1 INTRODUCTION

1.1 PROJECT AIMS

The Central Branch Parks and Wildlife Division (PWD) of the NSW Department of Environment and Conservation (DEC, formerly NSW National Parks and Wildlife Service (NPWS)) has established a biodiversity survey priorities (BSP) program for DEC managed estate within the Branch. This program recognises that information which documents the biodiversity values held within reserves is fundamental to successful reserve management and to generating an improved understanding of the contribution reserves make to the protection of vegetation communities, plant and animal populations and their habitats. Currently there is only sparse and incomplete information that describes the role reserves play in ensuring the viability of fauna species across large regions and local areas.

Typically the largest reserves, which potentially offer a significant contribution to biodiversity conservation, are the most poorly understood and the most deficient in data quality and quantity. The BSP program goes some way towards addressing this information shortfall by surveying the most poorly known reserves first and combining this work with larger regional conservation assessment projects.

Currently the Hunter region is the focus of considerable biodiversity assessment and environmental planning investigation. In terms of human population it represents one of the fastest growing regions in the state and extreme pressures are being placed on many of the habitats. Knowledge of the values of the large sandstone reserves that fringe the southern Hunter and Goulburn Valleys is fundamental to understanding the conservation priorities for many species. In 2003, the northern half of Wollemi National Park was recognised as having low levels of information on its fauna values and was identified as a priority for wildlife survey (NPWS 2003a). The north-eastern section of Wollemi National Park (Hunter Range Area) was the subject of study in 2004-05, following which a report on *The Vertebrate Fauna of North-eastern Wollemi National Park* was produced (DEC 2005a). North-western Wollemi National Park (Mudgee Area) was the next priority, and the focus of study in 2005-06. The specific objectives of the 2005-06 project are to:

- Document, review and collate pre-existing data on terrestrial vertebrate fauna.
- Carry out systematic field sampling of all terrestrial vertebrate fauna groups to establish baseline data for future conservation assessment and monitoring works.
- Identify and profile threatened fauna species and other regionally significant fauna that are known or likely to occur.
- Identify broad-scale patterns in fauna occurrence and habitat use across the study area and identify habitats of particular conservation significance.

The 2005-06 program and report are designed to accompany DEC (2005a) and together provide comprehensive information on vertebrate fauna across the entire northern half of the National Park.

1.2 BACKGROUND

Wollemi National Park comprises an area of approximately 488 620 hectares, making it the second largest national park in the state (NPWS 2001a). The area examined herein (the study area) is confined to the north-west of the park, within the Central Branch's Mudgee Area. This is roughly the area that is north of the Capertee River and west of Mount Monundilla. The study area encompasses approximately 184 210 hectares, just under 40 percent of Wollemi National Park. This area is located approximately twenty kilometres east of Rylstone and 100 kilometres north-west of the Sydney metropolitan area (Map 1).

The northern half of the study area, north of the Hunter Range, drains into the Goulburn River and eventually the Hunter River, incorporating the catchment of Widden Brook and the eastern half of the Bylong River catchment. A small section in the central west of the study area, just east of Olinda, drains west into the Cudgegong River, and eventually to the Macquarie River. The southern half of the study area drains via Wollemi Creek and the Capertee River to the Colo River and on to the Hawkesbury River.

The northern boundary of the study area is deeply indented and follows the southern escarpment of the Hunter Valley. Private lands border the park on the valley floors, which are primarily used for cattle grazing, agriculture and horse studs. Goulburn River National Park abuts the study area at its north-western corner, but is separated along the north-eastern boundary by farming lands on both sides of the Goulburn River. The study area is bound to the east and south by the remainder of

Wollemi National Park. Coricudgy and Nullo Mountain State Forests lie adjacent to the central western part of the study area, while the remainder of the western boundary is largely marked by the commencement of the open grazing lands of the central western slopes of NSW. Crown lands and private lands adjoin the western boundary of the park (Map 1).

Wollemi National Park forms part of the Greater Blue Mountains World Heritage Area, which was inscribed on the World Heritage List in November 2000. Sections of the park also form part of the Wollemi Wilderness Area, which was declared in March 1999. The eastern half of the study area, roughly south and east of Emu Creek, is part of this Wilderness Area. Areas of the national park that are declared as wilderness are managed in accordance with the Wilderness Act 1987, which involves the closure and rehabilitation of vehicular access routes, and cessation of maintenance of walking tracks and routes.

Two small additions were made to Wollemi National Park in February 2007, after completion of the BSP project. These additions are still marked as inholdings in the maps located herein, and are located around Kerry Mountain and Mount Coriaday, north of Mount Coricudgy.

