

BURNING MOUNTAIN NATURE RESERVE

PLAN OF MANAGEMENT

NSW National Parks and Wildlife Service

February 1993

Acknowledgments: This plan of management is based on a comprehensive report by Stewart McMahon and was prepared by staff of the Upper Hunter District of the Service with assistance from the Field Services Division of Head Office.

The work of Stewart McMahon is gratefully acknowledged.

The assistance of the following individuals and organisations is also gratefully acknowledged:

- the Upper Hunter District Advisory Committee;
- Robert Quirk and the Burning Mountain Nature Reserve Steering Committee;
- Nancy Gray and the Scone Historical Society for their assistance in gathering historical information; and
- cover photograph kindly provided by David Noonan, Scone.

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ISBN 0 7305 7389 3

FOREWORD

Burning Mountain Nature Reserve is situated in highly folded terrain approximately 25 kilometres north of Scone adjacent to the New England Highway. Although small in area, the reserve's 14.5 hectares conserves interesting features which have resulted from the naturally occurring burning of an underground coal seam, believed to be one of only three such phenomenon in the world. Features which are evident both within and surrounding the nature reserve demonstrate:

- geomorphic features, such as ground subsidence in the wake of the advancing burning coal front: and
- geochemical alterations to soil and rock material.

Such alterations in turn give rise to fascinating and only partly understood plant and animal communities.

The significance of this unique, area has been recognised by the Australian Heritage Commission, the National Trust and the Geological Society of Australia (NSW Division).

Over the last few years public use of the nature reserve has increased from a monthly average of 70 visitors to a current minimum figure of 1000 visitors per month. Such an increased visitation places great pressure on the area. This plan emphasises:

- the conservation of the unique geological phenomenon and the protection of unusual plant associations of the nature reserve; and
- the promotion of the nature reserve to the public for educational and low key recreational purposes.

Other management programs include the control of introduced species, the conservation of cultural resources the encouragement of scientific and heritage investigation and the development of an interpretative programme.

This plan of management establishes the scheme of operations for Burning Mountain Nature Reserve. In accordance with the provisions of Section 75 of the National Parks and Wildlife Act, 1974, this plan of, management is hereby adopted.

CHRIS HARTCHER

Minister for
the Environment

27 October 1992

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1. INTRODUCTION

The National Parks and Wildlife Act, 1974, requires that a plan of management be prepared for each nature reserve. A plan of management is a legal document that outlines how the area will be managed in the years ahead.

The procedures for the adoption of a plan of management for a nature reserve are specified in the Act:

- * Where a plan of management has been prepared, the Director is required to refer the plan to the National Parks and wildlife Advisory Council for its consideration and advice.
- * The Director is required to submit the plan to the Minister, together with any comments or suggestions of the Advisory Council.
- * The Minister may adopt the plan without alteration or with such alterations as he may think fit, or may refer it back to the Director and Council for further consideration.

Once a plan has been adopted by the Minister, no operations may be undertaken within the nature reserve except in accordance with the plan.

Although not a requirement under the Act, a plan of management for Burning Mountain Nature Reserve was placed on public exhibition for three months early in 1991, for comment on the proposals it contained. All comments received were referred, along with the plan, to the National Parks and Wildlife Advisory Council for its consideration and advice. The comments and suggestions of the Advisory council were, in turn, considered by the Minister in adopting this plan.

For simplicity, much background information has been omitted from the plan. Anyone who would like additional information on the plan or the management of the nature reserve can contact the Upper Hunter Area Office of the Service at 160 Bridge Street, Muswellbrook, or by phone on (065) 43 3533.

Following adoption of the plan by the Minister, copies of all representations received are available for public inspection in the library of the Service's Head Office at 43 Bridge Street, HURSTVILLE 2220 (telephone: 02 585 6444).

2. MANAGEMENT CONTEXT

2.1 NATURE RESERVES IN NEW SOUTH WALES

Reserving areas for nature conservation as a general purpose was introduced into Australia with the establishment of Royal National Park in 1879, some seven years after the world's first national park was created at Yellowstone in the United States of America.

Fauna reserves in New South Wales were first established under the Fauna Protection Act of 1948, which was replaced by the National Parks and Wildlife Act 1967. Under the latter Act, fauna reserves were reclassified as nature reserves. The 1967 Act has been replaced by the National Parks and Wildlife Act, 1974.

Under the National Parks and Wildlife Act, nature reserves are areas of special scientific interest containing wildlife or natural environments or natural phenomena.

The purposes of nature reserves are defined in the Act as:

"(a) the care, propagation, preservation and conservation of wildlife;

(b) the care, preservation and conservation of natural environments and natural phenomena;

(c) the study of wildlife, natural environments and natural phenomena; and

(d) the promotion of the appreciation and enjoyment of wildlife, natural environments and natural phenomena."

Nature reserves are valuable refuge areas, where natural processes, phenomena and wildlife can be studied. They differ from national parks which include as a major objective the provision of appropriate recreation opportunities.

2.2. BURNING MOUNTAIN NATURE RESERVE

2.2.1 Location and Regional Context

Burning Mountain Nature Reserve is located approximately 25 kilometres north of Scone, via the New England Highway, in the Upper Hunter Valley. The reserve is 14.5 hectares in area and consists of two blocks joined by a narrow strip. The nature reserve contains actively smoking vents from an underground burning coal seam, with related paths of geomorphic features and thermally altered soil materials. Due to the reserve's unique combination of natural, cultural and scenic resources, the area has been recognised by:

- the Australian Heritage Commission; the reserve (and a larger encompassing area) is on the Register of the National Estate.
- the National Trust; the reserve is listed as a Landscape Conservation Area; and
- the Geological Society of Australia (NSW Division); the reserve is listed as a Geological Site of Significance in New South Wales.

