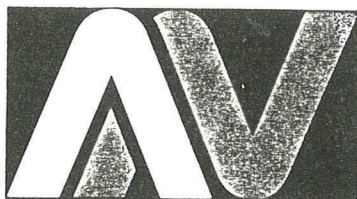


APPENDIX "D"



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Review of Proposed Wildlife Corridor
and Fauna Assessment for
Draft Local Environmental Plan LP145

Rural Parts of Nebraska Estate DP9699
in the vicinity of Pelican Road,
St Georges Basin

Prepared for
Shoalhaven City Council

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ABSTRACT

The Nebraska Estate lands are being considered for rezoning by Shoalhaven City Council. Part of the lands are located within the area proposed for a wildlife corridor as detailed by the New South Wales Department of Planning. Clearing on subdivided lands for dwellings and other purposes will cause the function of the wildlife corridor to be partly lost.

If Council chooses to go ahead with the development of the northern sections of the Nebraska Estate the wildlife corridor should be moved further north.

A preliminary survey and literature review reveals at least 14 species listed on schedule 12 may occur in the vicinity of the Nebraska Estate. Endangered fauna habitat occurs north of Pelican Road and within the creek line. Thus, any development within these areas should require the preparation of a fauna impact statement. Rezoning at this stage can proceed in habitat 3 south of Pelican Road without any further survey.

1.0 INTRODUCTION

Shoalhaven City Council requested Andrews.Neil to undertake a preliminary fauna assessment for a proposed development on the Nebraska Estate lands at St Georges Basin, near Nowra, New South Wales. The assessment involved a preliminary fauna survey, investigation of fauna habitat and a literature review of other studies undertaken in the area. A review of the wildlife corridor as proposed by the New South Wales Department of Planning is also included.

Council's brief requests:

- The value of the land proposed for the corridor in terms of fauna habitat.
- A preliminary fauna assessment according to the guidelines of the Endangered Species (Interim Protection) Act.
- Recommendations as to whether the rezoning of the Nebraska Estate should or should not proceed with appropriate justification.
- The implications of proposed amendments to the Endangered Species (Interim Protection) Act on the proposed development of the Nebraska Estate.

In addition, Council has requested further information as to what the impacts on fauna would be with the following development scenarios:

- Construction of a house on each of the lots within the corridor on the Nebraska Estate (i.e. those lots north of Pelican Road). This is on the basis that for bushfire management purposes, any dwelling approval would probably be conditioned such that a clearing to an area of 20 metres radius around the dwelling would be required, possibly with underscrubbing for a further area.
- Development of the lots, but the northern perimeter road (Nebraska Road) would not be constructed, but be left as a track and a new road would be constructed or a right-of-way negotiated, to give the lots fronting Nebraska Road access from Pelican Road.
- No development on the lots fronting Nebraska Road but development of lots fronting Pelican Road.
- No development on lots north of Pelican Road.

In addressing the above scenarios:

- Endangered species occurring in the region should be considered.
- Comments are to be made as to how necessary it is to maintain the vegetation in the general area of the corridor and if clearing were to occur what impact would it have. Identify critical areas.
- Assess whether the Nebraska area is significant in terms of the proposed wildlife corridor or as a wildlife habitat.

This report presents the above data following two field inspections to the site to determine fauna and habitat:

- The first was on 17 October 1993 between 0800 hours and 0000 hours.
- The second was between 9 November 1993 and 11 November 1993 by Ray Williams.

2.0 LOCATION AND CADASTRE

The site is located near St Georges Basin north of the Wool Road. On the Huskisson 1:25000 topographic map sheet (9027-4-N) the area of interest can be located at grid co-ordinates 790150. The area is found in the Parish of Wandrawandian and the County of St Vincent within the City of Shoalhaven. Cadastrally, the site is known as part of DP 9699 (Figure 1).

3.0 METHODOLOGY

On 17 October 1993 the field investigation involved:

- Inspecting, mapping and describing the vegetation and interpolating fauna habitat.
- Carrying out some preliminary fauna work during the day and evening. This involved detailing birds, arboreal mammals, reptiles and amphibians.

The habitat and preliminary survey work on 17 October 1993, suggested endangered fauna species were likely to be present based on the presence of tree hollows soil and canopy tree nutrient status. Therefore between 9 November 1993 and 11 November 1993 further survey was carried out to:

- Detail insectivorous bat species.
- Undertake further survey for the presence of the Yellow-bellied Glider.

Specific procedures for the fauna survey overall involved:

- Recording the bird species along a predetermined transect within the wildlife corridor and the Nebraska Estate area for a period of one hour.
- Recording all arboreal mammal species along the same transect using a spotlight and 12V wetcell battery.
- Recording all amphibians in creeks and ponds.
- Recording reptiles from opportunistic observations.
- Setting up harp traps and ultrasonic bat detectors for a period of three nights. Four bat traps were used at ten locations and two bat detectors were set up at six locations throughout the study area, including the wildlife corridor. This part of the survey was coupled with further spotlighting surveys.