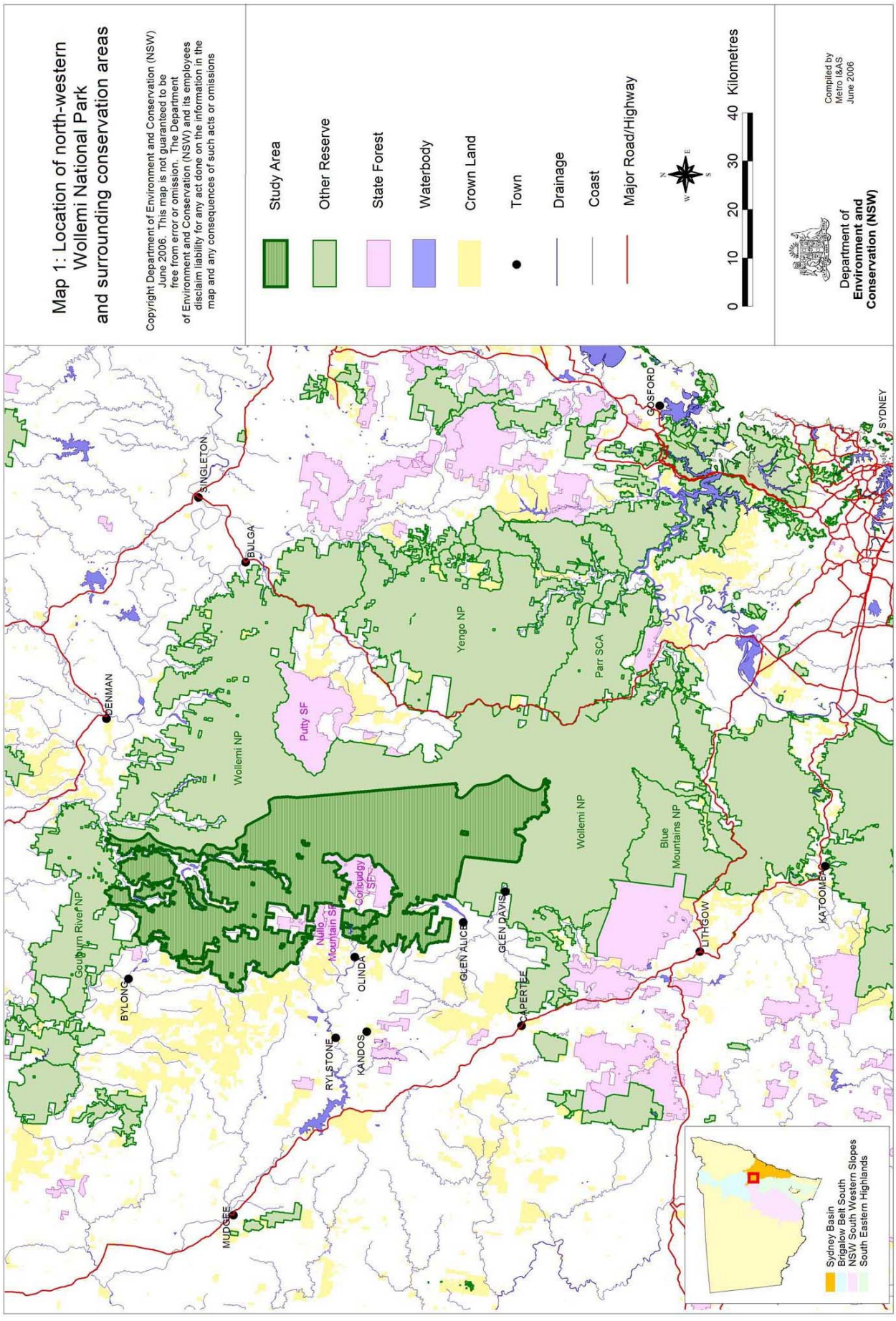
1.3 ENVIRONMENT

1.3.1 Biogeography

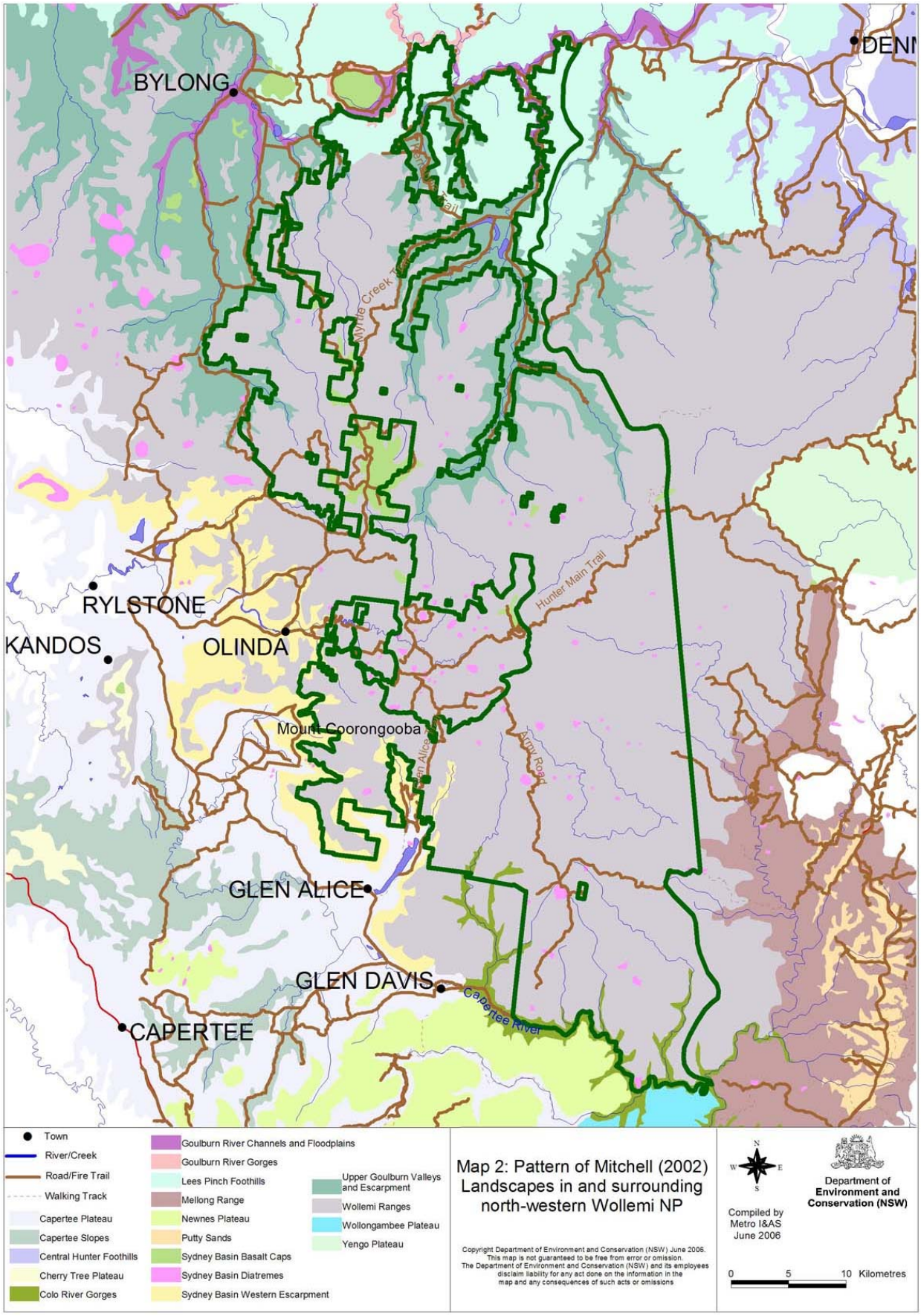
The study area lies near the north-western edge of a distinct environmental region known as the Sydney Basin Bioregion (Thackway & Cresswell 1995). This Bioregion extends from just north of Batemans Bay to Nelson Bay on the central coast, and almost as far west as Mudgee (inset Map 1). The Bioregion is characterised by a temperate climate with warm summers and no dry season (NPWS 2003b). This Bioregion has been broken down into Subregions by Morgan (2001) and further into Landscapes by Mitchell (2002). There are three Subregions located partly within the study area. The Kerrabee Subregion encompasses the northern third of the study area and is characterised by finely dissected sandstone plateaux, with Permian shale outcropping in broad gently undulating valleys (Morgan 2001). The Wollemi Subregion encompasses the large majority of Wollemi National Park and is characterised by dissected Triassic sandstone plateaux with benched rock outcrops, and numerous small basalt caps (NPWS 2003b). The Capertee Subregion includes a small part of the south-western corner of the study area, south and west of Tayan Peak. It is characterised by low hilly landscapes of Permian shales and siltstones, and areas of Triassic sandstone or Tertiary basalt capping hills (Morgan 2001). Table 1 provides a list of the Mitchell Landscapes that are present in a significant amount within the study area, while Map 2 shows where each occurs. Three additional Mitchell Landscapes, the 'Capertee Plateau', 'Goulburn River Gorges' and 'Wollongambe Plateau' occupy too small a portion of the study area to warrant inclusion in discussion. For a detailed description of the Landscapes see Mitchell (2002).

Landscape name	Percentage of study area occupied by the Landscape	Location within the study area and major characteristics
Lees Pinch Foothills	7.5	Hills and upper slopes along the northern fifth of the reserve. Narrabeen sandstone with low rainfall.
Goulburn River Channels and Floodplains	0.2	Floodplains of lower Widden Valley and Goulburn Valley. At the extreme northern boundary of the reserve. Alluvial.
Upper Goulburn Valleys and Escarpment	8.2	Lower slopes and valleys along the northern boundary. Includes the lower valleys of Widden Brook, Blackwater Creek, Emu Creek, Myrtle Creek, Kerrabee Creek, Bylong River, Lee Creek and their major tributaries. Permian-derived soils with sandstone talus.
Wollemi Ranges	80.2	Large majority of the study area. Encompasses the dissected Narrabeen sandstone plateaux. Narrabeen and a small amount of Hawkesbury Sandstone.
Sydney Basin Basalt Caps	0.5	Basalt caps in the northern half of the reserve including Nullo Mountain, Kerry Mountain, Mount Monundilla and the private properties 'Gowrie Hut' and 'Box Ridges'.
Sydney Basin Diatremes	0.7	Remnant volcanic features scattered throughout the 'Wollemi Ranges' Landscape. Well known diatremes include Box Hole Clearing and that west of Gospers Mountain.
Sydney Basin Western Escarpment	1.5	Forms the south-western boundary of the study area along the edges of the Capertee and Cudgegong River Valleys.
Colo River Gorges	1.2	Finger-like intrusions protruding into the far south of the study area along Coorongooba, Gospers and Girribung Creeks.