The nature reserve and surrounding lands are also zoned 7a (Scenery Protection) under Scone Shire Council's Local Environment Plan. This land demonstrates landscape and vegetative responses to the phenomenon of the burning coal seam, while encompassing large sections of yet unburnt coal to the south of the reserve. The protection of this additional land is considered vital to the effective management of the reserve and the features and processes of the burning coal seam.

2.2.2 The significance of Burning Mountain Nature Reserve

The rocks of the Upper Hunter region were laid down as part of the Sydney-Bowen Basin; a huge depression which formed as the earth's crust sagged to compensate for the uplift which created the New England Tablelands during the early Permian Period. The main geological formation in Burning Mountain Nature Reserve is the Lower Koogah Formation, a sedimentary sequence deposited as alluvial fans by rivers flowing from the surrounding highlands between 280 and 270 million years ago.

Tectonic activity occurred with this deposition about 265-260 million years ago resulting in the Hunter-Mooki Thrust System. This activity divided the newly formed New England Fold Belt to the east from the Gunnedah Basin to the west. The influence of these events, along with associated folding and thrusting, and subsequent stream incisions, has led to a highly dissected and uneven terrain in the Upper Hunter.

Outcropping to the west of the Koogah Formation is the overlying Bickham Formation (260-250 million years old), comprising poorly sorted conglomerates, coarse sandstones and shell debris. This deposit, formed during a late Permian sea level rise and is up to 100m thick. It is in turn overlain by the fresh water sediments of the Murrulla Beds, which lie to the west of the main northern railway. Underlying the Koogah Formation are the early Permian Werrie Basalts, a two kilometre thick lava pile composed of alkaline basalt flows, which also outcrop extensively to the east.

Burning Mountain Nature Reserve is in two parts and includes examples of three of these important geological formations:

- the northern section of the nature reserve (former ML 6) is partly Upper Koogah Formation and partly Lower Koogah Formation. It also contains a small area of the Bickham Formation; and
- the southern section of the reserve (former portion 111) is comprised of Upper Koogah Formation, Lower Koogah Formation and Werrie Basalts.

It appears that subsequent Triassic deposits (the top formation of the Sydney Basin) have been stripped from the Upper Hunter exposing these Permian strata.

Exposed rock outcrops of the Koogah and Bickham Formations both within and outside the nature reserve, contain examples of fossilized plant and animal remains. These include primitive pine and fern plants.

The coal seams present within the Lower Koogah Formation extend in a NE-SW orientation. Recent studies indicate that two coal seams were ignited in an outcrop about 16km to the north of Burning Mountain. Movement of the burning head suggests an overall rate of burning of 1 metre a year, giving a minimum time of 15 000 years since ignition. However, in times when conditions were not favourable for combustion that rate may have slowed and it is thought the seam may have ignited as long as 500 000 years ago. The 2m thick coal seam at Burning Mountain is still burning, 20-30 metres below the surface.

Suggestions for possible ignition sources include lightning strike, Aboriginal land management or camp fires and natural forest fire. The most accepted hypothesis, however, is that oxidation of iron pyrites in the sulphurous coal material, gave off sufficient heat to cause combustion of the coal.

The vegetation found at Burning Mountain is significant in that it demonstrates successional responses of plant communities to the effects of the burning coal seam on upper soil layers. Species diversity increases markedly away from the current vent site.

The differences arising from geology, the extent and degree of thermal metamorphism and topography, all lead to soil-plant relationships that are rare and important as a scientific and educative resource. It is apparent that Burning Mountain Nature Reserve contains only a minor proportion of these unique vegetation associations. The balance of the area that may have exhibited related features has been heavily modified by farming and extraction industries.

It is understood that the local Wonaruah tribe named the area "Wingen" meaning "fire", and linked the Burning Mountain to the Wingen Maid, a large sandstone outcrop situated across the valley to the west. The Maid represented in the outcropping

sandstone, is said to have ignited the burning seam after crying tears of fire for her husband, slain in a battle.

Evidence for Aboriginal use of the Burning Mountain area exists as scattered flake deposits; with worked rock fragments used as tools found in the upper most soil layers along the thermally altered path.

The Wonaruah tribe may have used the burning vent area as work sites where they heated cote stones rendering the rock material more susceptible to reworking. The area was also a rich source of recrystallised, glassy slag material which, if worked into tools, usually produces a keen edge but is fragile and prone to blunting.

The first non-Aboriginal observation of Burning Mountain, then known as Mount Wingen, occurred in 1828 when a local farm hand named Smart, claimed that the area was an active volcano.

Extensive speculation, observation and discussion followed, with the eminent geologist the Rev. C.P.N. Wilton correctly identifying the phenomenon as a burning coal seam in 1829.

Other notable scientific observers to visit the area over the next 70 years included the surveyor/explorer Sir Thomas Mitchell, and geologists Rev. W B Clarke and Professor Edgeworth David. Local grazier William E Abbott maintained constant observation of the area over 65 years, which he documented in his 1918 work, "Mount Wingen and the Wingen Coal Measures".

Commercial use of the sulphurous gases emitted from the burning vent occurred from the 1890's until the 1960's, with sulphur rich creams and liquids, sold under the name "Winjennia" and "Sulfazone", were produced by a condensation and collection process.

Remnants of earlier European use of the area are few, with those present relating to past observation of, or exploitation of the burning vent site.

Burning Mountain Nature Reserve has become a popular tourist site visited mainly by travellers on the New England Highway and tourists in the Scone District. The site is actively promoted by the Scone Shire Council and is the most commonly visited site managed by the Service in the Upper Hunter District.

The reserve has important educational value in interpreting both the unique geological features of the mountain but also the natural physiographical features and processes in the Upper Hunter Valley. The reserve additionally is an important contact point for interpretation and promotion by the Service of local national parks and nature reserves.

The significance of Burning Mountain Nature Reserve can be summarised:

International Value

The reserve:

- is the only naturally occurring burning coal seam conserved in Australia and is one of only three known in the world.

Regional Values

The reserve:

- conserves unique geomorphic and pedological features resulting from underground combustion and resultant thermal influences.
- conserves a complex series of ecosystems, housing plant and animal species which have adapted to various thermally influenced micro-climatic and pedological conditions.
- contains a variety of geomorphic and pedological features and plant and animal communities for education and research.
- the burning seam is incorporated in surviving Aboriginal mythology and has significance for both anthropological research and present day Aboriginal communities.
- the nature reserve contains examples of fossilised Permian freshwater and marine plant and animal life.

Local Values

The reserve:

- is part of the area of the Upper Hunter settled by Europeans at an early date. Scientific and recreational interest in the Burning Mountain dates from these early days.
- was the site of a unique commercial operation in Australia where sulphur was extracted from a natural source for a medicinal ointment which was widely used between the 1940fs and 60fs in Australia.
- is close and accessible to residents of the Upper Hunter Region and travellers on the New England Highway. The summit of the mountain provides spectacular views of the Upper Hunter Valley and Liverpool Range.

3. OBJECTIVES OF MANAGEMENT

The following general objectives relate to the management of nature reserves in New South Wales:

- * the protection and preservation of scenic and natural features;
- * the maintenance of natural processes as far as is possible; the conservation of wildlife;
- * the preservation of Aboriginal sites and historic features: and
- * the encouragement of scientific and educational enquiry into environmental features and processes.

In addition to these general objectives, the following specific objectives also apply to the management of Burning Mountain Nature Reserve:

- * the protection of that part of the actively burning coal seam that lies within the nature reserve so that the processes of combustion can continue;
- * the protection of the geological structures and plant and animal communities that have evolved as a consequence of the burning coal seam; and
- * the promotion of public awareness and appreciation of the features and processes demonstrated by the burning coal seam.

4. POLICIES AND FRAMEWORK FOR MANAGEMENT

This chapter contains the policies and framework for the management of Burning Mountain Nature Reserve, together with relevant background information. Policies are summarised under the following section headings:

- Natural resources
- Cultural resources
- Use of the area

The policies established in this plan of management will provide the framework for management consistent with anticipated resources available to the Service and with anticipated community trends for the next five to ten years.

The actions identified are those immediate proposals which are to be undertaken in the next five years. Other management actions may be developed over the life span of this plan consistent with the policies set out in the plan.

4.1 NATURAL RESOURCES.

4.1.1 Geology and soils

The nature reserve comprises two small blocks joined only by a narrow strip of land. The reserve is located on a prominent ridge and the two blocks occupy part of the north-western slope of Mount Wingen and the north-eastern slope of Burning Mountain. These are separated by about two hundred metres. A narrow strip of reserve which links these two blocks lies on the western side of a saddle between the two mountains.

The northern block consists almost entirely of the Koogah Formation, with a minor occurrence of Bickham Formation rocks. The latter outcrops extensively to the west of the nature reserve on the private land but which is included in the larger national estate area. The southern block also contains Koogah Formation rocks but also has important outcrops of Werrie Basalt. Fossils are found within the carbonaceous shales present in the Koogah Units. These fossils stem casts contain *Glossoptera* sp., *Gangamopteris* sp. and *Phyllothea* sp. floral assemblages deposited during low energy, fresh water environments during the early Permian Period.

The outcropping Bickham Formation sandstones contain numerous marine fossils indicating an earlier shallow, turbulent, coastal environment. The debris, preserved during the Late Permian, includes marine shells belonging to the Phyla Brachiopode, *Ingelarella* sp., *Echinalosia* sp., *Eurydesma* sp. and *Pelecypoda* sp.

That part of the nature reserve away from the vent site contains uniform clayey soils on ridge tops, duplex soils on

the mobile sandy slopes and on the deeper layers of alluvial and colluvial sandy clay on the valley floors.

Policies

- * Sites of palaeontological significance will be protected.
- * The soils of the nature reserve will be protected and erosion control and prevention measures will be undertaken where appropriate in accordance with Soil Conservation Service guide-lines.
- * Only material from the immediate locality may be used as fill for development and maintenance works.
- * Except where essential for safety, filling in of cracks or vents will not be permitted.

Actions

- * Non-destructive research into palaeontological sites will be encouraged.
- * Visitors may be restricted from palaeontological sites should visitation have an adverse effect on these resources.

4.1.2 The Vent and the Burnt Coal Seam

Burning Mountain is located on the southern end of a ridge running in a north-easterly direction. This ridge encloses a number of sulphur rich coal seams, one of which is alight and has been burning for up to 500 000 years.

The outstanding natural feature of Burning Mountain Nature Reserve is the area around the vent of the burning coal seam. The nature reserve also includes a part of the coal seam trending north-east where combustion has taken place in the past.

Periodic and spatial interruptions to combustion have probably taken place where faults have occurred in the coal seam, where ground water has seeped into the seam or because of a lack of oxygen at depth. However, such interruptions apparently failed to permanently cease combustion, and sufficient heat again built up to cause further ignition.

The phenomenon of the burning coal seam is associated with a number of features of geological, topographic and biological interest and gives rise to two broadly identifiable consequences:

- physical disturbance of the earth's surface as overlying rocks and soil collapse into the void created by the burning coal; and
- physical and chemical changes to the surrounding rocks and soil because of the great heat generated by the process of combustion.

Combustion of the coal produces a large decrease in the volume occupied by the coal seam, resulting in the collapse of the overlying rock, with slumping commonly between 1 and 4 metres. These rocks collapse in blocks along weak joint planes within the sandstone. Subsidence cracks open where such blocks of rock have slumped, providing ventilation which may feed coal combustion. Hot sulphurous gases escape, effectively baking the soil and rock adjoining the vents, altering their geochemical structure, colour and texture - a process called combustion metamorphism.

The effects of combustion metamorphism vary with the temperature reached. Rock immediately above the burning coal has been altered from kaolinite clay to a hardened, mullite mineral, apparently by temperatures between 1200C and 1750C. These high temperatures are created by ventilation into the seam causing a blast-furnace effect.

Lower temperatures of around 900C experienced beneath the burning coal have partially altered the kaolinite by heat metamorphism. Fumes emitted through the vents average between 100C and 300C. These temperatures have dehydrated and oxidised the clayey soil, causing reddening, while gases have deposited silicious sinter encrusted with an acidic precipitate of sulphur, gypsum and aluminium rendering them unsuitable to support life.

The heat altered soils of the current and more recent vent sites are particularly erodible, leading to rapid deposition on valley floors adjacent to these areas. The burning coal seam and its related ground subsidence features, create varied micro-environments which occur within the narrow, deep subsidence cracks. These micro-climates vary from warm to hot sulphur-rich conditions. They provide abundant conditions for the proliferation of different and possibly unique plant or animal associations.

Policies

- * The special geological, geomorphological and biological features of the current vent and past vent sites will be protected from disturbance.
- * Scientific investigation of the vent site and its attendant physical and biological features will be encouraged.

4.1.3 Native and Introduced Plants

Vegetation in the unique geological and geothermal environments of Burning Mountain Nature Reserve, and its surrounding area, show distinct adaptations and species diversity along the path of the thermally-altered rock and soil material.

At the vent site, chemical and temperature regimes are unsuitable for plant growth and an area of approximately 0.5 hectares has been denuded of vegetation. Plant colonisation begins with tea-tree (*Leptospermum brevipes*) together with lichens and mosses which grow on the most recently cooled ground. The tea-tree dominated slopes are then infiltrated by a few scattered individuals of narrow-leaved iron bark (*Eucalyptus crebra*), rusty fig (*Ficus rubiginosa*) and silky oak (*Grevillea robusta*), with a heath (*Leucopogon muticus*) and tea-tree as a dense understorey. Ground dwelling orchids *Pterostylis* sp are also found amongst the lichens and mosses scattered on the highly erodible, baked soil material.

Along the former path of the burning coal seam and on generally west facing slopes with narrow-leaved stringy bark (*E. oblonga* "Murrurundi Form") dominates the overstorey, while *L. brevipes*, *L. muticus* and geebung (*Persoonia linearis*) form the understorey of the open forest.

Upslope, canopy diversity increases with grey gum (*E. punctata*), rough-barked apple (*Angophora floribunda*), white box (*E. albens*), grey box (*E. moluccana*), narrow-leaved iron bark and an intermediate form of red gum (*E. blakelyi* - *tereticornis*), sheltering an undergrowth of kangaroo thorn wattle (*Acacia armata*) and spear grass *Stipa* sp.

Downslope, on westerly facing slopes open forest communities which include narrow-leaved ironbark, the intermediate form of red gum and kurrajong (*Brachychiton populneum*), while rusty fig grows exclusively from opened subsidence cracks, possibly due to higher moisture levels within the narrow, deep crevices. Understorey species include *Acacia armata*, *Parsonsia* sp. (a climbing form), mock olive (*Notolaea microcarpa*), native cherry (*Exocarpus cupressiformis*) and *Stipa* sp.

To the north and north-west of the nature reserve, similar canopy dominants persist within an open woodland, with narrow-leaved ironbark, grey box, grey gum, rough-barked apple, kurrajong and rusty fig growing on the north-west facing slopes of the outcropping Bickham formation. However lower growing species show a differing and greater variety, including mock olive, *A. armata*, blackthorn (*Bursaria spinosa*), cough bush (*Cassinia* sp.), everlasting daisy (*Hellchrysum bracteatum*), paper daisy (*Helichrysum*

diosmifolium), flax lily (*Diarella* sp.), *Melichras urceolatus*, *Hibbertia* sp. and kidney weed (*Dichondra repens*).

Introduced plants include prickly pear (*Opuntia stricta*), and tiger pear (*Opuntia aurantiaca*).

The risk of wild fire entering the reserve via the freehold land is small, as fuel loads of grasses and shrub understorey are extremely low and surrounding landowners would not benefit from regular hazard reduction burns of grazing land. Fires may however occur within the nature reserve due to lightning strike or deliberate ignition.

Even though a fire history for the region is not available, the reserve appears not to have burnt for many years. Fuel levels within the reserve are low, offering little or no risk to surrounding landholders.

The small area and isolated nature of the reserve places great importance on its conservation as an animal and plant habitat. Given the erodability of thermally altered soil materials in the region, it is also necessary to maintain vegetative cover to avoid major degradation of the reserve's soil resource.

Policies

- * Native plant communities will be protected and regeneration of disturbed lands promoted.
- * Research into the ecology and distribution of native plants, including rare and endangered species will be encouraged.
- * Only plant species endemic to Burning Mountain Nature Reserve will be used in landscaping and revegetation work. As far as possible plant material will be propagated from communities found within the area to be treated.
- * Introduced plants will be controlled and where practicable, eradicated.
- * Introduced species management programs may be developed in co-operation with adjoining landholders.
- * Control of introduced plant species will be by techniques that cause minimal disturbance to the environment.
- * All wildfires will be contained as quickly as possible.
- * Liaison will be maintained with bushfire brigades, local government and neighbours to ensure co-ordination in suppression of fire on the nature reserve and where appropriate on adjoining lands.

- * Prescribed fire may be applied to maintain the overstorey and the understorey vegetation of the reserve in an ecologically viable condition.

Actions

- * Introduced plant species will be monitored and programmes implemented for their control.
- * A fire management plan will be prepared by June 1994 and revised as required.
- * Section 41A Co-operative District Fire Management Plans will be prepared in consultation with local District Fire Committees.
- * Records and maps of all fire occurring on the nature reserve will be maintained in the District Office.
- * Fire prescriptions will be developed, as part of the fire management plan, to maintain the vegetation of the reserve in an ecologically viable condition.

4.1.4 Native and Introduced Animals

The various geology-soil-vegetation associations result in a confined, yet diverse range of faunal habitats in the vicinity of the reserve.

This small pocket of native open forest and closed woodland, surrounded by grazing and mining, offers refuge to thirty one recorded species of bird.

Arboreal mammal species include the common ringtail possum (*Pseudocheirus peregrinus*) and sugar glider (*Petaurus breviceps*), with occasional sightings of koala (*Phascolarctos cinereus*) within the reserve.

Common macropod species of eastern grey kangaroo (*Macropus giganteus*), wallaroo (*Macropus robustus*), swamp wallaby (*Wallabia bicolor*) and red-necked wallaby (*Macropus rufogriseus*) occur in the eucalyptus dominated forests as individuals or small groups. The only other ground-dwelling mammal observed in this area is the short-beaked echidna (*Tachyglossus aculeatus*).

Ground subsidence cracks, present to the north and north-east of the current vent site, provide suitable habitat for bats. There have been no formal surveys as yet. It is however believed that these mammals could prove to be in significant numbers in the vicinity of Burning Mountain.

Little is known about the variety, abundance and distribution of reptile species within the reserve. However the eastern brown snake (*Pseudonaja textilis textilis*), red-bellied black snake (*Pseudechis porphyriacus*), bearded dragon (*Amphibolurus barbatus*), lace monitor (*Varanus varies*) and the copper-tailed skink (*Ctenotus taeniolatus*) have been recorded in the nature reserve.

An introduced species is defined in this plan as any plant or animal species not indigenous to the nature reserve or surrounding area. Such introduced species within the reserve are of concern as they constitute a threat to the integrity of the area's natural resources and, in the case of introduced animals, may compete with and prey on native species.

Burning Mountain Nature Reserve is mostly unfenced and sheep frequently graze the area. Other introduced animals include the feral cat (*Felis catus*) and the rabbit (*Oryctolagus cuniculus*).

Policies

- * Research, including inventory, into the ecology and distribution of native animals including rare and endangered species will be encouraged.
- * Introduced animals will be controlled and where practicable eradicated.
- * Introduced species management programs may be developed in co-operation with adjoining landholders.
- * Control of introduced animal species will be by techniques that cause minimal disturbance to the environment.
- * Domestic stock will be excluded from the nature reserve.

Actions

- * Research into the distribution and abundance of bat and koala populations will be encouraged.
- * Introduced animal species will be monitored and programmes implemented for their control.
- * The whole or sections of the nature reserve may be fenced to exclude domestic animals.
- * The vent site fence will be upgraded to exclude cattle.
- * Domestic pets and horses will not be permitted in the reserve.

4.2 CULTURAL RESOURCES

The conservation of cultural resources within the nature reserve is a requirement of the National Parks and Wildlife Act, 1974. Cultural resources include Aboriginal and European features. The effective management of these resources requires the protection of individual sites, places and relics and the interpretation of their history to the community.

A limited number of archaeological surveys have been completed in this part of the Upper Hunter Valley. A number of open sites and scarred trees have been located during these surveys.

Several sites however have been privately recorded in the general area of the nature reserve, including a bora ground with a carved tree, a burial, scarred trees, open sites, a stone arrangement and an engraving site. Many of these were reported last century or early this century and have since been destroyed by agricultural activity. The sparsity of artefacts in the region does not tally with evidence from the ethnographic record, such as the presence of several ceremonial grounds, which suggests a constant Aboriginal occupation of the area.

