KOWMUNG RIVER
KANANGRA-BOYD NATIONAL PARK

Wild River Assessment

Parks and Wildlife Division
Department of Environment and Conservation

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SUMMARY

NSW has recently introduced legislation that enables wild rivers to be formally recognised and protected. Wild rivers are those rivers of which the biology, geomorphology and hydrology are in a substantially unmodified condition. Wild rivers are declared within areas currently reserved and managed for nature conservation purposes to ensure that the high conservation values of these rivers are maintained. Wild rivers can be used as focal points for a range of protection and rehabilitation works outside reserves.

The Kowmung River is located in the Hawkesbury Nepean catchment. The majority of the 80-kilometre stretch of the Kowmung River lies within Kanangra-Boyd National Park. The lower reaches of the river lie within Blue Mountains National Park. The river and catchment have attracted passionate interest from bushwalkers and nature lovers for over 100 years but have also been the site of natural resource use and of major mining and forestry proposals. The permanent protection of most of the catchment in the form of Kanangra-Boyd National Park was gradual, and the river and catchment are now viewed as a historic example of the strength and success of the conservation movement.

The Kowmung River has been assessed in terms of its biological, geomorphic and hydrological condition. Those parts of the sub-catchments affecting the river have also been investigated. The river shows some signs of disturbance: geomorphic condition has been modified to some extent by weed invasion and siltation from upstream, but overall the river is in good geomorphic health. This is likely to continue to improve given current weed control actions within the National Park and the expansion of willow and blackberry control programs into the Hollanders and Tuglow Rivers, both within and outside the park, from 2005. The presence of pine plantations and cleared land in the upper catchment is likely to affect the natural flows in the upper tributaries of the Kowmung River, but the proportion of the catchment that is modified is relatively small, and overall, the river is considered to be sufficiently hydrologically natural to be declared a wild river. The biological condition of the river is very good; the results of an analysis of invertebrates in the river were consistent with results from some of the most pristine waterways in the region. The river is predicted habitat for the Macquarie perch, a threatened fish.

The majority of the Kowmung River is considered to meet the criteria for wild rivers, and it is recommended that it be declared a wild river.

1 INTRODUCTION

Wild Rivers under the National Parks and Wildlife Act

The *National Parks and Wildlife Act 1974* (NPW Act) provides for the declaration of wild rivers.

In order to be considered wild, a river must be in a relatively natural condition. Both the river and the parts of the catchment that affect the river are taken into account:

Wild rivers are those *exhibiting substantially natural flow ... and containing remaining examples, in a condition substantially undisturbed since European occupation of …*

a) the biological, hydrological and geomorphological processes associated with river flow, and

b) the biological, hydrological and geomorphological processes in those parts of the catchment with which the river is intrinsically linked. (s. 61 (4), NPW Act)

Wild Rivers may be declared only on reserves managed by the Department of Environment and Conservation (DEC).

A wild river can be an estuary, a freshwater creek, or a chain of ponds. The Act states that a wild river may be:

> *any water course or water course network, or any connected network of water bodies, or any part of those, of natural origin, exhibiting substantially natural flow (whether perennial, intermittent or episodic) (s. 61 (4), NPW Act).*

Declaration of a wild river occurs by notice in the *Government Gazette*.

The Director General of DEC has the power to declare a wild river without an Act of Parliament, but in some cases the concurrence of certain Ministers must first be obtained: if the declaration may affect the functions of the Minister responsible for the *Water Management Act 2000* or, in the case of State Conservation Areas, the Minister responsible for the *Mining Act 1992,* the concurrence of the Minister(s) may need to be obtained (s. 61 (3), NPW Act).

DEC also needs to consider how the river will be managed. A river may not be declared wild unless the declaration is consistent with any Plan of Management that applies to the river's reserve, (s. 61A, NPW Act).

Wild rivers are to be managed in a manner that is consistent with the maintenance and restoration (if necessary) of their wild river values. Aboriginal objects and places associated with the wild river are to be identified, conserved and protected (s. 61 (5) (a) and (b)). Wild river declaration can therefore be used to trigger investigations of Aboriginal objects and places and the development of conservation plans.

The objectives of the NPW Act, such as the conservation of significant natural and cultural features and the fostering of a public appreciation and enjoyment of nature, also apply to wild rivers.

Community consultation

It is a requirement of the NPW Act that any plan of management for a reserve is made available for public comment before being adopted.

The Kowmung River falls within the Kanangra-Boyd National Park, for which a Plan of Management has been prepared. The Plan of Management identifies the Kowmung River as a wild river, and the declaration will not alter the current management of the river. Therefore, no amendment to the Plan of Management is required.

2 ASSESSMENT

The NPW Act requires that rivers and relevant parts of their catchments must meet certain standards of biological, geomorphic and hydrological condition in order for them to be declared a wild river. A range of existing information is available on the condition of Kowmung River and on its catchment. This study has drawn from this information and local expertise to assess whether this river is wild.

DEC has assessed the Kowmung River in accordance with its *Framework for Wild River Assessment* (Department of Environment and Conservation 2005b). This document outlines DEC's policy in relation to wild river assessment and declaration. The techniques adopted to assess wild rivers measure the current biological and geomorphological condition and compare it with a reference condition.