Table 1: Summary of Landscapes within north-western Wollemi National Park based on Mitchell (2002)



Map 1: Location of study area and surrounding conservation areas



Map 2: Pattern of Mitchell (2002) Landscapes in and surrounding north-western Wollemi National Park

Situated close to the north-western edge of the Sydney Basin, the study area shares some climatic and topographic features with adjacent Bioregions, including the Brigalow Belt South, the NSW South Western Slopes and the South-eastern Highlands (inset Map 1). These influences lead to a rather unique mix of environments. Wollemi National Park lies between Goulburn River, Gardens of Stone, Yengo and Blue Mountains National Parks, a system of reserves which protects the sandstone-based links between the Sydney, Hunter and Central West regions of New South Wales.

1.3.2 Geology and geomorphology

Wollemi National Park is based on four strata of sedimentary rock listed here from oldest to youngest: the Permian coal measures; the Narrabeen and Hawkesbury sandstones and shales; and the Wianamatta shales (NPWS 1997a). These rock strata tilt upward to the north-west (NPWS 1997a). Erosion activity has weathered away most of the Wianamatta and Hawkesbury series, exposing the Narrabeen group (NPWS 1997a). Weathering of the sandstones and claystones of this group has given the park its characteristic dissected landscape, dominated by many deep valleys, cliffs and narrow gorges. The majority of land within the study area contains rugged hills with rounded summits, irregularly benched slopes often littered with boulders and frequent sandstone outcrops, and narrow valleys (Story *et al.* 1963). Soils formed from the Narrabeen sandstones are generally very shallow, characterised by low nutrient levels, particularly of phosphorous (NPWS 1997a). Deep sand flats occur along the Upper Cudgegong River and associated tributaries, while sandy alluvium occurs along wider valley floors in the north of the study area. Hawkesbury sandstone outcrops in the far south of the study area, along the Wollemi and Wirraba Ranges and south-east of Gospers Mountain.

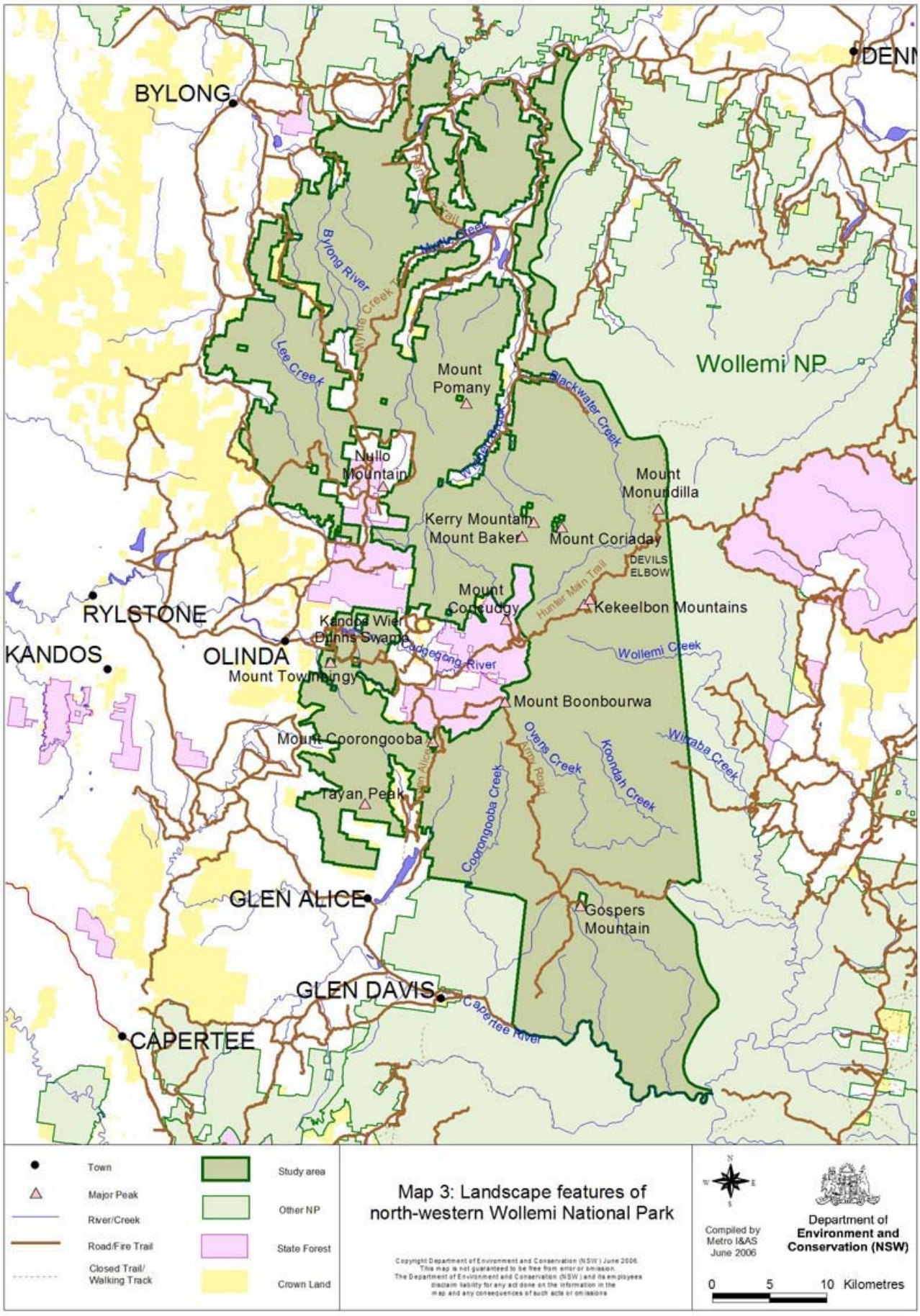
The Permian coal measures outcrop as steep slopes along the northern perimeter of the study area, visible beneath the clifflines that run along the large river valleys. The slopes are often littered with sandstone rubble and boulders, known as talus, that have fallen from the cliffs above. This stratum weathers to form moderately fertile clay loams (NPWS 1997a), with fragments of sandstone or shale (Story *et al.* 1963).

Tertiary basalt caps are a feature of the region, occurring as readily distinguishable landmarks, the most significant being Nullo Mountain and Mount Coricudgy, just to the west of the study area. Basalt caps occurring within the study area include Kerry Mountain, Mount Coriaday, Mount Baker, Mount Towinhingy, Gospers Mountain, Mount Pomany, Mount Boonbourwa, Mount Coorongooba and the Kekeelbon Mountains, amongst others (Map 3). Tayan Peak is a symmetrical cone rising 180 metres above the sandstone plateau, with a volcanic crater on its northern side (Mosley 1989). It is a unique landscape feature in the study area and has been identified as a significant geological site in NSW (Schon 1984 in NPWS 2001a).

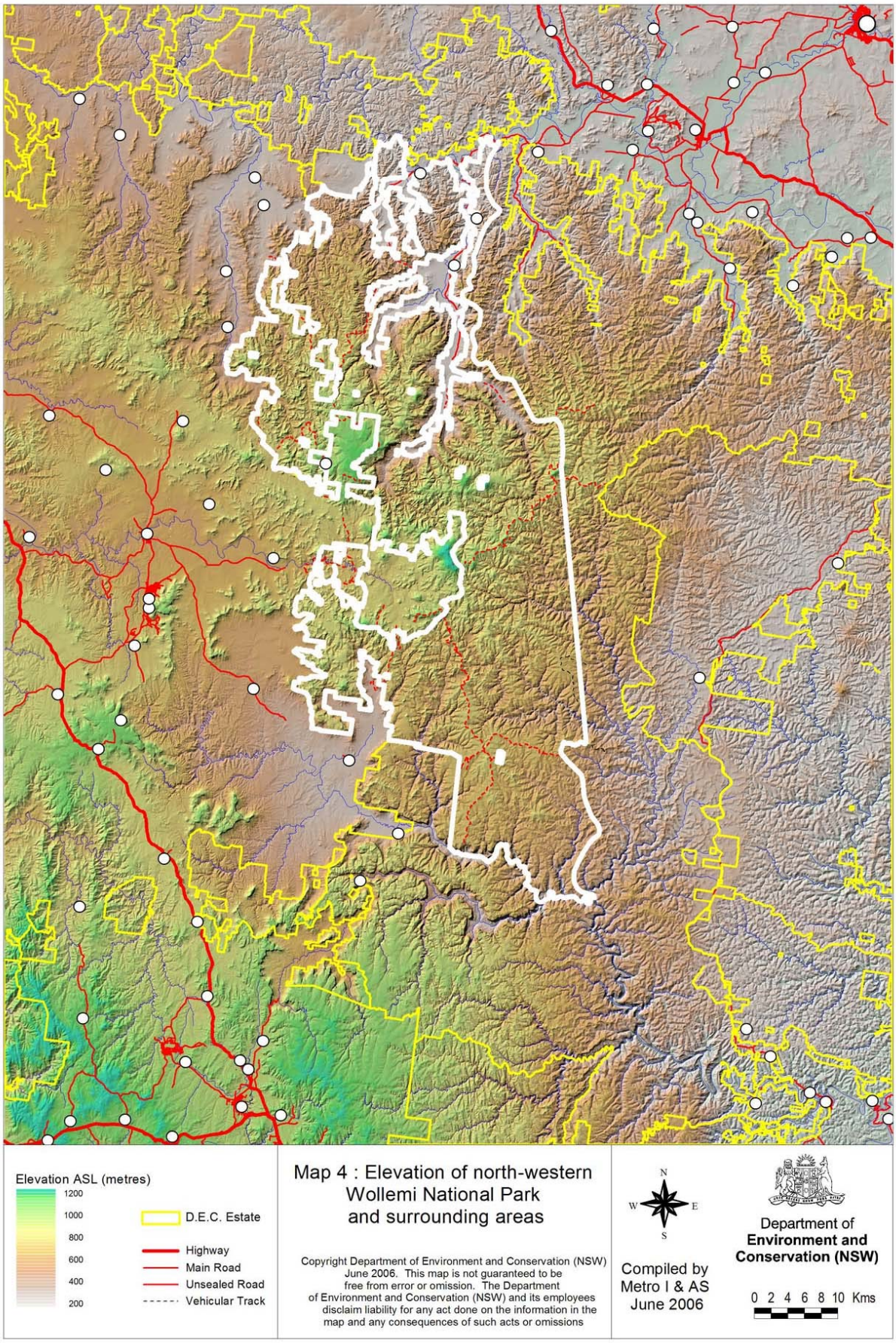
Also scattered throughout the study area are ‘diatremes’ that hold rich basalt-derived soils. These were formed as extinct volcanic vents eroded away faster than the surrounding sandstone into which they were intruded, often leaving saucer-shaped depressions and valleys (NPWS 2001a). These hollows are also known as ‘holes’, ‘craters’ or ‘clears’, and some examples within the study area are Box Hole Clearing, Swampy Hole (lying to the west and east of the Army Road respectively) and Gospers Hole. Diatremes can also be found in saddles or on the sides of ridges, identifiable only from close proximity due to the change in vegetation and the absence of sandstone outcropping (Macqueen 2005). It is estimated that hundreds of diatremes occur in north-western Wollemi National Park, many more than are currently mapped (Macqueen 2005).

1.3.3 Elevation

The highest elevations occur across the centre of the study area, around the sides of Nullo Mountain and Mount Coricudgy, and at Kerry Mountain and Mount Coriaday which are each over 1100 metres above sea level (asl) (Map 4). Tayan Peak also towers over the surrounding landscape, reaching 1150 metres asl. The Hunter Range, extending between Mounts Coricudgy and Monundilla, forms the watershed between the Hunter and Hawkesbury Catchments, and lies at between approximately 700 and 1000 metres asl within the study area. The remainder of the sandstone plateau ranges between roughly 600 and 800 metres asl, with occasional basalt caps rising above this and deep gorges dropping sharply down to about 400 metres asl. The northern boundary is defined by steep escarpments that drop sharply from 500 metres down to 300 or so metres asl, before opening into the wide and largely privately owned valley flats that gradually drop to approximately 100 metres asl before reaching the Goulburn River. The southern extremity of the study area also drops off very sharply, formed by escarpments that drop from 600 metres to the Capertee River at 300 metres asl.



Map 3: Landscape features of north-western Wollemi National Park



Map 4: Elevation of north-western Wollemi National Park and surrounding areas

1.3.4 Climate

Long term climate patterns across the study area are directly related to topography. The western two thirds of the study area are influenced by westerly moving continental air masses, with more elevated areas such as the basalt-capped mountains subjected to local orographic climatic effects (Bell 1998). The far south-eastern section is influenced more by coastal air masses, which generally carry more rain (Bell 1998). Seasonality of rainfall is consistent across the park, with the highest falls generally occurring between January and March (Bell 1998).

Generally the areas that lie above 1000 metres asl receive approximately 1000 millimetres of rain per year and have a mean annual temperature of between 10 and 11 degrees Celsius and a temperature range of between minus two and 24 degrees. The majority of the sandstone plateau receives in the order of 800 millimetres of rain per year, with a mean annual temperature of between 12 and 14 degrees Celsius.

The escarpments and valleys in the north are the driest parts of the study area, receiving on average between 600 and 700 millimetres of rain per annum. The mean annual temperature ranges between 14 and 17 degrees Celsius, with a mean maximum of between 28 and 33 and a mean minimum of between one and four degrees Celsius. The Capertee Valley, to the immediate south of the study area is also dry; the Glen Alice area receives an average of less than 700 millimetres of rain per year and relatively warm temperatures. This rainshadow effect generally continues north along the western boundary of the park, resulting in generally low rainfall (below 700 millimetres per annum) along the western escarpment.

1.4 VEGETATION

Bell (1998) provides detailed discussion of the vegetation of Wollemi National Park. Following is a very brief overview of broad patterns across the study area. North-western Wollemi National Park supports a diverse and complex array of vegetation communities. While much of the vegetation is characterised by sclerophyllous eucalypt forests and woodlands, a number of savannah woodland, rainforest, heath and native cypress pine communities are also found in small and disjunct patches. The species composition of the vegetation communities varies in response to regional climatic influences and geology. Three broad botanical divisions occur within the study area. Vegetation characteristic of the Central West Slopes of NSW is found on the northern half of the study area in dry, warm environments. NSW Central Tableland influences extend across elevated country through the middle of the area. Influences of the coastal hinterland that dominate the Central Coast botanical division are found in the south-eastern quarter.

Plate 1: Example of vegetation occuring on Permian sediments in the 'Lees Pinch Foothills' Landscape © E. Magarey/DEC

The 'Lees Pinch Foothills' in the north are characterised by low rainfall and moderately low fertility soils. Ridges are dominated by *Acacia* woodlands, with rocky heaths on exposed rock plates. Exposed slopes support woodlands dominated by Grey Gum (*Eucalyptus punctata*) and Stringybarks (such as *E. sparsifolia*), while Blakely's Red Gum (*E. blakelyi*), Rough-barked Apple (*Angophora floribunda*) and Forest Oak (*Allocasuarina torulosa*) occur on more sheltered slopes and gullies. The most sheltered situations contain a dry rainforest of Grey Myrtle (*Backhousia myrtifolia*) and Rusty Fig (*Ficus rubiginosa*). Below the Narrabeen sandstone escarpment, low rainfall and more fertile Permian sediments result in the growth of woodlands characteristic of the Upper Goulburn

Plate 2: Example of vegetation occuring on ridgetops and exposed slopes in the 'Wollemi Ranges' Landscape © H. Achurch/DEC

Valley. These woodlands are dominated by Slaty Box (*E. dawsonii*), Grey Box (*E. moluccana*), Grey Gum and occasionally White Box (*E. albens*) (Plate 1). Shrub density is relatively low (though still present) and grass cover is higher than on the sandstone plateaux. Valley flats that run like fingers into the park boundary support a variety of closely related vegetation types that variously include Red Gums (*E. blakelyi* and *E. tereticornis*), Ironbarks (including *E. crebra* and *E. fibrosa*), Rough-barked Apple, Grey and White Box and River Oak (*Casuarina cunninghamiana* subsp. c*unninghamiana*) in the canopy. Woodland and forests of similar structure are found along the south-western boundary of the park, though the communities differ floristically due to different regional and climatic influences. Much of the vegetation in the 'Upper Goulburn Valleys and Escarpment', 'Sydney Basin Western Escarpment' and 'Goulburn River Channels and Floodplains' Landscapes has been cleared, and either remains under agriculture today or is regenerating.

The vegetation of the 'Wollemi Ranges' Landscape covers the large majority of the study area. Dry sclerophyllous forests and woodlands dominate the ridges and exposed slopes with Sydney Peppermint (*Eucalyptus piperita*), Narrow-leaved Stringybark *(E. sparsifolia*), Smooth-barked Apple *(Angophora costata*), Silvertop Ash (*E. sieberi*), Grey Gum and Red Bloodwood (*Corymbia gummifera*) being common (Plate 2). These communities are characterised by a highly diverse and profusely flowering shrub layer from the families Fabaceae and Proteaceae. This includes well-known plant groups such as Wattles (*Acacia* spp.), Banksias (*Banksia* spp.), Epacrids (Epacridaceae) and Peas (Fabaceae).

Plate 3: Example of sheltered gully forest along a creekline in the 'Wollemi Ranges' Landscape © N. Williams/DEC

Sheltered forests and gullies within this landscape support contrasting vegetation communities. The deepest slot canyons feature impressive stands of warm temperate rainforest dominated by Coachwood (*Ceratopetalum apetalum*) and Sassafras (*Doryphora sassafras*) (Plate 3). These grade into tall wet sclerophyll forests with a canopy of Blue Gums (*E. deanii/E. saligna*) and Turpentine (*Syncarpia glomulifera*). These latter forests are widespread throughout the central and eastern sections of the study area. Small areas of vestigial vegetation are found in the most protected of canyons, the last traces of vegetation of the once wetter environment. The Wollemi Pine (*Wollemia nobilis*) in the most dramatic example, although the sub-tropical rainforest found in small areas of deep gorges on basalt-enriched soils are also noteworthy.

The vegetation occurring on the 'Sydney Basin Basalt Caps' Landscape is determined by local patterns of elevation and rainfall. Elevated caps that receive high rainfall, such as Mount Coriaday and Kerry Mountain, support montane forest dominated by Silvertop Stringybark (*E. laevopinea*), Eurabbie (*E. bicostata*) and Brown Barrel (*E. fastigata*), with Mountain Grey Gum (*E. cypellocarpa*) and Blue Mountain Ash (*E. oreades*) and occasionally Red Gums on the slopes (Plate 4). Sheltered aspects on these high elevation peaks sometimes feature rainforest dominated by Sassafras. Lower elevation and lower rainfall peaks in the north-west and south of the study area are characterised by White Box and Grey Box woodlands. Vegetation of the 'Sydney Basin Diatremes' again vary with rainfall. Lower rainfall diatremes contain White Box and Grey Box woodlands. Those at moderate to high rainfall, but low elevation, contain Blue Gum and Turpentine forests, while those at higher elevation support forest dominated by Ribbon Gum (*E. viminalis*) and Rough-barked Apple.

Plate 4: Northern slope of Tayan Peak showing grassy woodland on basalt soil © M. Schulz/DEC

The Central Tablelands exert their greatest

influences on the vegetation that stands on the deep sands around Dunns Swamp. The area is characterised by a low woodland of Scribbly Gum (*E. rossii*) and Brittle Gum (*E. mannifera*), with varying densities of Stringybarks, Grey Gum and Rough-barked Apple depending on local topographic patterns.

1.5 HISTORY OF LAND USE

Darkinjung Aboriginal people occupied the area now known as Wollemi National Park for at least 12 000 years prior to European settlement (NPWS 2001a). Sadly, little is known of Darkinjung history in the region. Aboriginal people are known to have at least travelled through the sandstone plateaux, sandy valleys and swamps, fertile volcanic diatremes and basalt mountains, the last holding particular spiritual significance (Macqueen 2004). In 2001 approximately 120 Aboriginal sites had been officially recorded within the entire park, though the actual number is expected to be far greater (NPWS 2001a). Bushwalkers exploring more remote sections of the park, such as the area east of Army Road and north and south of the Hunter Main Trail regularly encounter hand stencils and other paintings in caves and overhangs (M. Jessop pers. comm., Macqueen 2005). The landscape as a whole is also culturally significant, with stories often expressed through "Dreaming Tracks" that provide a spiritual connection between the Aboriginal sites and the land (NPWS 2001a). A summary of the region's Aboriginal heritage can be found in Macqueen (2004).

Early European attitudes to the Wollemi area were based on their perception of it as an unproductive, remote and undesirable landscape (NPWS 2001a). The rugged features, low nutrient soils and dry climate prevented use of the area for settlement or primary industry (NPWS 2001a) and as a result large tracts of the reserve have not been subject to European modification. The large majority of the study area was left as vacant Crown land until the gazettal of the national park in 1979. This stands in stark contrast to the Hunter and Goulburn Valley floors and the central western slopes, which were extensively cleared for agriculture, settlements and mining. However, some areas of the current national park have been affected by adjacent land uses. Pastoralists settled the Capertee Valley in the 1820s, and the Widden Valley during the 1830s and 40s (NPWS 1997a), clearing large tracts of land on the valley floors and lower slopes. Nullo Mountain was settled in the 1840s and occupation was established on Gospers Mountain in 1877, soon followed by Kerry Mountain (NPWS 1997a). Pastoralists bush-grazed Cattle along major creeklines and ridges running in from the northern boundary of the study area (such as Widden Brook), as well as on some basalt caps and diatremes scattered throughout what is now national park (for example that near the headwaters of Wirraba Creek). Evidence of these pastoral activities remain within the northern and north-western boundaries of the park, where much woodland on the lower slopes is regenerated from past clearing, as well as within the cleared or regenerating vegetation on basalt caps and diatremes. Low intensity Cattle grazing continues to occur in small sections of the National Park adjacent to cleared lands. Sporadic low-scale timber getting has been undertaken in a few areas, particularly around Koondah Creek (Colley and Gold 2004) and Wirraba Range (B. Wilson pers. comm.), while firewood collection and felling for fenceposts is likely to have occurred in the vicinity of agricultural areas. The defence force held a lease around Army Road and Gospers Mountain for many years, where troops underwent large scale training exercises, including the use of a dirt airstrip. Army exercises were also undertaken along the Wirraba Range (Mosley 1989).

1.6 FIRE

Little is known about traditional Aboriginal burning practices in Wollemi National Park, or the fire regime prior to the 1950s. Fire has long been a regular feature of the environment and the area is characterised by a highly flammable mix of fire-adapted flora, except in the most sheltered gullies. Human causes of bushfires account for 49 percent of all known fires across the park, with the remainder of known causes attributed to lightning strikes (DEC 2004a). Large areas of Wollemi National Park have been periodically burnt by major fires every three to ten years, with over half of the reserve being burnt within the last ten years (DEC 2004a). In comparison to the rest of the park, the study area has burnt less frequently, particularly in its north-western two thirds.

The following is a summary of recent fire history prior to the 2005-06 BSP surveys. The most recent wildfire at that time had burnt the far south of the study area, on the western side of the Army Road south of Mount Boonbourwa and south of Gospers Mountain, in the summer of 2002/2003. This area has been subject to more frequent fires than the remainder of the study area, with between one and three wildfires over the last 20 years (DEC 2004a). The area east of the Army Road and south of the Hunter Main Trail has a varied fire history, with the most recent wildfire ranging from 8 to 20 years ago, and a relatively low fire frequency (DEC 2004a). The area north of the Hunter Main Trail also has a varied fire regime, but the time since last wildfire is generally long and large tracts of land have not been affected by wildfire since at least the 1950s. The area between Widden Valley and Emu Creek

last burnt in the 1980s, while the Lee Creek Valley burnt in the summer of 1994-95. The majority of the Glen Alice area has not been subject to wildfire since the 1970s.

In December 2006, after completion of the BSP surveys and of the draft version of this report, a wildfire burnt a large portion of the study area. The fire spread from Mount Coricudgy in all directions, reaching Glenn Alice in the south-west, and the junction between Widden Brook and Blackwater Creek in the north-east. The intensity of the fire varied greatly, depending on daily weather conditions. Some sheltered rainforest gullies burnt, while others are thought to have remained unscathed.