It is understood that the local Wonaruah tribe, who named the area "Wingen", meaning fire, linked the Burning Mountain to the Wingen Maid, a large sandstone outcrop situated across the valley to the west. The "Maid" represented in outcropped sandstone, is said to have ignited the burning seam after crying tears of fire for her husband, slain in battle. Information on the mythological significance of the area has come from elderly members of a neighbouring tribal group, the Aniwan, in the New England Tablelands.

No systematic survey of the nature reserve for Aboriginal sites has been undertaken. However, a number of flake scatters and silcrete nodules have been found in the upper most soil layers along the thermally altered path of the burning seam during past track construction.

It is possible that the Wonaruah used the burning vent area as a quarry and stone tool manufacture site, where they heated silcrete cobbles rendering the rock material more susceptible to reworking. The area is also a rich source of recrystallised, glassy slag material, produced by the burning seam which was worked by the Wonaruah into tools.

There is a suggestion in a report by Threlkeld (in Gunson 1974:63-66) to a site where Aborigines of Lake Macquarie got red ochre which was used on important ceremonial occasions, as well as for other purposes. He reported about a volcano "up the River Hunter", where they obtained a "reddish earth, which they wet, mould up into balls, and then burn them in a strong

fire, in which the balls change into a brilliant red pigment". While no evidence of ochre quarrying has been found on site it is hard to believe any other location in the Hunter Valley would qualify in the description of 'volcano'.

Further evidence for Aboriginal use of the area rests on the possible existence of a bora ring or ceremonial ground, which is located adjacent to the nature reserve.

The first European observation of Burning Mountain occurred in 1828. A local farm hand named Smart noticed smoke rising from the location during a hunting expedition. Smart interpreted the phenomenon as an active volcano. Extensive speculation, observation and discussion followed, until the eminent geologist Rev. C.P.N. Wilton correctly identified the phenomenon as a burning coal seam in 1829. Other notable scientific observers to visit the area over the next 70 years included Lieutenant Thomas Mitchell (later to become Sir Thomas Mitchell), the surveyor W.B. Clarke and Professor Edgeworth-David.

As the size of the population grew in the area, Burning Mountain became a favourite picnic spot and was so popular that two inns were established adjacent to it on the original highway.

Local grazier William E. Abbott maintained constant observation of the area over 65 years, which he documented in his 1918 publication, "Mount Wingen and the Wingen Coal Measures."

In the mid 19th century, the gases and waters of the mountain which contain high levels of sulphur as well as various other minerals, were thought to have great medicinal value. In the 1920's a lease was given for the mining of sulphur. A medicinal ointment, liquid and soap using extracts from the burning seam were sold under the brand name "Wingenia".

Sometime in the late 1940's a Mr B.M. Halls took an interest in the potential of the product and devoted the remainder of his life to developing it. Mr. Halls extracted the ore which formed the base of his products by long flumes which trapped the hot gases rising from the crevices in the burning mountain and carried them away until they cooled and precipitated their solid content.

"Sulfazone", as he named his version was fairly widely sold for use on burns and wounds. After Mr Halls death in the late 1960's his family did not continue their interest in the product and it went off the market.

Other commercial exploitation of the seam occurred in the 1940's when a lease for the mining of silinite, a white by-

product of sulphur, was issued. The area was subsequently declared a nature reserve in August, 1975.

Remnants of historic use of the area are few, with those present relating to recent scientific investigation of, or exploitation of the burning vent site.

An old, partly revegetated track to the north-west of the current vent, is reportedly the original route walked by early visitors and scientists. There are also the remains of two low, crumbling sections of wall to the north and east of the entrance to the vent site. The actual role of this structural relic is unknown.

The history of grazing of domestic stock in the area is marked by two weathered, partly buried post and rail fence posts which are situated in the sunken valley to the north of and outside the southern portion of the Reserve.

Policies

- * All cultural sites located on the nature reserve will be recorded and protected from disturbance.
- * The provisions of the ICOMOS charter for the conservation of places of cultural significance (the Burra Charter) will be used as guidelines for the management of cultural sites in the nature reserve.
- * The Service will liaise with relevant Local Aboriginal Land Councils and communities on all aspects of Aboriginal site management in the nature reserve.

Actions

- * In particular, archaeological, anthropological and historical research will be encouraged into:
 - the bora ring site and its presumed mythological relationship with the Burning Mountain;
 - the presence of a stone workshop where heat treatment of stone may have been employed;
 - the history of commercial use of the burning vent.
- * Information on the prehistory, recent history and mythological significance of the reserve will be incorporated into interpretative material.
- * Remnants of the sulphur extraction process which remain will be fully surveyed and recorded.

4.3 USE OF THE AREA

It is an important aspect of the management of Burning Mountain Nature Reserve to ensure that its use - whether by the general public, special interest groups, Service managers or other authorities - is appropriate, i.e., in conformity with the Act and the management objectives and policies outlined in this plan.

The major categories of use that can be appropriate, to varying degrees, on Service areas are:

- education and promotion of the area, the Service and the conservation of natural and cultural resources;
- research;
- certain types of recreation; and
- management operations, by the Service itself and other authorities with statutory responsibilities in the area

The extent to which these categories of use are appropriate to Burning Mountain Nature Reserve is indicated below.

4.3.1 Promotion of the Area, Educational and Recreational Opportunities.

A purpose of management for nature reserves is the study of wildlife, natural environments and natural phenomena. The existing vent site and the path of past vent sites is a unique natural phenomena of great public interest.

There is also a strong local expectation that the nature reserve will be promoted as a tourist attraction.

It is an objective of management for the reserve to promote public awareness and appreciation of the features and processes demonstrated by the burning coal seam. The provision of a limited number of low key recreational facilities is seen as an appropriate means of promoting the natural and cultural phenomena of Burning Mountain.

Until recently, Burning Mountain Nature Reserve received only minor and sporadic visitation, averaging 500 to 1000 people per year. The area was poorly sign-posted and with limited and difficult access through private property, many people were discouraged from visiting the nature reserve.

In 1988 the Roads and Traffic Authority reconstructed the adjacent section of the New England Highway and provided a sign-posted lay-by for visitors to Burning Mountain. Concurrently, Scone Shire Council obtained funds to develop a "gateway" tourist facility on land at the base of the mountain

leased from the reserve's neighbouring landowner. As a result the nature reserve is now receiving a substantial increase in visitation, currently estimated at an average of at least 1000 people per month.

The initial contact visitors have of the reserve is at the parking area and lay-by where picnic facilities are provided by Scone Shire Council.

Current access to the nature reserve involves a walking track with rudimentary track conservation works. The track has several way-side "bush" seats and numbered posts which relate to an interpretative pamphlet.

The track passes through private grazing land at several locations as well as traversing sections of the reserve. The main feature of the nature reserve, the burning vent area is viewed from a short, raised walkway.

The escalation of public use arising from its promotion by the Shire Council and the Roads and Traffic Authority has inevitably placed pressure on the resources of the reserve with current facilities proving to be totally inadequate and serious resource degradation is taking place.

Public safety is also of concern at several sites, such as the vents where strongly sulphurous fumes are emitted from deep cracks and large crevices topped by loose, unstable surface materials adjacent to the walking track.

Most visitors to the reserve are travelling tourists and are primarily interested in other destinations. They are most likely to visit the site out of curiosity or for rest and picnicking. This pattern also has implications for management standards as visitors may not be adequately prepared for unsophisticated conditions and who may have expectations of relatively high grade facilities.

The site plays an important role in interpreting both the relationships of the burning coal phenomena and the ecology of the Upper Hunter valley. Importantly the reserve is the most commonly visited National Parks and Wildlife Service managed site in the Upper Hunter District and plays a role in the promotion of the Service as a land conservation and management authority.

The reserve therefore is important as both a tourist attraction and an educational resource.

Policies

- * The primary purpose of recreation management in Burning Mountain Nature Reserve is to promote visitor awareness of the natural and cultural significance of the reserve.

- * Promotion of the reserve will be directed towards encouraging the appreciation and awareness by visitors of the phenomenon of the burning coal seam and its attendant physical and biological features.
- * Promotion of the nature reserve will be undertaken in conjunction with Scone Shire Council and the local Tourist Association.
- * The impact of visitor use on fragile sites will be minimised by the construction of a walking track and the provision of interpretation signs. Visitors will be required to remain on the walking track system in designated areas near the vent site and along the path of former vent sites.
- * Interpretation programmes will emphasise the promotion of awareness amongst visitors of the importance and fragility of the resources of the nature reserve.
- * The levels of use of the nature reserve will be monitored and regular assessments made of the impact of such use on the special natural and cultural features of the reserve.
- * All facilities will be designed to ensure as far as possible, safe public access.
- * The existing walking track facilities will be maintained and the loop walking track system re-established with the co-operation of Scone Shire Council and the neighbours of the reserve. No additional recreational facilities will be provided.

Actions

- * The loop track system will be re-established and upgraded to appropriate standards.
- * The raised board-walk will be upgraded and extended to provide added protection to the vent sites and to provide a link with the loop walking track system.
- * The short walking track extension to the south of the vent site will be closed and rehabilitated.
- * Sites showing unacceptable levels of disturbance from visitor use may be temporarily closed for rehabilitation or permanently closed and rehabilitated.
- * Signs will be provided where necessary alerting visitors of dangerous conditions.

- * Track markers and obsolete signs will be removed and a system of track interpretation signs erected at selected sites along the walking track.
- * The brochure interpreting the reserve will be updated and distributed as a means of on and off-site information.

4.3.3 Research

The function of research in the nature reserve is to assist in the understanding of its resources, use of the area and subsequently, to aid in effective management.

The area has a long and well known history of scientific investigations which have resulted in notoriety and several publications over the last 150 years. Recent research has concentrated on both the geological and cultural aspects of the vent and related features. Both of these aspects have raised further interesting questions specifically concerning the use of the area by early Aboriginals and the subsequent use of the site by Europeans for distillation processes.

only cursory work has been undertaken on the plant and animal relationships in the reserve and the special micro-climatic niches relating to the vents and crevices of the burning coal seam. The relationship of this site to other natural remnants of the adjacent Liverpool, Warlands and Great Dividing Ranges also requires further investigation.

Policies

- * Research into the reserve's natural and cultural features will be encouraged.
- * All research will be subject to Service policy and procedures for the granting of permits, conduct of research and the production of results.
- * Research applications will be granted only where it does not conflict with the primary management objectives of the reserve
- * Research will be encouraged specifically in the following fields:
 - geological/geomorphological features and their ecological significance;
 - micro-climatological influences on vegetation and fauna;
 - bat species and their environmental adaptations;

- the bora ring site and its presumed mythological relationship with the Burning Mountain;
- the presence of a stone workshop where heat treatment of stone may have been employed; and
- the history of commercial use of the burning vent.

4.3.4 Management Operations

Management of the reserve is based at the Muswellbrook office.

As the reserve is small and readily accessible from the New England Highway, there is no foreseeable need to base management resources at this site.

Several private vehicular trails exist near the reserve and subject to landholders approval, are adequate for management access. Additionally, the site is surrounded by cleared agricultural land which facilitates access for fire management purposes.

Policies

- * No permanent vehicular trails or helipads will be constructed in the reserve.
- * No permanent management or storage facilities will be provided in the reserve.
- * Fire tracks and trails constructed during fire operations will be closed and rehabilitated as soon as practicable after those operations.

5. PLAN IMPLEMENTATION

This plan of management is part of a system of management developed by the National Parks and Wildlife Service. The system includes the National Parks and Wildlife Act, management policies, established conservation and recreation philosophies, and strategic planning at corporate, regional and district levels.

The orderly implementation of this plan will be undertaken within the annual programmes of the Service's Upper Hunter District. Priorities, determined in the context of district and regional strategic planning, will be subject to the availability of necessary staff and funds and to any special requirements of the Director or Minister.

District programmes are subject to ongoing review, within which works and other activities carried out at Burning Mountain Nature Reserve are evaluated in relation to the objectives laid out in this plan.

The environmental impact of all development proposals will continue to be assessed at all stages of their development and any necessary investigations undertaken in accordance with established environmental assessment procedures.

Section 81 of the Act requires that this plan shall be carried out and given effect to, and that no operations shall be undertaken in relation to the nature reserve unless they are in accordance with the plan. However, if after adequate investigation, operations not included in the plan are found to be justified, this plan may be amended in accordance with section 76(6) of the Act.

As a guide to the orderly implementation of this plan, identified activities are summarised below:

Activity,	Plan Reference
Upgrade the walking track	4.3.1
Re-establish the loop walking track	4.3.1
Upgrade the fence at the active vent site,	4.1.4
Fence sections of the nature reserve	4.1.4
Design, construct and install interpretative signs	4.3.1
Continue control programmes for introduced plants and animals	4.1.3

Protection of the reserve from wildfire and unnatural disturbances	4.1.3
Monitor public use levels	4.3.1
Prepare fire management plan	4.1.3
Map and record all fire occurring on the nature reserve	4.1.3
Survey and record remnants of the sulphur extraction process	4.2
Upgrade and extend the raised board-walk	4.1.3
Provision of signs alerting visitors of dangerous conditions	4.1.3
Revise interpretation brochure	4.1.3

6. SELECTED REFERENCES

- Abbott, W.E., (1918) "Mount Wingen and the Wingen Coal Measure" Angus and Robertson Ltd, Sydney.
- Beckett, J., Pers. Comm., 1989
- Benbrick, C. et al, (1973) "Structural Subdivision of the Sydney Basin" NSW Geological Survey Bulletin 26, 2-9
- Electricity Commission of NSW., (1985) "Summary Report on Coal Prospecting in Authorisation 323, Scone-Murrurundi". Report No. DE 232
- Elleyett, C.D. and Flemming, A.W., (1974) "Thermal Infrared Imagery of the Burning Mountain Coal Fire" Remote Sensing of Env.3, 79-86.
- Flemming, A.W., Unpub. "Investigations in Permian Geology and the Burning Mountain Coal Fire, Wingen, NSW." Honours Thesis, Univ. of Newcastle 1972.
- Glen, R.A. and Buckett, J., "Thin-skinned Tectonics in the Hunter Coalfield of NSW." in press, Aust. Journal of Earth sciences.
- Hamilton, D.S., (1984) "Depositional Systems and Coal Seam Correlation in the Greta Coal Measures of the Muswellbrook Region". Coal Geology Branch, Dept. of Mineral Resources.
- Loughnan, F.C., (1973) "Kaolinite Clayrocks of the Koogah Formation, NSW." Journal of Coal Society of Australia, 20 (3), 329-41.
- Loughnan, F.C. and Roberts, .F.I., (1981) "The natural conversion of ordered kaolinite to halloysite (10A) at Burning Mountain near Wingen, NSW." American Mineralogist, 66, 997-1005.
- Loughnan, F.C. Personal comm., 1989.
- Morris, G., Senior Aboriginal Sites Officer, NPWS. Personal comments, 1989.
- Nichol, D., (1985) "Report to Scone Shire Council on Mining of Chamotle at Wingen, NSW." Commercial Minerals Ltd, Report No. 21/85.
- Nichol, D., (1986) "A Sedimentological and Mineralogical Study of the Koogah Formation, NSW." Phd Thesis, University of NSW.

Nichol, D., and Kreutzer. Interview conducted by K Groze,
University of New England.

Packham, G.H., (ed), (1969) "The Geology of NSW." Geological
Society of Aust. Inc.

Percival, I.G., (1985) "The Geological Heritage of NSW., Vol.
111 NPWS., Sydney, 94-5.

Rattigan, J.H., (1967) "Phenomena about Burning Mountain,
Wingen, NSW.'*. Aust. Journal of Science, 30(5), 183-4.

Rogis, J., Chief Geologist Muswellbrook Coal Company, personal
comments, 1989.