- For assessment of **biological** health, 'AUSRIVAS' (Davies 2000) analysis is used. This method samples and analyses freshwater invertebrates and uses the presence/absence of groups of invertebrates as a surrogate for biological health.
- For assessment of **geomorphological** condition, River Styles® (Brierley and Fryirs 2005) is used. This method measures a range of physical features of a river to determine whether there are unnatural rates of change in the river system.

These methods have been used extensively in NSW. For AUSRIVAS the reference condition is represented by reference sites from all major river systems across NSW; these sites were selected from river reaches thought to be least affected by post-European human activities. Some minor disturbances may still be present at reference sites.

For river **hydrology**, there is no widely available means of estimating a river's natural flow and the degree of flow alteration since European occupation. Stations that measure river flow have been established along some rivers, and from the data obtained from them it is possible to estimate a river's flow regime. These data can be compared with those of models of pre-European flow conditions to determine the degree of alteration. Accurate data on river flow are available only where river-flow monitoring stations have been installed and data on river flow and rainfall in the catchment have been collected over long periods. To determine whether any land-use changes have had an impact on river flow, flow data from before and after major disturbances need to be collected. Such information is rarely available. In cases where data are insufficient the hydrological condition can only be surmised, on the basis of coarse indicators of river flow alteration such as water extraction or the presence or absence of dams and weirs.

The current and historical land-use practices within the relevant parts of the catchment may directly affect the river condition. Current land-use information is used to highlight any management practices that might affect the river or catchment in the future. Disturbances that may have an impact on the biology, hydrology and/or geomorphology of the river include logging, clearing, road works, mining, drainage works, water extraction, frequent or severe fires, intensive recreational activities, grazing, and the presence of certain weeds and feral animals. Sources of information include spatial data sets, maps of vegetation structure, aerial photographs, physical evidence and any documents relating to the history, use and management of the area. In this study, local knowledge has also been used.

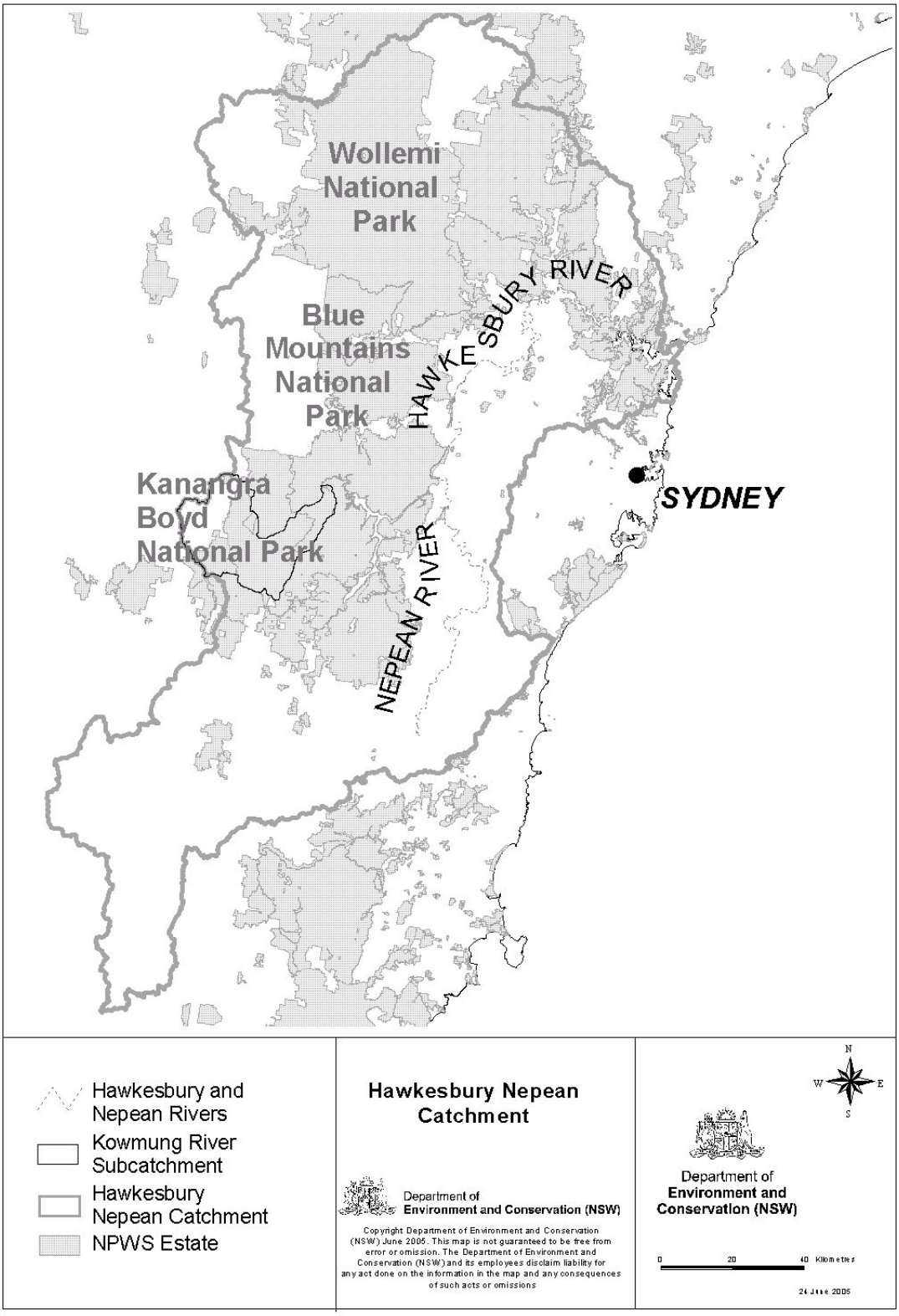
The data sources used and experts consulted for the technical assessment are listed in Appendix A.