Additional endangered fauna species likely to occur in the study area was derived from previous studies undertaken in the locality. Such studies included Andrews.Neil (1993), Symbiosis Pty Ltd (1993), Mitchell McCotter - Roslyn Muston and Associates (1990), Kevin Mills and Associates (1988) and CSIRO Division of Wildlife Ecology (1988).

4.0 RESULTS OF THE FIELD SURVEY

4.1 Birds

Thirty bird species were recorded during the survey, one of which is listed on schedule 12 of the National Parks and Wildlife Act, 1974. The relevant species is the Glossy Black-Cockatoo *Calyptorhynchus lathami* which is a specific feeder on *Allocasuarina* and *Casuarina* trees. In general the bird species recorded were a mixture of forest species and generalist species (Viz. Catterall, Green and Jones, 1991). Forest species are insectivorous feeding on and near the foliage of trees and understorey shrubs. Edge species are larger, feeding on open ground, eating insects but they require trees for nesting and perching. Several cockatoo and parrot species were recorded and in particular the Gang Gang Cockatoo *Callocephalon fimbriatum* was observed nesting in a large old growth tree within the wildlife corridor. Most of the birds recorded are common in the region.

4.2 Mammals

Eleven mammal species were recorded during the survey. The Sugar Glider *Petaurus breviceps* and the Greater Glider *Petauroides volans* were recorded as being present within the wildlife corridor and at the edge of the development proposal. The Grey-headed Flying Fox *Pteropus poliocephalus* was recorded in the wildlife corridor feeding in flowers of Turpentine *Syncarpia glomulifera*. The Common Bent-wing Bat *Miniopterus schreibersii* is listed on schedule 12 of the National Parks and Wildlife Act and was also recorded in the wildlife corridor just north of the proposed subdivision. All other bat species were recorded at various locations throughout the wildlife corridor and the subdivision area.

The Yellow-bellied Glider *Petaurus australis* was not recorded in the study area, despite four nights survey.

4.3 Amphibians

Six frog species were recorded during the survey but all are common species at a regional level. Frog habitat is restricted to the main creek and rural farm dams throughout the area. No species were recorded that are listed on schedule 12 of the National Parks and Wildlife Act, 1974.

4.4 Reptiles

Only one reptile species was recorded which was the Common Skink *Lampropholis delicata*. However, a number of other species are expected to occur but none are listed on schedule 12 of the National Parks and Wildlife Act, 1974.

4.5 Vegetation

There are three vegetation communities present at the site which are shown on the attached map. Descriptions are provided hereunder and at a broad scale could equate to fauna habitats. Exceptions at a microscale would be farm dams present in the study area:

Habitat 1 - Woodland on Low Nutrient Soils

Structure: Trees up to 25 metres high with an open canopy cover. Understorey dry dense to mid-dense with a cover of lower trees, shrubs, herbs, grasses and other monocotyledons.

Main Species Present:

Trees: *Eucalyptus gummifera*, *Syncarpia glomulifera*, *E. globoidea*, *E. piperita*.

Lower trees: *Leptospermum attenuatum*, *Allocasuarina torulosa*.

Shrubs: *Banksia spinulosa*, *Bossiaea obcordata*, *Acacia myrtifolia*, *Dampiera stricta*, *Oxylobium ilicifolium*.

Herbs: *Gonocarpus teucroides*.

Other Monocotyledons: *Burchardia umbellata*, *Ptilothrix deusta*.

Grasses: *Themeda australis*, *Entolasia stricta*, *Anisopogon avenaceus*.

Remarks: The above vegetation unit is adapted to soils of low nutrient status, with a predominance of *Proteaceous* and *Fabaceous* shrubs. However, some of the area now has been cleared for housing and only remnant pockets remain. Some large trees with hollows (habitat trees) occur throughout which are possibly roosting, nesting and den sites for fauna. Not specifically included in the subdivision area but recorded for reference purposes.

Habitat 2 - Riparian Open Forest

Structure: Trees up to 30 metres high with an open canopy cover. Dense layer of understorey trees with isolated pockets of ferns, herbs, grasses, reeds and sedges.

Main Species Present:

Trees: *Eucalyptus saligna* x *E. botryoides*, *Angophora floribunda*.

Lower Trees: *Melaleuca biconvexa*, *M. linariifolia*.

Ferns: *Hypolepis muelleri*.

Herbs: *Viola hederacea*, *Gonocarpus teucroides*.

Grasses: *Hemarthria uncinata*.

Reeds & Sedges: *Baumea articulata*, *Gahnia clarkei*.

Remarks: This vegetation community occurs alongside the creek line and is interrupted intermittently by ponded water sections. Along downstream sections large trees are dying due to a combination of altered drainage conditions and exposure. