Service Planning for Bush Fire Protection* (RFS, 2006) outlines the broad vegetation formation. The Keith (2004) equivalent vegetation communities are shown in Figure 4. Three (3) of these vegetation communities also correspond to Endangered Ecological Communities (EECs) as listed under the *NSW Threatened Species Conservation Act 1995*. These are; Pittwater Spotted Gum Forest (including dry and moist), Littoral Rainforest and Coastal Upland Damp Heath Swamp.

Threats to Pittwater Spotted Gum Forest (Scientific Committee, 1999) include 'inappropriate fire regimes'; threats to Littoral Rainforest (Scientific Committee, 2004) include: 'fire, particularly along the boundary of the community' and threats to Coastal Upland Damp

Heath Swamp (Scientific Committee, 2012) include 'changes in fire frequency and intensity' and 'high frequency fire threatening structurally dominant species'.

Changes to vegetation communities are occurring due to the prolonged absence of fire and increased soil nutrient levels from urban runoff. This has caused extensive eucalypt dieback resulting in eucalypts being replaced by weeds and rainforest vegetation. Mesophyllic species such as Cheese Tree, Sweet Pittosporum and Blueberry Ash are becoming more abundant particularly on the lower slopes. Also, where there is Sydney Coastal Dry Sclerophyll Forests vegetation, She-oaks *Allocasuarina spp*. also appear to be increasing with the absence of major fires. These changes are further discussed in Appendix 1.

Figure 4 Vegetation Communities



2.4.2 Flora

Council maintains an active species list for Angophora Reserve, which is amended when new information becomes available. A total of 315 species of vascular plants have been recorded from the Reserve (Pittwater, 2008 & Pittwater, 2002). The total comprises 236 native species and 79 introduced species, not including various garden plants seen only on the very edges of the reserve. The number of native species is high for such a small reserve, reflecting the variety of habitats present.

None of the plant species recorded from the Reserve are listed as threatened species under the *NSW Threatened Species Conservation Act 1995* (TSC Act). However, the Elbow Orchid *Arthrochilus prolixus* occurring in the reserve is listed on the Rare or Threatened Australian Plants (ROTAP) list as having a 'restricted distribution range extending over less than 100km' and is considered 'a poorly known species suspected of being at risk' (ANPSA, 2010 & RBG, 1993). Angophora Reserve is the only known site in Sydney where the Elbow Orchid *Arthrochilus prolixus* still grows (Pittwater, 2002). A small terrestrial orchid, this species is found in Dry Sclerophyll Forests on the north coast of New South Wales and in Queensland, the Northern Territory and New Guinea. Sydney represents the southern limit of its distribution.

2.4.3 Fauna

Characteristics of the Reserve influencing the diversity of fauna species;

- The vegetation assemblages provide habitat for feeding, roosting and breeding for many species including reptiles, birds, ground and arboreal-mammals etc.
- Dense vegetation (to around 2m) provides protection and nesting areas for a number of small birds, gliders and Ring-tail Possums.
- Sandstone rock outcrops, caves and ledges and vegetated rock platforms occur on the site. These rock areas are suitable for some reptile species and rock wallabies; and there is anecdotal evidence that Diamond Pythons and even Death Adders once lived in this area (information from neighbour June 2001).
- Permanent and temporary drainage lines, creeks and pools occur throughout the reserve providing habitat for frogs and reptile species.
- Vegetation typical of damp areas grows at the base of the sandstone outcrops indicating the area may often be moist (Pittwater, 2002). These areas may provide potential habitat for frog species such as the threatened Red-crowned Toadlet.

Three (3) frog species, five (5) lizards, forty-four (44) birds and eleven (11) mammals have been recorded in or near the Reserve. There is potential for other species to be identified with further survey, but the fauna is generally limited, as with most small urban reserves. A list of fauna, including significant species, recorded or expected in the Reserve has been complied based on records from the; Angophora Reserve Plan of Management 2002, BioNet – Atlas of NSW Wildlife Website (OEH, 2013) and the Pittwater Native Fauna Management Plan 2011 (Pittwater, 2011). This list is provided in Appendix 3.

Of particular note is the Koala, which is listed as a Vulnerable Species in NSW under Schedule 2 of the *Threatened Species Conservation Act 1995* (TSC Act). The Pittwater Koala Population has also been listed as an Endangered Population under Schedule 1 of the TSC Act. This population had become isolated on the Barrenjoey Peninsula and Angophora Reserve did provide one of the remaining strongholds. A survey conducted by the National Parks and

Wildlife Service in 1993 estimated the koala population at only four to six animals (Higgs and Campbell 1993), and a further survey in 2003 found no animals at all (Pittwater, 2011). However, the last confirmed Koala sighting in the area was in 1987. The decline is likely due to a number of factors including, dog attacks, road kill and predation by feral animals. Koala habitat in the reserve has also been degraded through the extensive eucalypt dieback as mentioned above.

The Squirrel Glider has been listed as a Vulnerable Species in NSW and as an Endangered Population under the TSC Act. This species has also been recorded from the Angophora Reserve area, with two animals killed by cats in the adjacent Palmgrove Road in 1988 and 1994. The Barrenjoey Peninsula is the only known location for this species in the Sydney suburbs but it is likely that this population is also in serious decline (Pittwater, 2011).

One main threat to the fauna species in the reserve includes inappropriate fire regimes impacting habitat and prey availability. Fires in remnant bushland, whether they are wildfires, hazard reduction burns or ecological burns, can cause significant mortalities amongst fauna, including threatened species. In addition, even low intensity fires, may render the burnt area uninhabitable for particular fauna species during the post-fire period, by reducing food resources and shelter sites, until regeneration occurs. The loss of cover may also make the animals more vulnerable to predation (Pittwater, 2011).

2.5 Cultural Heritage

2.5.1 Aboriginal Heritage

Angophora Reserve contains one of the most archaeologically significant Aboriginal shelter sites in the Sydney region (Pittwater, 2002). This is a large overhang in a sandstone cliff-line, containing faded red and black drawings (ochre and charcoal), a large shell midden, stone artefacts and a burial site. This site has been known locally for some time and is recorded on the Office of Environment and Heritage - Aboriginal Heritage Information Management System (AHIMS) (OEH, 2011).

One and possibly two other Aboriginal sites have been found in the Reserve (Pittwater, 2002). The definite site is a small rock overhang with two Aboriginal drawings, and is listed in AHIMS. The other two sites are also small rock shelters. There appears to be evidence of Aboriginal occupation at these two shelters but this is still to be confirmed. An archaeological survey has been made along the first sewer-line constructed in the Reserve but no sites were detected (Pittwater, 2002). No survey has been made for the Reserve as a whole. There is high potential that other unrecorded sites also occur in the Reserve.

The two known sites as described above have also been recorded by the Aboriginal Heritage Office and site locations are held by Council. These sites have the potential to be impacted on by manual hazard reduction, controlled and uncontrolled fires within the Reserve.

2.5.2 European Heritage

There appears to be no significant European heritage in the reserve although a complete survey of the site has not been completed.

2.5.3 The Giant Angophora

A special feature of the reserve is the giant specimen of Sydney Red Gum (also known as Smooth Barked Apple) *Angophora costata* occurring in SFAZ 2. Preservation of this particular

tree was the chief reason for the establishment of Angophora Reserve in 1937. This tree is identified in Council's Heritage Study of the Barrenjoey Peninsula and Pittwater area as a landscape item of heritage significance. It is also listed in the Pittwater Local Environment Plan for Heritage Conservation. The tree is not especially tall, estimated 30 to 35 metres, but has a very thick trunk measuring 10 metres circumference at the base. It was thought to be the largest and oldest of its species in the world. The tree is still standing but no longer living, believed to have died in 1993 after a long drought, but remains on site and contains significant hollows providing habitat for a number of species of fauna (Pittwater, 2002).

3. BUSH FIRE RISK ANALYSIS

This chapter describes the bush fire risks to the reserve through an examination of fire history, a field based and desktop analysis of the bush fire hazard based on fuel loads, vegetation formations and slope, and an analysis of assets at risk.

3.1 Bush fire History

The fire regime in Angophora Reserve has changed since the 1940's with its isolation by urban development, refer to Appendix 1. Anecdotal evidence suggests the last wildfire to occur in the Reserve was in approximately 1958.

The reserve is now subject to prescribed burning at the recommended fire intervals for a particular vegetation type, refer to Table 2. Prescribed burning is usually undertaken in autumn to spring to decrease fuel loads and reduce the risks associated with incidence of any damaging summer wildfires which are difficult to control. Recording of fire events in the past has been from rough records and anecdotal evidence. Figure 5 shows known hazard reduction burns between 1996 and 2013. Future hazard reduction burns to occur in Angophora Reserve have been determined based on fire history and fire interval, refer to Appendix 2.

3.2 Fire Interval Thresholds

Table 2 provides intervals and thresholds for the vegetation communities occurring in Angophora Reserve. The minimum fire interval for each community is taken from the *NSW Bush Fire Environmental Assessment Code 2006*. The minimum and maximum threshold, identified in the Pittwater Native Vegetation Management Plan 2012, are not optimal fire intervals but minimum and maximum measures, above or below which a loss of biodiversity can be expected (deLacey *et al*. 2012).

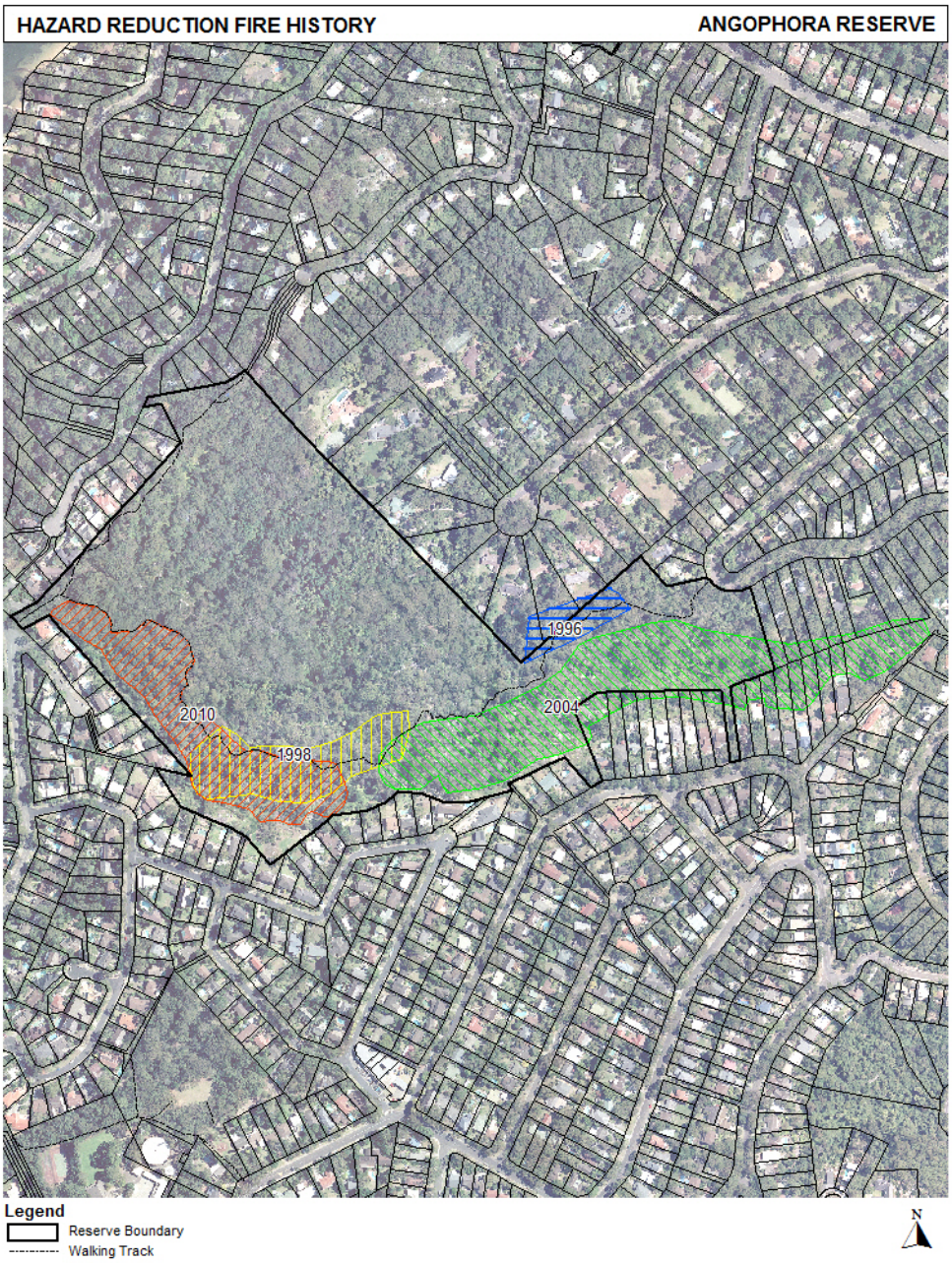
Table 2 Fire Intervals

Pittwater Vegetation Community	**Keith (2004) Equivalent**	**Minimum Fire Interval for SFAZ (years) (Code, 2006)**	**Minimum Threshold**	**Maximum Threshold**
Coastal Dry Spotted Gum Forest	Hunter-Macleay Dry Sclerophyll Forests	7	5	50
Coastal Moist Spotted Gum Forest	Southern Lowlands Wet Sclerophyll Forest (PSGF EEC)	10	25	60
Coastal Escarpment Littoral Rainforest	Littoral Rainforest EEC	Avoid Fire	Avoid Fire	Avoid Fire
Hawkesbury Sandstone Exposed Bloodwood Woodland	Sydney Coastal Dry Sclerophyll Forests	7	7	30
Coastal Upland Damp Heath Swamp	Coastal Heath Swamp	7	6	35

The minimum fire interval for Pittwater Spotted Gum Forest as detailed in Part 3 of the *Threatened Species Hazard Reduction List for EECs* (RFS, 2005a & RFS 2004) prescribes the conditions relating to the use of fire as "no fire more than once every 10 years". In areas of Pittwater Spotted Gum Forest EEC on the lower slope, where mesic species are becoming dominant, using Keith's fire interval of 10 years for Wet Sclerophyll Forests will allow Pittwater Spotted Gum Forest EEC species to regenerate. Small ecological burns may be applied to encourage recruitments of eucalypt species.

Fire management has previously concentrated on the protection of land and property on the surrounding residences. In the future, fire management will aim to conserve biodiversity through hazard reduction burning as well as protect land and property from the dangers of wildfire.

Figure 5 Fire History



3.3 Assets at Risk

Bush fires as well as activities for bush fire management and suppression all have the potential to adversely impact built and environmental assets in and around the Reserve. Damage or destruction of these assets may have major economic, social, and environmental consequences (EcoLogical, 2008).

3.3.1 Built Assets

There are no assets requiring specific bush fire protection located within the reserve. Residential development surrounds the Reserve, and as such, built assets that are typical for these types of development e.g. dwellings, decks and sheds adjoin the reserve. Some of these structures have little setback from the reserve and are therefore more vulnerable to the impact of bush fire. As mentioned in section 1.8, Angophora Reserve and adjoining properties are mapped as bush fire prone land. Requirements of the NSW Rural Fire Service document *Planning for Bush Fire Protection 2006* and *Australian Standard 3959-2009 - Construction of buildings in bushfire prone areas* apply to development on these properties.

The most obvious threat to built assets is the impact from the elements of bush fire attack, being flame contact, wind, radiant heat, smoke and burning embers. Evidence indicates ember attack is responsible for most bush fire related house fires (RFS, 2006a). However strong winds generated by severe bush fires may drive embers into vulnerable areas of a building, preheat and dry fuel ahead of a fire, lift roofing, damage windows, and extend flames along a more horizontal plane closer to building elements. Embers can cause spotting well in advance of a bush fire and provide piloted ignition to building elements. Radiant heat can impair fire-fighting operations, the health of residents and the integrity of building elements. Flames restrict fire-fighting operations, provide piloted ignition to building elements and threaten the health of residents and their capacity to evacuate the area (RFS, 2006a). Smoke may affect the health of nearby residents, especially the elderly and those with or susceptible to respiratory disorders.

Effective bush fire protection planning should aim to prevent flame contact, reduce radiant heat to below the ignition thresholds for various elements of a building, to minimise the potential for embers to cause ignition, and reduce the effects of smoke on residents and fire fighters.

3.3.2 Natural Values

Natural values are also at risk from bush fires and bush fire management. Inappropriate fire regimes can severely impact the natural environment. A fire regime is determined by fire interval, fire intensity, season of burn and pattern of burning. Each of these four factors combined determine the effect of an individual bush fire and a sequence of bush fires on the natural environment.

In March 2000, the Scientific Committee, established through the *NSW Threatened Species Conservation Act 1995* (TSC Act), made a Final Determination to support a proposal to list "High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition" as a Key Threatening Process on Schedule 3 of the Act. The threat of high frequency fire occurs in all fire-prone habitats in New South Wales, although the likelihood of occurrences of high frequency fire is currently greatest in coastal and tablelands habitats and in urban areas (Scientific Committee, 2000).

One of the main threats to Pittwater Spotted Gum Forest and Littoral Rainforest is inappropriate burning which reduces the diversity of woody plant species. Therefore, to conserve these communities, fire management within the Reserve must aim to avoid the incidence of high frequency and high intensity fires and ensure that fire is predominantly within regimes that promote biodiversity and the conservation of threatened species and EECs, refer to Table 2.

As mentioned above, bush fire, bush fire suppression and bush fire management activities have the potential to exacerbate weed problems. Weed invasion is a threatening process to both EECs present and a general problem for many of Sydney's urban reserves. Weed species respond well to the exposed, nutrient rich, and competition free conditions following fire. Bush fire management activities may allow these and other weeds to penetrate new areas and increase the density of existing infestations. As such, appropriate management before and after fire is required to mitigate this risk, refer to 4.2.6.

Other potential threats from fire include; illegal clearing post-fire by adjacent property owners and damage resulting from fire suppression activities. Fire suppression activities may cause damage to vegetation and soil through the creation of new tracks as fire control lines. New tracks have the potential to become vectors for problems associated with access such as weed and pest invasion, erosion and fire ignition.

3.4 Bush fire Hazard Assessment

Further to the long-term fire hazard assessment undertaken as part of the Angophora Reserve Management Plan 2002 detailed in Appendix 1, a map based bush fire hazard assessment has been prepared, see the Map Based Plan.

This assessment provides an indication of the varying levels of bush fire hazard affecting the site. It was derived spatially through a classification of the slope and the Keith (2004) vegetation formations found on the site and adjoining properties. These two classifications are then amalgamated to produce a final classification of which a hazard rating is applied which reflects likely bush fire behaviour. Generally, steep slopes combined with areas of high fuel vegetation (i.e. forests) lead to classification of the highest bush fire hazard (EcoLogical, 2008).

Although the rainforest vegetation formation has relatively low fuel loads, the majority of the site is on extreme slopes over 18 degrees, thus resulting in a generally moderate-high hazard rating. Majority of forest formation vegetation have a high to extreme hazard rating (EcoLogical, 2008).

3.5 Risk Assessment

Whilst the hazard risk rating indicated in the Warringah Pittwater Bush fire Risk Management Plan is extreme, a risk assessment builds on hazards and considers if a fire is likely to occur and cause damage to neighbouring assets. In this context, the risk is considered to be relatively low, given aspect, limited areas of potential 'fire run', and the dominance of rainforest vegetation and generally mesic understorey.

4. BUSH FIRE MANAGEMENT AND HAZARD REDUCTION

The fire management strategies identified in this Plan aim to limit the availability of fine fuels and subsequently, fire intensity. These strategies do not prevent unscheduled fire within the reserve, but with the implementation of fire management strategies, fire should be manageable within the resources of Fire and Rescue NSW and the NSW Rural Fire Service (RFS). However, it should be noted that on a day of Catastrophic Fire Danger, fires are unlikely to be manageable and adjoining properties may not be defendable.

In order to implement his plan, the following factors are required;

- Commitment to the proposed hazard reduction burn schedule with the flexibility for adjustment in the event of a wildfire. This also requires the support of Fire and Rescue NSW for the implementation of the program.
- Ongoing maintenance of Defendable Space, particularly on the southern boundary.
- Continued funding for weed management over an extended period.
- Encourage community involvement in all aspects of the maintenance and usage of the reserve (EcoLogical, 2008).

4.1 Fire Management Zones

In consultation with the NSW RFS, Angophora Reserve has been divided into 13 fire management zones to apply specific fire or fuel management strategies. These zones as shown on the Map Based Plan, form the basis for operational fire planning within the reserve. These zones were developed based on: location of neighbouring dwellings; vegetation type including EECs; natural or existing containment lines such as escarpment edges and walking tracks. The objectives of the following zones include:

- Strategic Fire Advantage Zones (SFAZ) – to provide strategic areas of fire protection advantage which will reduce the speed and intensity of bush fires, and reduce the potential for spot fire development. Also to aid containment of wildfires to existing containment management boundaries (RFS, 2010). SFAZ compliment APZs and Defendable Space where these do not provide adequate protection to adjoining private property (RFS, 2006b).
- Fire Exclusion Zones (FEZ) – to exclude fire to conserve biodiversity and protect cultural and historic heritage. Fire Exclusion Zones to protect sensitive vegetation and Management Actions for each zone are detailed on the Map Based Plan. Generally these areas are rainforest vegetation which is a lower risk (RFS, 2006a). Outside of these areas fire management will be undertaken via the burn schedule to burn lower fuels.
- Defendable Space (DS) – a fuel reduced area too allow for the safer use of suppression strategies during a bush fire event within the Reserve.

As outlined in the Plan, Council will maintain existing areas of Defendable Space as well as manage the reserve to provide up to 20 metres from the rear of a residential dwelling, where it extends into the reserve. Defendable Space provides an area in which a person can undertake property protection after the passage of fire. Defendable Space shown on the Map-based Plan is already maintained to some extent with reduced fuel and mown areas. Council will maintain remaining fuel loads in line with the *NSW RFS Standards for Asset Protection Zones 2005*. It must be noted that APZs and Defendable Space cannot be provided on slopes greater than 18 degrees (RFS, 2006a).

4.1.1 Constraints to Fire Management

Constraints limiting the application of fire management include:

- steep slopes often greater than 18 degrees;
- a high geotechnical hazard rating;
- rainforest vegetation;
- vegetation dominated by Endangered Ecological Communities (EECs);
- limited options for the creation of control lines; and
- adequacy of existing access.

In addition, Angophora Reserve is surrounded by existing residential development, most of which has been constructed outside the guidelines specified in the *NSW Planning for Bush fire Protection* (RFS, 2006a). As an alternative to these guidelines, Defendable Space occurring within the reserve is recommended where the vegetation is downslope from the asset and adequate Asset Protection Zones cannot be established on private property. Where the vegetation is upslope from the asset, Defendable Space may not be considered necessary, however boundaries should be monitored as conditions may change and some fuel reduction may be required to provide Defendable Space. Defendable Space widths may vary where natural features provide logical boundaries.

Angophora Reserve has been identified as H1 on Council's Geotechnical Risk Management Map. H1 identifies areas of high geotechnical hazard being almost certain, likely or possible to experience land slip in the near future, refer to the Geotechnical Hazard Map on the Map Based Plan. Under the *Pittwater Council Geotechnical Risk Management Policy 2009,* Council is required to assess potential geotechnical impacts of Defendable Space and mitigate landslide risk due to bush fire management (Pittwater, 2009).

Manual removal in most Fire Management Zones is not practical due to the large urban interface, limited access and the topography of the reserve. It can cost up to $240,000 a year to manage an 80 metre area of Defendable Space at $1.00 per square metre. In this instance, manual fuel reduction and selective pile burning may be appropriate.

4.1.2 Environmental Assessment

All prescribed burns and manual hazard reduction work require a site-specific environmental assessment to be undertaken at the Annual Hazard Reduction Program planning stage prior to works commencing. An environmental assessment can include either a Review of Environmental Factors (REF) prepared under Part 5 of the Environmental Planning and Assessment Act 1979 (EP&A Act) or a Hazard Reduction Certificate (HRC) issued under the *NSW Bush Fire Environmental Assessment Code 2006* (EcoLogical, 2008 & RFS, 2006b).

A HRC cannot be issued for hazard reduction works on slopes over 18 degrees.

4.1.3 Fuel Hazard

Generally, the more flammable and dense the fuel, the greater the fire hazard and potential fire intensity will be. Vegetation formations across the reserve mostly fall into the categories of ‘Dry sclerophyll forests’, ‘Wet sclerophyll forests’ and ‘Rainforest’ (RFS, 2006a - from Keith 2004).

Current fuel loads have been estimated across the reserve based on a brief field assessment and vegetation mapping. With the long absence of fire in a large portion of the reserve, it is

assumed that on the lower escarpment the fuel loads have accumulated to maximum levels. Table 3 provides fuel loads which contribute to the rate of spread and intensity of a fire for each vegetation community as detailed in *NSW Planning for Bush Fire Protection 2006*.

Table 3 Fuel loads contributing to rate of spread and fire intensity

Pittwater Vegetation Community	**Keith (2004) Equivalent**	**PFBP Fuel Level (t/ha)**
Coastal Dry Spotted Gum Forest	Hunter-Macleay Dry Sclerophyll Forests (PSGF EEC)	20-25
Coastal Moist Spotted Gum Forest	Southern Lowlands Wet Sclerophyll Forest (PSGF EEC)	25-30
Coastal Escarpment Littoral Rainforest	Littoral Rainforest EEC	8-10
Hawkesbury Sandstone Exposed Bloodwood Woodland	Sydney Coastal Dry Sclerophyll Forests	20-25
Coastal Upland Damp Heath Swamp	Coastal Heath Swamp	15

4.2 Fire Management

Table 4 identifies hazard reduction methods permitted in each Fire Management Zone in accordance with the *NSW RFS Bush Fire Environmental Assessment Code 2006*. The following operational guidelines and additional information complement the information shown on the Map Based Plan. The following guidelines should also be encouraged on adjoining private property.

Table 4 Works permissible in each Fire Management Zone (RFS, 2006b)

Technique	**Defendable Space**	**SFAZ**	**FEZ**
Manual Hazard Reduction			
Graders, ploughs and dozers	Not permitted	Not Permitted	Not permitted
Hand tools and hand held machinery	Permitted	Permitted	Permitted
Slashing machinery	Slashing machinery may be used in DS where slope is less than 18 degrees. Where slashing is permitted, vegetation must not be slashed below 5cm and at least 90% of ground cover is to be maintained. Slashed material is to be composted *in situ* away from assets or removed off site.	Slashing machinery may be used in SFAZ where slope is less than 18 degrees. Where slashing is permitted, vegetation must not be slashed below 5cm and at least 90% of ground cover is to be maintained. Slashed material is to be composted *in situ* away from assets or removed off site.	Not permitted
Tree pruning / removal	The root structure of trees must be left undisturbed. Tree	Not permitted	Not permitted

	removal is not permitted on slopes over 18 degrees.		
Burning			
Burning	Permitted in accordance with Part 5 of the BFEAC 2006.	Permitted in accordance with Part 5 of the BFEAC 2006.	Not permitted
Pile Burning	Permitted only where material in piles cannot be removed off site or composted in situ.	Not permitted	Not permitted
Weed Management	Permitted	Permitted	Permitted

4.2.1 Fuel Management within Defendable Space

Defendable Space is to be inspected annually and treated as detailed in the Draft Pittwater Boundary Management Plan 2013 (Pittwater, 2013). Specific hazard reduction works to be undertaken in Defendable Space areas are detailed on the Map Based Plan.

The following works are permitted within Defendable Space areas , as per *NSW RFS Standards for Asset Protection Zones 2005(RFS, 2005b);*

Tree Pruning / Removal

- 75% of original canopy cover must be retained.
- No tree should be removed on slopes over 18 degrees or from any EEC
- Larger trees (> 200 mm in diameter) can remain within the APZ/DS provided;
    - No part of their crown occurs within 5 m of any building (significant habitat trees can remain 2 m out from the building line);
    - Canopies are discontinuous, that is canopies are separated by at least 2 m;
    - They are smoothed barked species or, if rough barked, are maintained free of hanging bark and other ladder fuels;
    - Low branches holding fine fuel (i.e. leaves and twigs of <6mm in diameter) are pruned to 2 m from the ground;
- All branch removal should adhere to the following pruning standards;
    - Use sharp tools to ensure clean cuts to minimise damage to the tree.
    - Decide which branches are to be removed before commencing work. Ensure that you maintain a balanced, natural distribution of foliage and branches.
    - Remove only what is necessary.
    - Cut branches just beyond bark ridges, leaving a small scar.
    - Remove smaller branches and deadwood first.

Manual Works

Elevated fuel layer

- Small trees (<200 mm in diameter), shrubs, fallen trees and tree-limbs and stumps may be removed and continuously suppressed;
- Retain clumps or islands of shrubs rather than continuous shrub layers.
- Remove all shrubs within 2m of any building.

- Do not remove shrubs where removal would leave the ground cover exposed.
- Established stands of Bracken fern with increased dead fuels should be slashed on an ongoing basis to supress reoccurrence.

Near-surface fuel layer

- All shrubs and tree saplings are to be removed off-site or mulched outside of the Defendable Space.

Surface

- Fines fuels are to be removed by raking or hand removal. Large build-ups of litter such as leaves, twigs (less than 6 mm in diameter) and bark should be removed from the surface regularly during the fire season, however no soil should be left exposed.
- All native grasses within the Defendable Space are to remain in-situ wherever possible; and a minimal ground fuel is to be maintained to include either mown grass or rock of less than 4 tonnes per hectare of fine fuel (i.e. material of <6 mm in diameter).
- Care should be taken at all times to consider the geotechnical hazard of the site. Avoid removal of fuel that may destabilise surrounding debris, particularly around large sandstone outcrops. No roots should be removed.
- All cut material should be mulched and left in 1x1 metre compostable piles or spread along the ground to prevent weeds and reduce soil erosion.
- Materials such as piles of wood, household rubbish, composted garden clippings and other combustible materials are not to be dumped on Council land or within Defendable Space.
- 90% ground cover must be maintained to prevent soil erosion.
- Lawns and native grasses need to be kept short (10cm) and green where possible.

Weeds

- Removal of noxious weeds from ground, shrub and canopy layers should be conducted pre, during and post hazard reduction.
- Noxious and environmental weeds should be prioritised for removal before native species when reducing fuel.

Other

- If Defendable Space is in close proximity to a creek, all mechanical works are to be excluded within a 5 metre buffer area of the creekline. All prescribed and pile burning is to be excluded within a 30 metre buffer area of the creekline.

Manual hazard reduction is required on an ongoing basis to continue to maintain DS in Angophora Reserve. Defendable Space is to be inspected and treated in consultation with the NSW Rural Fire Service (RFS, 2010).

Under Part 5.5.2 of the *NSW RFS Bush Fire Environmental Assessment Code 2006*, a Hazard Reduction Certificate may be issued for prescribed burning in an APZ or Defendable Space regardless of fire interval, unless threatened species, populations or EECs are identified, in which case burning is only permitted if the fire interval is longer, or equal to the specified fire interval (RFS, 2006b).

4.2.2 Fuel Management within SFAZ

Specific hazard reduction works to be undertaken in SFAZs are detailed on the Map Based Plan. The following works are permitted in SFAZs;

Burning

Prescribed burning is permitted in accordance with Part 5 of the *NSW Bush Fire Environmental Assessment Code 2006.* Prescribed burning removes ground litter and fine fuels from larger areas (RFS, 2005a). Refer to the burn schedule as detailed in section 4.3.

Manual Works

Elevated fuel layer

- Where fuel levels are required to be reduced manually, small trees (> 200 mm in diameter), shrubs, fallen trees and tree-limbs and stumps may be removed or piled in small compostable piles less than 1m x 1m;
- Do not remove any vegetation where removal would leave soil exposed.
- Established stands of Bracken fern with increased dead fuels should be slashed on an ongoing basis to supress reoccurrence.

Surface

- Fines fuels are to be removed by mosaic burning in line with the burn schedule detail in section 4.3. Where mosaic burning is not permitted due to fire interval, pile burning may be considered in consultation with Fire and Recuse NSW.
- Care should be taken at all times to consider the geotechnical hazard of the site. Avoid removal of fuel that may destabilise surrounding debris, particularly around large sandstone outcrops. No roots should be removed.
- All cut material should be mulched and left in 1x1 metre compostable piles or spread along the ground to prevent weeds and reduce soil erosion.
- 90% ground cover must be maintained to prevent soil erosion.

Weeds

- Removal of noxious weeds from ground, shrub and canopy layers should be conducted pre, during and post hazard reduction.
- Noxious and environmental weeds should be prioritised for removal before native species when reducing fuel.

Other

- In close proximity to a creek, all mechanical works are to be excluded within a 5 metre buffer area of the creekline. All prescribed burning is to be excluded within a 30 metre buffer area of the creekline.

4.2.3 Fuel Management within FEZ

FEZ 1 and 2 contain Littoral Rainforest EEC. Burning in these FEZs is to be excluded indefinitely to protect the Littoral Rainforest EEC. Where an adjoining SFAZ is burnt, fire must be of low to moderate intensity and must be self-extinguishing before it penetrates the edges of the rainforest vegetation.

Weed management will be undertaken to reduce fuels particularly in Defendable Space areas adjoining private property.

4.2.4 Biodiversity Management

Fire ecology for threatened flora and fauna species identified within 3km of Angophora Reserve is identified in Appendix 4. In general, the following management requirements should be applied throughout the Reserve;

Fauna

- Avoid burning during nesting season from late winter to early spring where possible or ensure other similar vegetation areas remain unburnt.
- Avoid medium to high intensity fires during nesting season and over large areas which reduces foraging habitat.
- Where there is potential foraging habitat, undertake mosaic burns in each vegetation community to maintain different age classes so that unburnt refuges are available to allow fauna populations to survive and eventually recolonise the burnt areas (Pittwater, 2011);
- Protect potential nesting sites such as tree hollows and dreys by minimising burn temperatures and keeping scorch heights low by raking fuel away from tree bases.
- Avoid damaging roost caves and structures (e.g. culverts). A 20 metre buffer from all escarpment edges is required to protect cave-dwelling bat species.
- A WIRES or Sydney Wildlife carer is to be contacted where a rescue can be undertaken safely to help injured fauna and relocate displaced animals during hazard reduction burning.

Vegetation

- Prescribed burns should only be undertaken in accordance with the recommended fire intervals for that vegetation community, refer to Table 2. Avoid the incidence of high frequency and high intensity fires.
- Avoid the use of Littoral Rainforest EEC and creeklines as control lines for prescribed burns and suppression activities.
- Consider the impact of fire frequency on locally significant and threatened flora species such as Waratah *Telopea speciosissima* and Elbow Orchid.

The Elbow Orchid *Arthrochilus prolixus* is a significant orchid occurring in Angophora Reserve. Very little is known of its ecological requirements, such as response to disturbance from clearing, fire etc. It has a patchy distribution throughout the Reserve, mostly occurring in colonies close to walking tacks in the Sydney Coastal Dry Sclerophyll Forests and Pittwater Spotted Gum Forest vegetation. This orchid often occurs where there is an opening in the usually dense Bracken fern. As a general rule, disturbance to known colonies should be avoided. Hand clearing around known colonies may be appropriate in areas planned for burning and to prevent over shadowing my Bracken fern (Pittwater, 2002).

Fires are a major influence on the persistence of Waratah *Telopea speciosissima.* Above ground Waratahs are removed by fire, however individual plants survive fire by having dormant buds stored underground in lignotubers, from which new stems can re-sprout. Waratahs do not have a persistent seed-bank on the plant or in the soil and they rely on post-fire flowering for the establishment of new individuals. Flowering occurs mostly in the first 3 years following fire, although a lower level of flowering can be maintained up to a decade after fire. A variable fire interval of 7 to 10 years is preferred to ensure persistence of this species (Denham et al. 2012). Alternatively every few years stems could be removed to encourage fresh shoots from the lignotuber. A program should be developed to ensure fire intervals and or pruning is not over zealous.

As mentioned previously, the Giant Angophora *Angophora costata* tree, though dead since 1993, contains significant hollows providing habitat for a number of species of fauna. Prior to burning, fuels should be racked away from the base of the tree to prevent flame contact and reduce scorch to the trunk of the tree. All major hollow trees, where possible, should have fuel removed from the base of the tree prior to burning.

She-oaks *Allocasuarina spp*. maybe increasing in the reserve due to the absence of major fires, in particular, large areas of the Sydney Coastal Dry Sclerophyll Forests now have a dense understorey of black she-oak *A. littoralis*. Small hot ecological burns could be undertaken to encourage diversity of species. However, it should be noted that these she-oaks are a significant food source for the threatened Glossy Black-cockatoo.

4.2.5 Aboriginal and Cultural Heritage Management

The major concern with fire management activities on Aboriginal heritage is the unintentional damage to sites during works. Hazard reduction burning and manual hazard reduction works generally have a low potential threat to Aboriginal heritage provided certain precautions are undertaken (AHO, 2013). Prior to hazard reduction works, a review of Aboriginal heritage issues should be conducted, as part of a Review of Environmental Factors or a Hazard Reduction Certificate. Aboriginal heritage issues should also be discussed prior to the commencement of a burn on the day with the appropriate fire agency i.e. Fire and Rescue NSW or NSW Rural Fire Service.

In addition to the Site Management Guidelines provided in Appendix 5 for known Aboriginal Cultural Heritage items, the following considerations must also be applied during hazard reduction works and fire suppression activities to reduce impacts on known and potential Aboriginal heritage sites.

- In the event of fire management activities uncovering, disturbing or damaging an unknown site, the NSW Office of Environment and Heritage (OEH) and the Northern Region Aboriginal Heritage Office (AHO) must be informed.
- In the event of an unrecorded site being found during fire suppression operations, action should be taken to avoid damage to the site and it must be reported to the incident controller. Councils Bushland Management Officer must also be informed to report the finding to the OEH and AHO.
- Intense fire, smoke and heat around overhangs can damage rock art sites (AHO, 2013). In order to protect known and potential Aboriginal sites, a fire exclusion zone for hazard reduction burns of at least 20 metres along the low side of escarpment edges is required. To prevent damage to overhangs in the event of wildfire, fuel should be reduced manually within the fire exclusion zone, targeting exotic and flammable species in the first instance to reduce wildfire intensity. Removal of exotic species in most cases will provide the discontinuity of vegetation required to reduce the fire hazard.

  Further investigation of SFAZ 4, 9 and 10 for overhangs is required prior to burning. Overhangs should be recorded using a GPS and fire intensity reduced during burning.
- Within 1 km of the reserve; scar trees, shelters, middens, rock engravings, shelter art and axe grinding grooves are known to occur. Consider follow-up Aboriginal archaeological surveys in areas of thick bush within 12 months following a hazard reduction burn or wildfire.
- Staff and/or contractors undertaking bush regeneration and manual hazard reduction works are to be made aware of known sites and management

requirements. Staff and/or contractors should be trained in Aboriginal Site Awareness (AHO, 2012).
- Ensure staff and/or contractors undertaking the works recognise that all Aboriginal heritage sites must be treated with respect regarding cultural values and keep site locations confidential.

The Aboriginal Heritage Office undertook a Due Diligence Assessment on behalf of Pittwater Council to determine if an Aboriginal Heritage Impact Permit (AHIP) application was necessary under the *Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW (2010)* prior to undertaking any hazard reduction activities in Angophora Reserve. It concluded that; *the AHO has inspected the rock shelters in question and considers that bush fire management conducted in accordance with basic cautionary procedures can ensure no harm be inflicted in the sites. Provided works will not affect archaeological deposits of the shelters or shelter ceilings, walls and structures, no AHIP is required* (AHO 2013), refer to Appendix 6.

4.2.6 Weed Management

In fire management zones to be treated or burnt, noxious and environmental weeds must be treated to prevent spreading (RFS, 2006b). To avoid exotic seeds and pathogens being introduced on equipment and to prevent increased weed distribution and abundance in the Reserve during fire management activities the following conditions must be implemented;

- Wash down all equipment likely to disturb the soil prior to, during and after prescribed burning or trail maintenance activities.
- Vehicles and machinery regularly used in wildfire suppression should be thoroughly cleaned on a regular basis.
- Weeds are to be targeted prior to burning to prevent proliferation of weeds species post fire.
- Disturbance may open an area up to weed invasion therefore a weed control program should be implemented. Carry out weed management within 3 to 6 months following fire management activities, hazard reduction burning or a wildfire.
- Avoid movement through areas of untreated weed infestation and Bracken fern prior to accessing burnt areas.
- Target weeds in problem areas including Reserve access points, main tracks, and along the southern boundary on the upper escarpment where weed encroachment and rubbish dumping is problematic.
- Herbicides are to be used to treat weeds species only. Herbicides are not to be used within 20 metres of any creekline.

Bracken fern *Pteridium esculentum* is a native species which regenerates rapidly after fire and may dominate recently burnt areas. Bracken fern can reduce the diversity of native understorey species as it develops a thick understorey which out compete regenerating native species. Bracken fern has a hardy, persistent rhizome root system which causes infestations to grow larger over time. Established stands of bracken usually contain a mixture of green and dead fronds. Within Angophora Reserve, Bracken fern may be selectively controlled using some of the measures below.

Burning stands of bracken is not an effective control technique as the rhizome underground is unharmed, however burning can be used to reduce the amount of dead fronds prior to herbicide application. Smaller areas can be treated by slashing. Slashing can be an effective control method if done on a monthly basis, consecutively for a minimum of three years

which would deplete plant energy stores in the rhizome (I&I 2010). Slashing cannot be undertaken on areas where slope is greater than 18 degrees (RFS, 2006b).

A bush care group of approximately 18 volunteers meet in Angophora Reserve once a month to undertake bush regeneration works including weed management and management of Defendable Space. This group has been undertaking works in the reserve over the last 5 years. These works are coordinated with the hazard reduction contract in the Reserve.

4.3 Burning Proposal / Burn Plans

The fuel loads within designated Strategic Fire Advantage Zones will be managed through low to moderate intensity burning implemented by NSW Fire and Rescue. A proposed burn schedule has been established based on recommended fire intervals for each vegetation community, as detailed in Table 2. The proposed burn schedule is detailed in Table 5.

Table 5 Proposed Burn schedule for the life of the plan and beyond

Proposed Burn Year	Fire Management Zone
2014, 2015, 2016	SFAZ 10, SFAZ 3
2015, 2016, 2017	SFAZ 11, SFAZ 2
2016, 2017, 2018	SFAZ 4
2017, 2018, 2019	SFAZ 6, SFAZ 1
2018, 2019, 2020	SFAZ 8, SFAZ 5
2019, 2020, 2021	SFAZ 9, SFAZ 7

A 3 year window is provided for burns, as hazard reduction burns are often postpone due to inappropriate weather conditions. No two adjacent zones should be burnt within the same or consecutive years. Adjustment to the burn schedule following wildfire may be required (Parry, 2005).

Low to medium intensity burns may occur in areas of Defendable Space regardless of fire intervals unless threatened species, populations or EECs have been identified. However, as a large portion of the Sydney Coastal Dry Sclerophyll Forest and Pittwater Spotted Gum Forest vegetation occurring in the Defendable Space along the escarpment ridge have been burnt in recent years, with some of the Pittwater Spotted Gum vegetation being burnt over the fire threshold, burns are not proposed in the Defendable Space for the life of this plan. Prescribed burns for the study area occurring in the next 5 years are proposed to occur in the SFAZs for ecological biodiversity purposes as well as strategic hazard reduction. Fire is excluded from a large portion of the reserve where Littoral Rainforest EEC vegetation occurs (FEZ 1 & 2), refer to Map Based Plan.

Prescribed burning must be conducted in accordance with Part 5 of the *NSW Bush Fire Environmental Assessment Code 2006*. All prescribed burns are to be included on the Annual Hazard Reduction Program in consultation with the Warringah Pittwater Bush Fire Management Committee. Fire & Rescue NSW prepares a burn plan in consultation with Council which describes details of the proposed burn. The burn plan refers to the environmental assessment undertaken for each Fire Management Zone with special consideration for threatened species, populations and EECs. Fire and Rescue NSW are responsible for notifying residents of a burn to be undertaken.

In general, the following management requirements should be applied when undertaking hazard reduction burning;

- Prescription burning should temporarily or permanently remove some of the shrub layer in a given area, avoiding scorching of the overstorey canopy.
- Access to the reserve will need to be closed when undertaking a burn. Following a burn, access to the burn area must be restricted to allow for regeneration.
- Any prescribed burns undertaken must be mapped and intensity recorded in Councils fire history mapping to ensure future burns are not carried out within prescribed fire intervals. Burning must be delayed if it will exceed fire interval thresholds.
- Zones bordering FEZ 1 & 2 or any gully areas should only be burnt under conditions where the fire is self-extinguishing as it approaches the rainforest vegetation.
- If heavy rain occurs post fire there may be increased nutrients entering the ephemeral creeklines running through a burn area, erosion controls may need to be installed.
- Light-up patterns should be specified in a Burn Plan prepared by Fire and Rescue NSW. Light-up direction should be into the wind and burning upslope (OEH, 2012). Light-up patterns must allow fauna to escape the fire front.
- During hazard reduction burning rocky outcrops will provide some refuge for wildlife during and immediately after a burn. Flame intensity should be minimised around these areas where possible.
- In areas of Defendable Space where manual hazard reduction is undertaken and vegetation cannot be removed off site due to terrain, piles may be constructed and burnt in accordance with the NSW RFS *Standards for Pile Burning* (RFS, 2005c). Where piles are constructed within in the Reserve, they must be positioned outside of Defendable Space areas. It must be noted that pile burns are an ember hazard and should not exceed specified dimensions, this included neighbouring residents adding garden waste to piles.
- Property owners of adjoining land must be notified of pile burns or area burns occurring at least 2 weeks prior to ignition and again at least 24 hours prior to burn proceeding. Signs are to be erected notifying visitors to the reserves of the proposed burn.
- Where possible natural or existing containment lines should be used, If a containment line is to be created it should be the minimum width necessary to carry out a burn safely and must not exceed 4 metres in width. Containment lines to be constructed are shown on the poster.
- It is up to council and Fire and Rescue NSW to determine appropriate containment lines prior to burning within different vegetation communities. Some proposed containment lines have been identified on the Map Based Plan.

4.4 Track and Access

During a wildfire or hazard reduction burn, it is likely the NSW RFS and/or Fire and Rescue NSW will access the reserve via access points identified in Figure 2. Due to steep slopes and ecological constraints, fire trails are not appropriate for Angophora Reserve. There is no vehicle access for fire trucks within the reserve.

The best access points for hoses and equipment from fire trucks is available from Wandeen Road and Palmgrove Road. Adequate turning points or thru road access are identified on the Map Based Plan. Cars and boats are not to be stored within the Reserve at the end of Chisholm Avenue to allow emergency vehicle access in the event of a fire.

Access points and walking tracks are to be kept open and free from fallen branches, weeds and increased fuel. Following a burn, tracks should be assessed for risk matters such as dead/dangerous trees with tracks being closed as required with access by the public to burnt areas restricted.

4.5 Community Education & Preparedness

The establishment and maintenance of Defendable Space and SFAZs proposed in this plan will provide a significant improvement in the protection of neighbouring properties. Despite these works, assets on adjoining properties cannot be totally protected without complimentary bush fire protection activities undertaken on private land, particularly on the eastern end of the escarpment, refer to the Map Based Plan.

Fire and Rescue NSW are responsible for implementing Community Education in line with the *Fire and Rescue NSW Community Education Strategy* (RFS, 2010). Preparedness of neighbouring properties is vital to ensure the safety of people and property. To achieve this, the following should be implemented;

- Raise community awareness and preparedness for prevention, preparation and emergency planning for bush fire events through the Warringah Pittwater BFMC FireWise Program.
- Council and the NSW Rural Fire Service are to hold a community meeting or deliver Bush Fire Survival Plans to adjoining residences and highlight their responsibility to reduce the risk to their home and family and take action to survive a bush fire (RFS, 2012). Residents receiving a Bush Fire Survival Guide are to be recorded on Pittwater's Bush Fire Survival Guide Register which is reported to the NSW RFS.
- Fire and Rescue NSW are to promote the Community Fire Unit (CFU) Program as per the Fire and Rescue NSW Policy (RFS, 2010). CFU members assist firefighting operations by preparing properties, managing spot fires and ember attacks, and assisting with recovery operations (NSWFR Website). Fixed Community Fire Unit (CFU) equipment is installed at the Chisholm Avenue entrance into the Reserve. The CFU is a fixed cabinet installed on a concrete slab. Equipment includes; fire hose, stand pipes, portable pump and other miscellaneous items (FRNSW, 2003).
  Consider installing a fixed or mobile CFU, at the top of the escarpment ridge off Bilwarra Avenue.
- Fire and Rescue NSW are to promote the Static Water Supply (SWS) program to identify adjacent properties with a static water supply such as swimming pool or a tank designated for firefighting purposes.
- Fire and Rescue NSW are to notify neighbouring residences of hazard reduction burns to be undertaken at least 24 hours prior to burning to give residences time to prepare their properties. Council to provide a follow-up letter to adjoining residents letter detailing post-burn requirements e .g. stay of regenerating land, dead fuel to remain in-situ i.e. not to be cut down as it increases fuel etc.
- Negotiate with residents on the eastern end of the escarpment to share cost to maintain their properties for asset protection. RFS to serve notifications under s.66 of the *NSW Rural Fires Act 1997* for fuel hazard removal on private property on the lower escarpment and stating their obligation under s.63 the Act. Council to investigate the likelihood of NSW RFS Fire Mitigation Works Funding to undertake one-off APZ works on private property.
- Develop a procedure to close the reserve on days with Extreme or Catastrophic weather conditions
- Install interpretive signage at the reserves main entrances detailing bush fire risk within the reserve and evacuation strategies in the event of an emergency.

- Encourage local residents to be involved in the Angophora Reserve bush care group to assist in weed and fuel management within the Reserve.

4.6 Fire Prevention

Although the occurrence of a bush fire in Angophora Reserve is relatively low, there is a possibility that a fire may occur accidently or by arson. Fire may occur accidently, from the arching of power lines, plant and machinery, escaped prescribed burns and, although unlikely, by lightning strikes.

Bush fire prevention strategies include;

- Closing the Reserve on days of extreme or catastrophic fire danger ratings.
- Installing interpretive signs within in the reserve detailing fire hazards and prevention.
- Liaise with the NSW RFS to ensure all neighbouring residences obtain appropriate Hazard Reduction Certificates to undertake hazard reduction works to ensure fire does not escape from their properties.
- Ensure staff and/or contractor's machinery is in good working order to prevent potential ignition.
- Ensure Energy Australia inspect and maintain power lines as required to ensure there is no arching or exposed wires.
- Ensure prescribed burns are carried out by trained staff and within define weather prescriptions to prevent fire escape. Ensure thorough mop up of prescribed burns to prevent re-ignition.

4.7 Fire Suppression

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 creates a discontinuous 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 impede the passage of fire for both wildfire and hazard reduction burning. During wildfires, while offering some containment line potential, the outcrops may also 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.

Water supply hydrants are available along the surrounding public roads and water fill points for both fixed wing and helicopters is available in the local area (Pittwater estuary). Hydrants have not been installed within the Reserve. Other than a fixed Community Fire unit, no other supply of water for firefighting exists within the Reserve. Fire agencies do not need permission to use water supply hydrants and water fill points in the event of wildfire or for hazard reduction works. Fire agencies are also able to use any water source, including neighbouring swimming pools. The NSW RFS is the only agency allowed to enter private property to check for potential hazards.

In the event of a wildfire, properties upslope (12 – 38 The Circle and 1 – 4 The Pinnacle) could be affected by extreme heat and embers. However, due to the escarpment edge, radiant heat would not be an issue.

Fire suppression is; all actions undertaken to contain, manage and control fire, from the time it is detected until it has been extinguished (OEH, 2012).

Bush fire prevention strategies include;

Be prepared

- RFS to prepare a Community Protection Plan for Angophora Reserve detailing bush fire threat and protection options available to the community within 5 years.
- Council to provide interpretive signs within the reserve detailing the bush fire hazard, emergency contact information and clear direction for the evacuation of visitors to the reserve.
- NSW Fire and Rescue to maintain existing CFU equipment and consider installing an additional CFU on the southern perimeter.
- Ensure Defendable Space is maintained on an ongoing basis.
- Water hydrants suitable for the purpose of bush fire protection should be clearly marked. Sydney Water, in consultation with the RFS is to inspect and maintain hydrants once every 5 years.

Response

- Fire detection will generally be through notification from the public via 000. Maintain communication with NSW RFS and Fire and Rescue NSW to ensure adequate dispatch of resources in the event of a fire to minimise spread. Either firefighting authority may make the first response to a wildfire. The responding firefighting authority must inform Council (RFS, 2000).
- Initial attack is aimed at rapid suppression within 30 minutes of ignition of a wildlife, using ground attack. The use of ground crews in extreme/catastrophic conditions will be carefully considered. Firefighting personnel will not be placed in a situation that could endanger their lives or wellbeing (RFS, 2000).
- Council staff required to attend the Reserve when hazard reduction burns are underway, must be issued with approved firefighting personal protective equipment.
- Construction of containment lines should be avoided unless they can be constructed with minimal environmental impact. Containment lines must be stabilised and rehabilitated following a wildfire.
- Fire suppression chemicals such as surfactants and retardants must not be used due to the sensitive nature of the Reserve.
- Aerial water bombing should only be used in extreme wildfire cases. Where feasible fresh water should be used instead of saltwater (RFS, 2000).
- All occurrences of wildfire are to be mapped and intensity recorded in Councils fire history MapInfo layers and the NSW RFS Bush fire Risk Information Management System (BRIMS) to ensure future burns are not carried out within prescribed fire intervals.

Recovery

- Where necessary, prepare rehabilitation plans post fire to reduce significant impacts such as; sedimentation in creeklines, weed invasion, damage to infrastructure etc.

- The part of the Reserve recently impacted by fire must not be opened to the public until a formal risk assessment has been undertaken (OEH, 2012).
- Implement weed and feral animal programs to prevent invasion and degradation. Feral animals in particular rabbits, may impact regeneration of burnt areas by feeding on regenerating native species.

5. CONCLUSION, RECOMMENDATIONS, IMPLEMENTATION AND REVIEW

The implementation of hazard reduction activates in Angophora Reserve is highly constrained due to the presence of Endangered Ecological Communities, steep slopes (>18º), Aboriginal sites, and a high geotechnical hazard. Many hazard reduction activities on steep slopes are restricted under the *NSW Bush Fire Environmental Assessment Code 2006*. In addition, hazard reduction works will not be carried out in FEZs containing Littoral Rainforest vegetation except in areas immediately adjoining private property.

Defendable Space has been established where appropriate within the reserve; however greater emphasis needs to be given to active mitigation measures on adjoining private property.

The Map Based Plan summarises works required in each zone to achieve the bush fire management objectives of this Plan. Bush fire management activities are to be implemented in accordance with section 4. Priorities for hazard reduction burning are given in section 4.3.

Monitoring of each zone should be undertaken annually prior to hazard reduction contractors being appointed to undertaken hazard reduction works as part of the Warringah Pittwater Annual Hazard Reduction Program. An annual assessment of fuel levels should be undertaken in each zone using the Overall Fuel Hazard Assessment Guide 2010 (Hines *et al*. 2010). Defendable Space is to be inspected annually and treated as detailed in the Draft Pittwater Boundary Management Plan 2013. Fixed photo monitoring points should be established particularly in Defendable Space areas.

All occurrences of manual hazard reduction, hazard reduction burning and wildfire must be mapped in Pittwater Councils GIS systems as well as being reported in the NSW RFS Bush fire Risk Information Management System (BRIMS) (OEH, 2012). Recent fire history must be reviewed prior to undertaking hazard reduction burning in line with section 4.3.

Consider undertaking biodiversity monitoring. Due to the lack of resources and baseline data, analysis of vegetation and indicator species response to fire is often difficult. Consider establishing a long-term fire exclusion site within the Pittwater Spotted Gum Forest vegetation to monitor changes such as increased mesic species. A rapid flora and fauna assessment should be undertaken pre and post burn.

This Plan is to be reviewed and updated after 5 years. Minor variations in the management of each zone may occur when planning for annual work programs. Significant variations must be discussed with the NSW Rural Fire Service or Fire and Rescue NSW.

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Appendix 1 – Fire History and Ecological Changes

This chapter describes the bush fire history in Angophora Reserve and the ecological changes that occur with the presence and absence of fire.

Bush fire History

The fire regime in Angophora Reserve has changed with its isolation by urban development. In the 1920's and 1930's when there were few residents at Avalon, the area was subject to numerous wildfires (Pittwater, 2002). Their occurrence, especially the more severe fires, has declined with extensive urban development since the 1950's. As the adjacent bushland has been cleared, Angophora Reserve is now subject only to internal fires, not ones sweeping in from other areas. The reserve was last burnt by severe wildfire in the early 1940's, although there have been several minor wildfires since then (Pittwater, 2002). Anecdotal evidence suggests the last wildfire to occur in the Reserve was in approximately 1958.

The reserve is now subject to prescribed burning. This is the practice of burning an area in a controlled manner at the recommended fire intervals for a particular vegetation type, refer to Table 2. Prescribed burning is undertaken in autumn and winter to decrease fuel loads and reduce the incidence of any damaging spring or summer wildfires which are difficult to control. Recording of fire events in the past has been from rough records and anecdotal evidence. To effectively prescribe and manage fire it is necessary to record and map all fires occurring in the reserve. Figure 4 in section 3.1 shows known hazard reduction burns occurring between 1996 and 2013.

Ecological Effects of the Changes

As described in the Angophora Reserve Plan of Management 2002 (Pittwater, 2002)

In the prolonged absence of fire and under favourable conditions, rainforest plants tend to invade eucalypt forests and may form a dense understorey and midstorey. The eucalypt forest species may eventually be excluded from such sites because they are unable to regenerate under the dense canopy.

In Angophora Reserve there is evidence of increasing populations of fire-sensitive rainforest species of the lower slopes. Particular species involved are Cheese Tree *Glochidion ferdinandi*, Sweet Pittosporum *Pittosporum undulatum* and Cabbage-Tree Palm *Livistona australis*. If this trend continues the Spotted Gum Forest may eventually be degraded by inappropriate species. Because of the moist conditions on the lower slopes, these sites are burnt only by the hottest fires. They have probably not burnt since the big fire of the early 1940's, if then.

Expansion of mesophyllic species such as Cheese Tree, Sweet Pittosporum and Blueberry Ash is a general phenomenon in bushland reserves around Sydney and is also linked to increasing soil nutrient levels due to urban runoff. She-oaks *Allocasuarina spp*. also appear to be increasing in the reserve in the absence of major fires. In particular, large areas of Sydney Coastal Dry Sclerophyll Forests now have a dense understorey of black she-oak *A. littoralis*, whereas air photos from the 1940's and 1950's indicate a much more open understorey in these areas. At Ocean Grove, Victoria, Withers & Ashton (1977) and Withers (1978 a, b, 1979) have described how a eucalypt woodland which had remained unburnt for over 90 years was in the process of being replaced by a dense scrub of Black She-oak. A similar transition seems to be occurring at Avalon. Although Black She-oaks are killed by major fires, few are killed in less intense fires, such as prescribed burns. She-oaks are an integral part of

the natural floristic of this reserve. They provide a significant food source for the endangered Glossy Black-cockatoo.

General reviews of fire ecology in Australia are provided by Gill *et al.* (1981) and Ealey (1984). Hawkesbury Sandstone vegetation has been comparatively well studied, both at a community level (Siddiqi et al. 1976, Benson 1985; Nieuwenhuis 1987; Clark 1988) and by detailed studies of individual species (Bradstock & Myerscough 1981; Bradstock & O'Connell 1988, Auld 1986a, b, 1987, Zammit & Westoby 1987a, b, 1988 Zammit 1988). These studies indicate that the optimal fire regime to maintain plant species diversity in Sydney Coastal Dry Sclerophyll Forests involves moderate to high intensity fires in summer or autumn at intervals of 7 to 30 years.

Comparable information is lacking for the Southern Lowlands Wet Sclerophyll Forests (or Pittwater Spotted Gum Forest EEC) of the lower slopes. However, the moister conditions including natural drainage lines indicate a rather longer period between fires, since only the hottest fires are likely to penetrate. The cabbage-tree palm stands, like other rainforest types, occur in infrequently burnt sites.

Fires in remnant bushland, whether they are wildfires, hazard reduction burns or ecological burns, can cause significant mortality amongst fauna, including threatened species. From the point of view of fauna conservation, individual fires occurring in the reserve should be limited in extent. Large area burns are to be replaced with mosaic area burns and manual works. Even low intensity fires, may render the burnt area uninhabitable for particular fauna species during the post-fire period, by reducing food resources and shelter sites, until regeneration occurs. The loss of cover may also make the animals more vulnerable to predation (Smith and Smith, 2000). Mosaic burning with varying fire frequency and intensity should be planned to ensure different age communities of the same vegetation type.

Fire Hazard in the Reserve

As part of the development of the Angophora Reserve Plan of Management 2002, the long-term fire hazard in the reserve was assessed using methods from the Department of Environment and Planning's Circular No. 74 (1984), which was superseded by Circular C10 - *Planning in Fire Prone Areas* in 2001. Both of which have now been superseded by the NSW RFS *Planning for Bush Fire Protection 2006* document. It was determined that the hazard is low on the downslope side of the Southern Lowlands Wet Sclerophyll Forests (or Pittwater Spotted Gum Forest EEC) and Littoral Rainforest EEC vegetation. However, because of the steep topography, even allowing for the small size of the reserve, the potential fire hazard increases to high upslope on the Sydney Coastal Dry Sclerophyll Forest vegetation. The bush fire hazard is further investigated in section 3.4.

As described in the Angophora Reserve Plan of Management 2002, to reduce the hazard around the upper rim of the reserve it is desirable to have a fire protection zone up to 40 metres wide where fuel loads are maintained at low levels - preferably below 5 tonnes per hectares (Luke 1982). However it has been determined, with guidance from the Warringah Pittwater Rural Fire Service, that an Asset Protection Zone to this extent is not required. The existing Defendable Space areas as identified on the Map Based Plan are considered appropriate to enable safe use of suppression strategies in the event of a bush fire. Defendable Space areas adjoining houses along Wandeen Avenue and Bilwara Avenue would probably require prescribed burns at intervals of about seven years, depending on the rate of fuel accumulation, refer to Map Based Plan. An alternative but more costly and difficult method is manual hand clearing.

Ecological Effects of Hazard Reduction

Frequent burns at intervals of about five years within the same location will eliminate some native species from the burnt areas. While adult plants of some species are able to survive fire and re-sprout, other species are readily killed by fire, even at low intensities, and must rely on regeneration from seed. More frequent fires will not allow obligate-seeders to set seed therefore eliminating or severely reducing their populations, this also allows the expansion of re-sprouting species leading to a reduction in biodiversity. The various studies quoted above indicate that a fire-free interval of at least ten years is required to prevent loss of plant species from Sydney Coastal Dry Sclerophyll Forests (or Hawkesbury Sandstone Exposed Bloodwood Woodland).

In the absence of fire, Littoral Rainforest establishes over a period of a few decades, however this vegetation could be eliminated in a single fire event. Mature Littoral Rainforest stands are not very flammable, however where Littoral Rainforest is expanding into adjacent sclerophyll forest, there tends to be highly flammable ground cover such as Bracken fern. Littoral Rainforest vegetation cannot remain under even an occasional fire regime, full fire exclusion is necessary to retain this community within the Reserve (Eurobodalla).

Weeds certainly increase in numbers after an area is burnt, especially on the edges of a reserve where there is likely to be a large supply of weed seeds in the soil (Pittwater, 2002). Increasing soil nutrient levels due to urban runoff are also a major factor promoting weed invasion in the reserve, as well as vegetation dumping and bird seed spread. Little information is available on the ecological effects of hazard reduction by hand clearing. Like prescribed burning it is a form of disturbance likely to favour some plant species, including some weed species, at the expense of others. Hand clearing if carried out carefully, may have less impact on vulnerable native species than burning, but the extra time and money involved has to be weighed against both ecological and hazard reduction benefits.

Fire management has previously concentrated on the protection of land and property on the surrounding residences. In the future, fire management will also aim to conserve biodiversity through hazard reduction burning, as well as protect land and property from the dangers of wildfire.

Table 2 in section 3.1 provides intervals and thresholds for the vegetation communities occurring in Angophora Reserve. The minimum fire interval for each community is taken from the *NSW Bush Fire Environmental Assessment Code 2006*. The minimum and maximum threshold are not optimal fire intervals, but minimum and maximum measures, above or below which a loss of biodiversity can be expected (deLacey *et al*. 2012).

Appendix 2 – Recommended Burn Year (based on Fire Interval and Fire History)

FMZ	No	Last burnt	Veg Type	Interval (Years)	Burn Permitted From
SFAZ	1	2004	- Dry Sclerophyll Forests - Pittwater Spotted Gum Forest EEC (Moist)	7 10	2011+ 2014+
	2	2004	- Dry Sclerophyll Forests - Pittwater Spotted Gum Forest ECC (Dry)	7 7	2011+ 2011+
	3	1996	- Pittwater Spotted Gum Forest EEC (Moist)	10	Any
	4	No burn history*	- Pittwater Spotted Gum Forest EEC (Moist) - Pittwater Spotted Gum Forest ECC (Dry)	10 7	Any Any
	5	2004	- Dry Sclerophyll Forests - Pittwater Spotted Gum Forest EEC (Moist) - Pittwater Spotted Gum Forest ECC (Dry)	7 10 7	2011+ 2014+ 2011+
	6	1998 / 2010	- Dry Sclerophyll Forests - Pittwater Spotted Gum Forest EEC (Moist) - Coastal Heath Swamp	7 10 7	2017+ 2020+ 2017+
	7	2010	- Dry Sclerophyll Forests - Altered/Managed Vegetation	7 N/a	2017+ N/a
	8	2010	- Dry Sclerophyll Forests	7	2017+
	9	No burn history*	- Pittwater Spotted Gum Forest EEC (Moist)	10	Any
	10	No burn history*	- Dry Sclerophyll Forests - Pittwater Spotted Gum Forest EEC (Moist)	7 10	Any Any
	11	No burn history*	- Dry Sclerophyll Forests - Pittwater Spotted Gum Forest EEC (Moist)	7 10	Any Any
FEZ	1	No burn history*	- Littoral Rainforest	Exclude fire	
	2	No burn history*	- Littoral Rainforest - Pittwater Spotted Gum Forest EEC (Moist)	Exclude fire 10	 Any

*****possibly burnt by wildfire 1950s

Appendix 3 – Fauna Species List

Fauna species recorded or expected to occur in Angophora Reserve

SPECIES	COMMON NAME	LOCALLY SIGNIFICANT	REGIONALLY SIGNIFICANT	THREATENED IN NSW	THREATENED NATIONALLY
Mammals					
Perameles nasuta	Long-nosed Bandicoot		X		
Petaurus norfolcensis	Squirrel Glider			V	
Petaurus norfolcensis	Squirrel Glider (Endangered Population)			E	
Pseudocheirus peregrinus	Common Ringtail Possum				
Trichosaurus vulpecula	Common Brushtail Possum				
Bats					
Chalinolobus dwyerii	Large-eared Pied Bat			V	
Chalinolobus gouldii	Gould's Wattled Bat				
Miniopterus australis	Little Bent-wing Bat			V	
Miniopterus schreibersii	Eastern Bent-wing Bat			V	
Nyctinomus australis	White-striped Freetail Bat	X			
Pteropus poliocephalus	Grey-headed Flying Fox			V	V
Reptiles					
Ctenotus taeniolatus	Copper-tailed Skink				
Lampropholis delicata	Dark-flecked Garden Sunskink				
Lampropholis guichenoti	Pale-flecked Garden Sunskink				
Saproscincus mustelinus	Weasel Skink				
Tiliqua scincoides	Common Bluetongue Lizard				
Frogs					
Crinia signifera	Common Eastern Froglet				

SPECIES	COMMON NAME	LOCALLY SIGNIFICANT	REGIONALLY SIGNIFICANT	THREATENED IN NSW	THREATENED NATIONALLY
Limnodynastes peronii	Brown-striped Frog				
Litoria peronii	Peron's Tree Frog				
Birds					
Alectura lathamii	Australian Brush Turkey				
Anas superciliosa	Pacific Black Duck				
Alisterus scapularis	Australian King Parrot				
Cacatua sanguinea	Little Corella				
Cacatua galerita	Sulphur-crested Cockatoo				
Calyptorhynchus funereus	Yellow-tailed Black-Cockatoo				
Eolophus roseicapillus	Galah				
Platycercus elegans	Crimson Rosella				
Platycercus adscitus eximius	Eastern Rosella				
Glossopsitta concinna	Musk Lorikeet	X			
Trichoglossus haematodus	Rainbow Lorikeet				
Trichoglossus chlorolepidotus	Scaly-breasted Lorikeet				
Dacelo novaeguineae	Laughing Kookaburra				
Eurystomus orientalis	Dollarbird				
Eudynamys orientalis	Pacific Koel				
Centropus phasianinus	Pheasant Coucal	X	X		
Menura novaehollandiae	Superb Lyrebird	X	X		
Ninox boobook	Southern Boobook	X	X		
Acanthiza pusilla	Brown Thornbill				
Lichenostomus chrysops	Yellow-faced Honeyeater				

SPECIES	COMMON NAME	LOCALLY SIGNIFICANT	REGIONALLY SIGNIFICANT	THREATENED IN NSW	THREATENED NATIONALLY
Malurus cyaneus	Superb Fairy-Wren	X			
Malurus lamberti	Variegated Fairy-Wren	X			
Manorina melanocephala	Noisy Miner				
Melithreptus lunatus	White-naped Honeyeater				
Pachycephala pectoralis	Golden Whistler				
Pardalotus punctatus	Spotted Pardalote				
Pardalotus striatus	Striated Pardalote				
Philimon corniculatus	Noisy Friarbird				
Psophodes olivaceus	Eastern Whipbird				
Sericornus frontalis	White-browed Scrubwren				
Acanthorhynchus tenuirostris	Eastern Spinebill				
Anthochaera chrysoptera	Little Wattlebird				
Anthochaera carunculata	Red Wattlebird				
Coracina novaehollandiae	Black-faced Cuckoo-shrike				
Corvus coronoides	Australian Raven				
Cracticus torquatis	Grey Butcherbird				
Gymnorhina tibicen	Australian Magpie				
Strepera graculina	Pied Currawong				
Streptopelia chinensis	Spotted Turtle Dove				
Dicaeum hirundinaceam	Mistletoebird				
Hirundo neoxena	Welcome Swallow				
Monarcha melanopsis	Black-faced Monarch	X			
Rhipidura albiscapa	Grey Fantail				

SPECIES	COMMON NAME	LOCALLY SIGNIFICANT	REGIONALLY SIGNIFICANT	THREATENED IN NSW	THREATENED NATIONALLY
Zosterops lateralis	Silvereye				

Legend:
V = Vulnerable, E = Endangered

Appendix 4 – Threatened Species and Endangered Ecological Communities Fire Ecology

Threatened Fauna Fire Ecology	
Species	**Fire Ecology**
Ninox connivens **Barking Owl** *(Vulnerable)*	• Protection of known nesting sites required in late winter – early spring breeding season. • Avoid med-high intensity fire during nesting season and over large areas that reduce forage habitat.
Burhinus grallarius **Bush Stone-curlew** *(Endangered)*	• Slashing in winter, but no trittering or tree removal • No burning from 1 August to 31 March, and no more than once every 2 years. • Retain logs on ground.
Miniopterus schreibersii oceanensis **Eastern Bentwing-bat** *(Vulnerable)*	• Avoid fire in the near vicinity of roost within known/potential habitat where possible, especially during the breeding season (spring and summer). • Maintain a mosaic of age classes within known/potential foraging habitat. • Avoid damaging roost caves/structures.
Mormopterus norfolkensis **Eastern Freetail-bat** *(Vulnerable)*	• No slashing, trittering or tree removal.
Calyptorhynchus lathami **Glossy Black-Cockatoo** *(Vulnerable)*	• Feeds exclusively on *Allocasuarina* and *Casuarina sp*., so maintain diversity of age structure of these species. • Avoid med-high intensity fire with a recurrent frequency of <15 years. • Avoid large scale fires that reduce forage habitat.
Pteropus poliocephalus **Grey-headed Flying Fox** *(Vulnerable)*	• Avoid fire in the vicinity of roosts within known/potential habitat where possible, especially during the breeding season (March to October). • Maintain a mosaic of age classes within known/potential foraging habitat. • Avoid slashing, tittering or tree removal within known habitat.
Phascolarctos cinereus **Koala** *(Vulnerable)*	• Historical records only. • For prescribed burns: avoid medium to high intensity fires in areas of known colonies or low open forests with known forage tree species.
Chalinolobus dwyeri **Large-eared Pied Bat** *(Vulnerable)*	• Avoid fire in the near vicinity of roost within known/potential habitat where possible, especially during the breeding season (Spring and Summer). • Maintain a mosaic of age classes within known/potential foraging habitat. • Avoid damaging roost caves/structures.
Miniopterus australis **Little Bent-wing Bat** *(Vulnerable)*	• Avoid fire in the near vicinity of roost within known/potential habitat where possible, especially during the breeding season (December). • Maintain a mosaic of age classes within known/potential foraging habitat. • Avoid damaging roost caves/structures.
Glossopsitta pusilla **Little Lorikeet** *(Vulnerable)*	• Avoid burning in known locations during breeding (May to September). Protect potential nesting trees with small hollows from fire damage.

	• Avoid med-high intensity fire during nesting season and over large areas that reduce forage habitat.
Ninox strenua **Powerful Owl** *(Vulnerable)*	• Apply low-intensity, mosaic pattern fuel reduction regimes. • Avoid fires in woodland and forests and, protect potential habitat trees from fire damage. • Large home range suggests the species will be minimally impacted by inappropriate regimes affecting small areas, but the survival of this species relies on the survival of its prey which is primarily smaller, arboreal species that are more sensitive to inappropriate fire regimes. • Frequent fires can reduce prey numbers and frequent low intensity burns can reduce prey habitat quality.
Dasyurus maculates **Spotted-tailed Quoll** *(Vulnerable)*	• In known locations avoid high intensity fires over large area. • Autumn burns are preferred timing to avoid breeding season. • During mop-up avoid felling potential den trees.
Petaurus norfolcensis **Squirrel Glider (endangered ecological population in Pittwater)** *(Vulnerable)*	• Found in dry forests and woodlands with tree hollows and winter flowering trees. • Low intensity fires. • Avoid felling trees with hollows in known/potential locations.
Ptilinopus superbus **Superb Fruit-Dove** *(Vulnerable)*	• Found in Rainforest or Rainforest margins. • Avoid burning in known locations during breeding. • Unlikely to be affected by low intensity fires due to habitat preference.

*All species recorded within 3km of study area
Reference: BioNet – Atlas of NSW Wildlife Website (OEH, 2013), Pittwater Native Fauna Management Plan (Pittwater, 2011), Bilgola Newport Escarpment Bush Fire Management Plan (EcoLogical, 2008).

Threatened Flora Fire Ecology	
Species	**Fire Ecology**
Syzygium paniculatum **Magenta Lilly Pilly** (Vulnerable)	• Avoid Fire. • Avoid the use of rainforest margins as control lines for prescribed burns and suppression activities. • Found in sheltered gullies, closed forest and rainforest.
Genoplesium baueri **Bauer's Midge Orchid** (Vulnerable)	• Grows in sparse sclerophyll forest and moss gardens over sandstone. • Fire ecology is unknown.
Eucalyptus nicholii **Narrow-leaved Black Peppermint** (Vulnerable)	• Not native to this area. Planted trees only. • No fire more than once every 10 years. • No slashing, trittering or tree removal.
Chamaesyce psammogeton **Sand Spurge** (Endangered)	• Not present in Angophora Reserve. Found on foredunes and exposed sites on headlands. • Exclude fire from known locations.
Arthrochilus prolixus **Elbow Orchid** (ROTAP)	• Grows in dry sclerophyll forest. • Fire ecology is unknown. • Avoid disturbance to known locations. Surrounding vegetation is to be removed by hand to minimise the risk of damage to this species by fire.

*All species recorded within 3km of the study area
Reference: NSW RFS Bush Fire Environmental Assessment Code (RFS, 2006b), BioNet – Atlas of NSW Wildlife Website (OEH, 2013), Pittwater Native Vegetation Management Plan (Pittwater, 2009), Bilgola Newport Escarpment Bush Fire Management Plan (EcoLogical, 2008).

Endangered Ecological Communities Fire Ecology	
Community	**Fire Ecology**
Pittwater Spotted Gum Forest	• Long-term exclusion of fire may reduce understorey species diversity and recruitment of tree species. • Fire thresholds to be within threshold for Wet Sclerophyll Forests. • Minimum fire interval of 25 years should apply to reduce sapling mortality. • Avoid burning more than 30% of any patch at one time and avoid burning 100% of patches within 10 years. • Medium intensity prescribed burns should be implemented to maximise recruitment of flora species.
Littoral Rainforest	• No fire • No slashing, trittering or tree removal
Coastal Upland Swamp	• Several different fire regimes threaten species diversity of this community including substrate fires, recurring short or long interval fires. Substrate fires can result in the mortality of the soil seed bank. High frequency fires may result in populations decline whereas medium to long fire intervals promote dense growth of competitive dominants. • Fire thresholds to be within threshold for Freshwater Wetlands • Minimum fire interval of 6 and maximum 35 years should be applied.

Reference: NSW RFS Bush Fire Environmental Assessment Code (RFS, 2006b), Warringah Pittwater Bush Fire Management Plan (RFS, 2008), Pittwater Native Vegetation Management Plan (Pittwater, 2008), Bilgola Newport Escarpment Bush Fire Management Plan (EcoLogicaL, 2008), NSW Scientific Committee Final Determinations (Scientific Committee, 1999, 2004 & 2012).

Appendix 5 – Aboriginal Cultural Heritage – Site Management Guidelines

Aboriginal Cultural Heritage	
Type	**Site Management Guidelines**
Rock shelters with archaeological deposit (SITT-039) In rock outcrops such as sandstone, overhangs sometimes form creating useable shelters. Sediments from fires, roof fall, discarded stone tools and food remains form a deposit protected within the shelter (AHO, 2008). A midden is a deposit composed of the remains of edible shellfish and also usually contains fish and animal bones, stone tools and campfire charcoal (AHO,2008)	• A fire exclusion zone for hazard reduction burns of at least 20 metres along the low side of all escarpment edges is required. • Fuel should be reduced manually within the fire exclusion zone, targeting exotic and flammable species in the first instance to reduce wildlife intensity. • Avoid sandstone outcrops (overhangs and flat/level areas over approximately 1m in size). • Avoid the use of machinery directly on sandstone. • If burning, loose leaf litter must be carefully removed from rock platforms and from the top of overhangs. • If burning, rake loose leaf litter away from vegetation in the vicinity of the site if smoke is likely to impact upon rock paintings. • No use of chemicals or other retardants within 20 metres of art sites. If windy, the distance is to be extended to 50 metres. • Vegetation which is screening the site must not be damaged. • Noxious and environmental weeds are to be controlled in accordance with 5.15 of the NSW Bush Fire Environmental Assessment Code 2006. • Walking within the vicinity of known sites should be avoided. • Hoses and other fire suppression equipment must not be dragged across known/potential Aboriginal sites. • Bush regenerators are not to store weeds to dry in caves or overhangs. • Bush regeneration and fire suppression equipment is not to be stored on sandstone platforms or within caves/overhangs that may contain Aboriginal Heritage items e.g. rock engravings, paintings etc.
Shelter with Art (SITT – 040) Aboriginal paintings are found on the ceilings and walls of rock shelters, which occur wherever suitable rock surfaces and outcrops exist. Figures include humans, kangaroos, emus, echidnas, grid patterns, animal tracks, boomerangs, axes, hand stencils and other motifs. Paintings are drawn with white, red, yellow and black pigments and charcoal drawings are also common (AHO,2008)	
Other Potential Aboriginal Heritage	• There is potential for unrecorded sites to occur within Angophora Reserve. Intense fire should be avoided around all overhangs, particularly near known rock art sites as smoke and heat can damage art (AHO, 2008) • Educating staff, contractors, bush care volunteers, and the public about the identification of sites and the landscapes in which they generally occur, as well as how to proceed should a site be discovered, is essential (AHO,2008)

Reference: NSW RFS Bush Fire Environmental Assessment Code (RFS, 2006b), Pittwater Aboriginal Site Management Report (AHO, 2008), Draft Pittwater Council Aboriginal Site Management Report – Part 5 Planning and Assessment (AHO, 2012). Communication with Phil Hunt, Archaeologist, Aboriginal Heritage Office September 2013.

Appendix 6 – Due Diligence Aboriginal Heritage Assessment

Under current legislation the Office of Environment and Heritage has put out guidelines (Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW, 2010) for carrying out work that may impact Aboriginal heritage. The due diligence process provides a step by step checklist to ensure Aboriginal heritage is protected. It also provides a mechanism to determine whether an Aboriginal Heritage Impact Permit (AHIP) is required from OEH (formerly DECCW) to carry out the works and a defence from prosecution if a site is impacted. Following this process, the AHO considers that an AHIP is not required if the above steps are taken:

1. Will the activity disturb the ground surface or any culturally modified trees?
There are no recorded modified trees in the reserve. Provided works will not affect archaeological deposit of the shelters or shelter ceilings, walls and structures, no AHIP is required.

2. Are there any: a) relevant confirmed site records or other associated landscape feature information on AHIMS?
Yes. There are two sites registered. Provided works will not affect archaeological deposit of the shelters or shelter ceilings, walls and structures, no AHIP is required.

3. Can harm to Aboriginal objects listed on AHIMS or identified by other sources of information and/or can the carrying out of the activity at the relevant landscape features be avoided?
Yes. Provided works will not affect archaeological deposit of the shelters or shelter ceilings, walls and structures, no AHIP is required.

4. Does a desktop assessment and visual inspection confirm that there are Aboriginal objects or that they are likely?
Yes. Sites are present and registered. Provided works will not affect archaeological deposit of the shelters or shelter ceilings, walls and structures, no AHIP is required.

5. Further investigation and impact assessment.
The AHO has inspected the rock shelters in question and considers that bush fire management conducted in accordance with basic cautionary procedures can ensure no harm can be inflicted on the sites. Provided works will not affect archaeological deposit of the shelters or shelter ceilings, walls and structures, no AHIP is required.

“If you have followed this code and at any point have reasonably decided that an AHIP application is not necessary either because Aboriginal objects are not present or, if they are present, harm to those objects can be avoided, you can proceed with caution”. (DECCW, 2010: 13).