3 RESULTS

Description of the Hawkesbury Nepean Catchment

The Kowmung River sub-catchment is located in the Hawkesbury Nepean catchment (Figure 1). The Hawkesbury Nepean catchment covers approximately 2.2 million hectares; 42% of this is in

Figure 1. The Hawkesbury Nepean catchment



DEC reserves, and a further 5% is owned by the Sydney Catchment Authority. This catchment is the major source of drinking water for the populations in Sydney, Blue Mountains and the Illawarra and supports economically significant agriculture and industries, including tourism. Major rivers in the catchment include the Hawkesbury, Nepean, Wollondilly, Wingecarribee, Nattai, Nepean, Cox's, Kowmung, Grose, Colo and Macdonald. The Hawkesbury Nepean Catchment is undergoing rapid urban expansion, which is placing increasing pressure on the catchment's water resources.

The catchment has significant natural and economic values. Over 60% of the Hawkesbury Nepean catchment remains as native vegetation (NSW National Parks and Wildlife Service 2003), and in 2000 the Kanangra-Boyd National Park, together with Blue Mountains, Wollemi, Gardens of Stone, Nattai, Thirlmere Lakes and Yengo National Parks and Jenolan Karst Conservation Reserve, was listed as the Greater Blue Mountains World Heritage Area. The world heritage area covers over 1 million hectares, and 73% of this occurs within the Hawkesbury Nepean catchment, including the reserves in the Kowmung sub-catchment. This area has a high degree of diversity of eucalypt species and provides examples of the range of structural adaptations of the eucalypts to Australian environments. Another significant feature is the presence of ancient, relict species of global significance, the most famous of these being the recently discovered Wollemi pine.

Description of the Kowmung River sub-catchment

Physical features

The Kowmung River sub-catchment consists of a number of different landforms, from the higher plateau of the Boyd through the steep slopes of the metamorphic gorge country and the rolling to hilly terrain of the upper catchment. The sub-catchment covers some 76 000 hectares, and just under 75% of the subcatchment is within Kanangra-Boyd National Park. The remaining land is either rural freehold or pine plantations managed by State Forests NSW.

The sub-catchment contains the headwaters of the Kowmung River, which, along with the Kanangra and Jenolan Rivers, supplies potable water to Sydney's major water storage at Lake Burragorang (Warragamba Dam). Maintenance of water quality is an important factor in park management, and activities in the park are carefully controlled. DEC and the Sydney Catchment Authority co-operatively manage a large section of Kanangra-Boyd National Park and of the adjoining Blue Mountains National Park. The Sydney Catchment Authority has management control over water quality and issues and activities likely to affect water quality in this part of the park (NSW National Parks and Wildlife Service 2001).

Natural values

The geology and geomorphology of the park provide significant evidence of geological processes dating back to the early Palaeozoic Period (400 million years ago). Sections of what is now south-eastern Australia were then part of the Gondwana shelf. In the deeper troughs, Ordovician, Silurian and Devonian sediments were deposited. These deposits now form the outcropping bedrock of much of the park.

Over the following 300 million years, the southern seaboard was subject to mountain-building, volcanic activity, land-mass slumping and the initial uplift of the Lachlan Fold Belt. Kanangra-Boyd National Park embraces a significant geological boundary between the Lachlan Fold Belt and the Sydney Basin. During the early part of this period the Kanangra granites and the Permian and Triassic sediments evolved. These now form the higher areas of the Boyd, Kanangra Walls and Ti Willa plateaus.

During the latter part of this evolution, tectonic events associated with the opening of the Tasman and Coral Seas resulted in the uplift of eastern Australia, forming the Great Escarpment. These features dominate the topographic landscape of Kanangra-Boyd National Park and provide

excellent opportunities for research, education and aesthetic enjoyment (NSW National Parks and Wildlife Service 2001).

The deeply dissected topography has exposed a range of rock types, notably the folded and partly metamorphosed Silurian and Devonian sandstones, limestones, shales and siltstones. The steeply dipping limestone lenses have been eroded to form extensive karst landscapes, which include several cave systems of importance to science, conservation and recreation. Outstanding karst sites within the park include Tuglow caves, Colong caves and Billy Creek caves.

Active erosion of the Great Escarpment has resulted in spectacular cliffs and waterfalls. The most popular of these include the dramatic wilderness vistas at Kanangra Walls and Morong Creek and the deeply eroded Cox's and Kowmung valleys. The result is a landscape of dramatic relief and a large altitudinal range (almost 1200 metres), which attracts a wide range of visitation (NSW National Parks and Wildlife Service 2001).

Vegetation. The majority of the sub-catchment falls within reserve and is covered by native vegetation. Only the western-most section has undergone significant disturbance; it comprises pine plantations, cleared agricultural land and remnant patches of native vegetation.

The southern side of the upper catchment in the area around Mt Werong and the northern side of the catchment along the Boyd Plateau are dominated by areas of snow gum (*Eucalyptus pauciflora*) and brown barrel (*Eucalyptus fastigata*), often as tall grassy forests on rolling terrain. Some of this area is rocky, and the vegetation communities in these sections resemble those on the steeper parts of the upper catchment. The dominant form in the areas around Tuglow Caves is a low open forest or woodland of narrow-leaved peppermint (*Eucalyptus radiata*), broad-leaved peppermint (*Eucalyptus dives*) and mountain gum (*Eucalyptus dalrympleana*) with a shrubby understorey, although this may be sparse.

The gorge country downstream of Tuglow Caves and south of the Kanangra-Boyd National Park is dominated by sharp hills with an open forest or woodland of stringybark (*Eucalyptus blaxlandii* and *Eucalyptus eugenoides*), ash (*Eucalyptus sieberi*) and grey gum (*Eucalyptus punctata*). The understorey is often sparse and the community is distinguished by an extensive cover of litter on the ground, often among areas of broken rock. Within these communities there are occasional thickets dominated by wattles, including the broad-leaved hickory (*Acacia falciformis*) and the locally abundant but vulnerable Kowmung wattle (*Acacia clunies-rossiae*). The deeper gullies and ravines often support depauperate rainforests, with stinging trees (*Dendrocnide excelsa*) and red cedar (*Toona ciliata*) as common components. Along the river may be found areas of grey myrtle (*Backhousia myrtifolia*), forming a dense, low forest with a grassy and ferny ground cover. River oaks (*Casuarina cunninghamiana*) dominate the banks, at times in dense thickets.

Areas of heath are rare; they occur mainly on the sandstone plateau at Kanangra (in the mid north of the catchment) and near Mt Colong, although a dense mallee heath is to be found fringing the south-east of the catchment at Big Plain on the Bindook Plateau. The localised areas of limestone found in a few places have a community of figs (*Ficus rubiginosa* and *Ficus coronata*) and blackthorn (*Bursaria spinosa*) clothing the outcrops (Greg Steenbeeke, DEC, *pers. comm.* 2005).

Threatened fauna. The native animals of the park have recently been subject to comprehensive fauna surveys by DEC (Department of Environment and Conservation 2004), and the area is known to provide habitat for a number of animal species that are listed under the *Threatened Species Conservation Act 1995*. These include the vulnerable species powerful owl (*Ninox strenua*), sooty owl (*Tyto tenebricosa*), barking owl (*Ninox connivens*), yellow-bellied glider (*Petaurus australis*), glossy black cockatoo (*Calyptorhynchus lathami*), large-eared pied bat (*Chalinolobus dwyeri*), eastern freetail bat (*Mormopterus norfolkensis*), eastern bent-wing bat (*Miniopterus schreibersii oceanensis*), greater broad-nosed bat (*Scoteanax rueppellii*), red crowned toadlet (*Pseudophryne australis*), brown treecreeper (*Climacteris picumnus*), brown treecreeper (eastern subspecies; *Climacteris picumnus victoriae*), tiger quoll (*Dasyurus maculatus*), koala (*Phascolarctos cinereus*), eastern pigmy-possum (*Cercartetus nanus*), eastern false pippistrelle (*Falsistrellus tasmaniensis*), squirrel glider (*Petaurus norfolcensis*) and grey-headed flying fox (*Pteropus poliocephalus*). The

following endangered species have also been recorded in this catchment: brush-tailed rock wallaby (*Petrogale penicillata*), stuttering frog (*Mixophyes balbus*) and giant dragonfly (*Petalura gigantea*) (Department of Environment and Conservation 2005a).

The threatened fish, Macquarie perch (*Macquaria australasica*), listed in the *Fisheries Management Act 1994*, is considered likely to occur within the Kowmung River (John Percy, Department of Primary Industries, *pers. comm,* 2005).

Threatened flora in the catchment includes the endangered *Trachymene saniculifolia,* buttercup doubletail (*Diuris aequalis*) and *Hakea dohertyi*. Vulnerable flora includes the Kowmung wattle (*Acacia clunies-rossiae*), *Kunzea cambagei* and *Acacia flocktoniae* (Department of Environment and Conservation 2005a).

Aboriginal cultural heritage

Understanding of Aboriginal prehistory in the park is presently based upon extrapolation from sites and places adjacent to the park. Knowledge of the western slopes and coastal areas adjoining the Great Escarpment indicates that Aboriginal occupation of the area dates back approximately 20 000 years (NSW National Parks and Wildlife Service 2001).

Important evidence has been derived from the early European records in the Burragorang Valley and the more recent archaeological investigations in the upper and lower Blue Mountains. These studies suggest the Kanangra region was inhabited by the Gundangarra language group and possibly the Wiradjuri of the south-western slopes. Kanangra-Boyd National Park has not been systematically surveyed for Aboriginal sites and places. There are approximately 40 recorded sites and places in the park, primarily art and grinding groove sites, including some important sites in the Kanangra Walls area (NSW National Parks and Wildlife Service 2001).

In addition to these, the park is likely to contain hundreds of as-yet unrecorded sites and places. Campsites are likely to be found along the main watercourses, and additional grinding grooves, shelter occupation sites and engravings are also likely to be found. Of the known sites and places in the park, several are particularly important for understanding Aboriginal occupation (NSW National Parks and Wildlife Service 2001).

There is evidence to suggest that the park has spiritual significance to the Gundangarra people. The Kowmung River is believed to figure strongly in their beliefs (NSW National Parks and Wildlife Service 2001), and the name of the river is thought to be the name used by the Dharug or Tharawal tribes for the river (Barrett 1993).

The area is of contemporary significance to the Gundangarra people. The area is included in the Gundangarra people's native title claim, and DEC and the Gundangarra people are currently discussing the management of a large part of the Greater Blue Mountains World Heritage Area, including Kanangra-Boyd National Park.

Land-use history

The area was explored in the early 1800s, and by the 1860s the area around Kanangra Walls was being used for grazing of cattle. Cattle grazing continued in the Kowmung and Cox's valleys for almost 100 years. Attempts at sheep grazing failed owing to the presence of large numbers of dingoes, which persisted despite major shooting campaigns. Cedar cutting was undertaken in the late 1800s and led to the construction of Cedar Road over Scott's Main Range. Some cedar extraction continued until the late 1940s, although the resource was scarce by the early 1900s. Small stands of cedar remain at some locations, including Wonga Wonga Brook (Little Tiwilla Creek) (Barrett 1993).

Gold was extracted from slate bars along the Kowmung River bed and from quartz reefs in the late 1800s to early 1900s, and again in the 1930s, and gold leases were held in the Cedar Creek – Church Creek area north of Kowmung Mountain (Barrett 1993).

The value of Kanangra Walls for public recreation was formally recognised as early as 1891, when the area was dedicated as a Reserve for Public Recreation. However, the permanent protection of the Kanangra-Boyd area took almost 100 years to achieve. The area now embraced by Kanangra-Boyd National Park was proposed as part of a Greater Blue Mountains National Park by Myles Dunphy in the 1920s (NSW National Parks and Wildlife Service 2001). An initial reserve, created in 1937, of nearly 40 000 hectares excluded an area at Mt Armour and most of the Boyd Plateau owing to their mining and forestry potential. Attempts to protect these areas came to the fore in the 1960s, when mining leases were held for the Colong and Mount Armour areas and forestry activities were taking place on the Boyd Plateau (Colley and Gold 2004, Barrett 1993). The historical use of the area for recreation and its continued popularity, combined with major campaign efforts from early environmental groups, brought about a heated public and political debate, and major limestone and bat guano mining proposals were eventually rejected. A debate over the creation of substantial pine plantations on the Boyd Plateau continued for some time, and the proposal was finally rejected in 1975 (Colley and Gold 2004). These areas were subsequently added to the park.

Little sign of the past disturbances within the Kowmung River sub-catchment and Kanangra-Boyd National Park remain today. Small, isolated areas show indications of past selective logging and clearing, particularly in the Mt Werong (Ruby Creek) area and at Cockerill's Lookout north of the Kowmung River (NSW National Parks and Wildlife Service 1991). The small-scale and superficial nature of gold prospecting in the region generally caused limited disturbance to native vegetation. A NSW National Parks and Wildlife Service wilderness assessment of the Kanangra-Boyd National Park (NSW National Parks and Wildlife Service 1991) did not note any disturbances from the gold mines in-park (within the Kowmung River sub-catchment) but did note that similar historic mines in the Blue Mountains were regenerating quickly.

Warragamba Dam was completed in 1960 and resulted in the formation of Lake Burragorang, which collects water from the Cox's, Wollondilly and Kowmung Rivers and accounts for about 80% of the water supply in the Sydney Region. Although the lake lies outside the Kowmung River sub-catchment, hydrological influences are felt upstream (discussed below).

Current usage. The upper catchment is dominated by a combination of lands cleared for grazing, often alongside those cleared and replanted with exotic pine (mostly *Pinus radiata*), and areas that retain some elements of the native vegetation. There are very limited areas of cropping, mainly near the pine plantations around the far west of the study area (Gingkin – Shooters Hill – Jaunter), where the terrain is less steep. Main crops include forage crops such as oats (Greg Steenbeeke, DEC, *pers. comm.* 2005).

Mining in the sub-catchment has been limited to small placer and shaft finds in the middle sub-catchment, mainly near Church Creek north of Mount Colong (Greg Steenbeeke, DEC, *pers. comm.* 2005).

Much of the Kanangra-Boyd National Park is declared wilderness, which is afforded the highest form of protection within the DEC reserve system. All 80 kilometres of the Kowmung River lie within the Kanangra-Boyd and Blue Mountains National Parks.

Trails. All roads and trails in the sub-catchment are unsealed. Trails within the wilderness area are few and are used for essential management purposes only.

Much of the Boyd Plateau area is excluded from wilderness and contains roads that may be accessed by the public.

Within the upper catchment outside the park, a network of roads transects the pine plantation on the western-most section of the sub-catchment; property access roads form a less dense network in the remainder of the area.

Recent fire events. Little information is known about fires in the Kanangra area before 1957. In that year most of the area, except the south-eastern escarpments of the Boyd Plateau, was burned by a single wildfire. Only four substantial fires have occurred in the 38 years since 1957. Two occurred in the Morong Swamps area of the Boyd Plateau and two on the drier slopes in the lower Kowmung

Valley and the Lake Burragorang catchment to the south-east of the Kowmung. The two lower Kowmung fires burned relatively large areas (NSW National Parks and Wildlife Service 2001).

Threatening processes

Weeds are restricted mainly to the upper catchment to the west of the National Park, where they result from the agricultural activities undertaken by the very few residents in the area. Weeds here are dominated by the usual weeds of agriculture such as thistles, Scotch broom, blackberry and serrated tussock. Radiata pine (*Pinus radiata*) is also starting to invade native vegetation near the plantations in the far west of the sub-catchment.

Within the majority of the National Park and gorge country the vegetation is overwhelmingly native, and weed infestations are usually localised. Local occurrences of concern are associated with disturbed sites such as old logging camps at Budthingeroo on the Boyd Plateau, former agricultural properties such as at Whalania Heights, zones with highly altered fire regimes, park boundaries adjoining agricultural and forestry areas, and areas with high populations of introduced animals. Introduced plants, such as blackberry (*Rubus fruticosa*), have dispersed along waterways from disturbed sites, notably the upper Kowmung River. Other introduced plants of concern include serrated tussock (*Nassella trichotoma*) and Scotch broom (*Cytisus scoparius*). The Kowmung River, on the north-western slopes of the lower altitude country, has patchy but consistent occurrences of prickly pear (*Opuntia stricta*) and tiger pear (*Opuntia aurantiaca*). Blackberry and willow have patchy but consistent distributions along the main watercourse and larger secondary drainage lines. Willow trees (*Salix babylonica*) have also spread down the Kowmung River from a variety of sources.

Control programs are in place for blackberry, Scotch broom, willows, radiata pine, serrated tussock, prickly pear and moth vine.

Introduced animals within Kanangra-Boyd National Park include the feral pig, wild rabbit, hare, feral goat, feral cattle, feral horse, feral dog, feral cat, red fox, fallow deer and European honeybee.

There are no current beekeeping licences in the park.

There are introduced fish in the park, including brown trout (*Salmo trutta*) and rainbow trout (*Salmo gairdneri*). Existing information on the impacts of these species is not sufficient to determine the effect they may be having on the biota of the Kowmung River.

There is good information on the distribution and abundance of introduced animals within the park. Control programs are in place for:

- feral pigs (*Sus scrofa*), the Boyd Plateau and Kowmung River being the most affected areas
- wild dogs; park boundaries are baited twice a year to prevent attacks on livestock
- fallow deer, which have recently been introduced to the park. Currently there are populations at Colong, Black Range, the northern end of the Boyd Plateau and on the Hollanders River, as well as in Blue Mountains National Park. Control programs are carried out four times annually.
- goats, foxes, cats and rabbits, as required.

Recreational uses

Kanangra-Boyd National Park is a major wilderness and scenic resource. Although most visitors are day users, a significant proportion are attracted by wilderness bushwalking, adventure caving, canyoning and camping opportunities.

Technical assessment

Biological condition

AUSRIVAS samples were collected from the Kowmung River at the Kowmung River fire trail in May and September 1999, and then again in June 2005. Both edges and riffles were sampled on all occasions. During the June 2005 visit, additional sampling was undertaken by using a preliminary sampling protocol for assessing aquatic invertebrate diversity in running waters (Department of Environment and Conservation unpublished).

The AUSRIVAS scores at the sites were high (average observed to expected ratio O/E = 1.02, minimum O/E = 0.86, maximum O/E = 1.24). The aquatic fauna was rich, with 52 taxa (identified mostly to family level) recorded for the AUSRIVAS analysis (Appendix B). With material collected from additional samples, 80 taxa were identified to the lowest taxonomic level (Appendix C).

The site sampled was close to the upper boundary of Kanangra-Boyd National Park within the Kowmung River sub-catchment; only a very small area of land outside the park drains into the river below this point. It is unlikely, therefore, that there would be disturbances causing significant reduction in aquatic biodiversity in the Kowmung River between the sampling site and the lower boundary of the Park.

These results suggest that the effects of past and present disturbances are likely to be too small to have a measurable impact on the aquatic fauna of the Kowmung River and its tributaries. Both the high AUSRIVAS scores and high aquatic biodiversity support the view that the Kowmung River is suitable for listing as a wild river.

Geomorphic condition

A geomorphic assessment of streams has been undertaken across the Hawkesbury Nepean catchment (Department of Land and Water Conservation 1999). This study assessed the Kowmung River and its major tributaries, the Tuglow and Hollanders Rivers and Browns Creek. These rivers were assessed for their geomorphic style, geomorphic condition and ability to recover from disturbance.

The River Styles® in the sub-catchment were predominantly gorge (70%), with confined and partly confined types also common. Small sections of headwater and cut and fill were present.

The study used four categories for describing geomorphic condition: Near Pristine, Good, Moderate and Degraded. All of the Kowmung River is of gorge style and was found to be in good condition.

The sampled rivers upstream of the Kowmung River and outside the reserve were found to have unnaturally high rates of geomorphic change owing to clearing and agricultural practices. Most of these rivers are in a degraded or moderate condition, and only a section of the Tuglow River, which runs though remnant native vegetation, is ranked as being in good condition. The condition of these rivers corresponds directly to their geomorphic style: cut-and-fill sections have the lowest condition category, as these river types are more susceptible to siltation and erosion than partly confined river types.

The upper catchment is likely to have had a historical effect on the Kowmung River. The river did not qualify for the category of least disturbance, despite the river being a gorge river and therefore relatively resilient to geomorphic disturbances. The exact reason behind the lower condition categorisation was not recorded in the 1999 study; it could be the presence of sand slugs created by disturbance and erosion upstream, or the presence and effects of weeds such as willows.

A general trend was noted during the geomorphic assessment of rivers in the Hawkesbury Nepean catchment. Those rivers within the catchment that were affected by forestry and clearing activities in the 1950s—as evidenced from aerial photos from the time—showed substantial improvement by the 1990s (Rohan Lucas, Earth Tech, *pers. comm.* 2005).

Geomorphic disturbances are not apparent from recent ground visits to the Kowmung River. Willows have nearly been eradicated from the river and no sand slugs have been sighted, although an investigation of current aerial photographs would be necessary to confirm their absence. The topography of the upper section of the river is relatively steep, a fact that would help the river to recover from any major erosion events upstream. Overall, the river is considered to be geomorphically natural within the Kanangra-Boyd National Park boundary.

A range of activities are being implemented in the upstream reaches of the Kowmung to improve its condition, and these could be further improved upon. Such actions include enforcement of pollution-control measures during logging operations within pine plantations, revegetation of banks on cleared lands areas to create buffers from agricultural activities, and the placement of bed controls to slow stream flow.

Hydrological condition

No water-extraction licences are issued for the Kowmung River sub-catchment, but other hydrological influences need to be taken into account.

A weir is present within the National Park and is associated with a flow station monitored by the Sydney Catchment Authority. The weir is located on the Kowmung River just below the Gingra Creek confluence, approximately 15 kilometres upstream from the eastern edge of the catchment. The weir is small and retains a pool that is no larger than pools that have formed naturally elsewhere in the river. Some seepage emerges from below the weir. The hydrological impact of this weir is considered to be minimal and does not constitute substantial disturbance.

The presence of pine plantations and cleared land in the upper catchment is likely to affect the natural flows in the upper tributaries of the Kowmung River, although the proportion of the catchment that is modified is relatively small.

Overall, the river is considered to be sufficiently hydrologically natural to be declared a wild river.

The eastern boundary of the park and of the Kowmung River corresponds to the full supply level of Lake Burragorang; this may be an appropriate boundary for the wild river declaration.

4 REFERRALS

As stated in *Wild Rivers under the National Parks and Wildlife Act* in Section 1 above, in some cases DEC requires the concurrence of certain Ministers before a river can be declared wild. Concurrence is required where the declaration may affect the functions of the Minister responsible for the *Water Management Act 2000* or, in the case of State Conservation Areas, the Minister responsible for the *Mining Act 1992* (s. 61 (3), NPW Act).

That part of the Kowmung River sub-catchment under investigation in this report falls entirely within National Park. However, tributaries in the upper catchment of the Kowmung River lie outside National Park. DEC has confirmed with the Department of Infrastructure, Planning and Natural Resources that there are no water-extraction licences within the Kowmung River sub-catchment upstream of the section under investigation. Therefore, it is considered that the declaration of this river will have implications for DEC only, and the concurrence of the Ministers responsible for the *Water Management Act 2000* and the *Mining Act 1992* is not required.

5 RECOMMENDATION

The Kowmung River and its tributaries are considered to meet the criteria for wild rivers as listed in the *National Parks and Wildlife Act 1974.*

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APPENDIX A: DATA SOURCES—TECHNICAL ASSESSMENT: CRITERIA FOR WILD RIVERS

	Biological condition	**Geomorphic condition**	**Hydrological condition**
Data source	Department of the Environment and Heritage (2003) *Australian River Assessment System (AusRivAS) National River Health Database*. Australian Government, Canberra. ANZCW0501009864	Department of Land and Water Conservation (1999) Geomorphic Categorisation of Streams in the Hawkesbury Nepean Catchment. Unpublished Report.	Department of Infrastructure, Planning and Natural Resources water extraction licence data.
Technical advice	Eren Turak, Research Scientist, Policy and Science, Department of Environment and Conservation. Graeme White, Department of Primary Industries.	David Outhet, Research Scientist, Department of Infrastructure, Planning and Natural Resources.	Paul Simpson, Senior Natural Resource Officer, Water Management Division, Department of Infrastructure, Planning and Natural Resources.

APPENDIX B: AQUATIC MACROINVERTEBRATE FAUNA (AUSRIVAS)

Aeshnidae	Hydracarina
Amphipterygidae	Hydrobiidae
Athericidae	Hydrobiosidae
Atyidae	Hydrophilidae
Baetidae	Hydropsychidae
Caenidae	Hydroptilidae
Calamoceratidae	Leptoceridae
Calocidae	Leptophlebiidae
Ceinidae	Libellulidae
Ceratopogonidae	Notonectidae
Chironominae	Odontoceridae
Coenagrionidae	Oligochaeta
Conoesucidae	Orthocladiinae
Corbiculidae	Ostracoda
Corduliidae	Philopotamidae
Corixidae	Philorheithridae
Corydalidae	Physidae
Dixidae	Podonominae
Dugesiidae	Psephenidae
Dytiscidae	Scirtidae
Elmidae	Simuliidae
Empididae	Synlestidae
Gerridae	Tabanidae
Gomphidae	Tanypodinae
Gripopterygidae	Tipulidae
Helicopsychidae	Veliidae

APPENDIX C: AQUATIC MACROINVERTEBRATE FAUNA IDENTIFIED TO THE LOWEST POSSIBLE TAXONOMIC LEVEL FROM ADDITIONAL SAMPLES

Taxon	AUSRIVAS name
Austroaeschna	Aeshnidae
Notoaeschna sagittata	Aeshnidae
Amphipterygidae	Amphipterygidae
Araneae	Araneae
Athericidae	Athericidae
Paratya australiensis	Atyidae
Baetidae Genus 2	Baetidae
Centroptilum	Baetidae
Cloen/*Centroptilum*	Baetidae
Tasmanocoenis	Caenidae
Caenidae Genus C	Caenidae
Anisocentropus	Calamoceratidae
Austrochiltonia australis	Ceinidae
Ceinidae	Ceinidae
Ceratopogonidae	Ceratopogonidae
Chironominae	Chironominae
Coenagrionidae	Coenagrionidae
Conoesucidae	Conoesucidae
Corduliidae	Corduliidae
Diaprepocoris barycephala	Corixidae
Micronecta	Corixidae
Archichauliodes	Corydalidae
Corydalidae	Corydalidae
Paradixa	Culicidae
Diphlebia lestoides lestoides	Diphlebiidae
Dixidae	Dixidae
Dugesiidae	Dugesiidae
Necterosoma	Dytiscidae
Batrachomatus	Dytiscidae
Austrolimnius	Elmidae
Simsonia angusta	Elmidae

Taxon	AUSRIVAS name
Empididae	Empididae
Rheumatometra philarete	Gerridae
Rheumatometra dimorpha	Gerridae
Glacidorbidae	Glacidorbidae
Gomphidae	Gomphidae
Illiesoperla	Gripopterygidae
Dinotoperla	Gripopterygidae
Helicopsyche	*Helicopsyche*
Helicopsychidae	Helicopsychidae
Heloccabus	Helocophidae/Calocidae
Hemicorduliidae/Libellulidae	Hemicorduliidae/Libellulidae
Hydracarina	Hydracarina
Hydrobiidae	Hydrobiidae
Taschorema	Hydrobiosidae
Ulmerochorema	Hydrobiosidae
Hydrophilidae	Hydrophilidae
Cheumatopsyche	Hydropsychidae
Asmicridea	Hydropsychidae
Hydropsychidae	Hydropsychidae
Hydroptila	Hydroptilidae
Oxyethira	Hydroptilidae
Hymenoptera	Hymenoptera
Rhadinosticta simplex	Isostictidae
Triplectides similis	Leptoceridae
Notalina	Leptoceridae
Oecetis	Leptoceridae
Atalophlebia	Leptophlebiidae
Austrophlebioides	Leptophlebiidae
Ulmerophlebia	Leptophlebiidae
Libellulidae	Libellulidae
Anisops doris	Notonectidae
Marilia fusca	Odontoceridae
Odontoceridae	Odontoceridae
Oligochaeta	Oligochaeta
Orthocladiinae	Orthocladiinae

Ostracoda	Ostracoda
Taxon	**AUSRIVAS name**
Philopotamidae	Philopotamidae
Aphilorheithrus	Philoreithridae
Physa acuta	Physidae
Podonominae	Podonominae
Sclerocyphon	Psephenidae
Scirtidae	Scirtidae
Simuliidae	Simuliidae
Sphaeriidae/Corbiculidae	Sphaeriidae
Synlestes weyersii	Synlestidae
Tabanidae	Tabanidae
Tanypodinae	Tanypodinae
Tipulidae EPA sp.40	Tipulidae
Microvelia	Veliidae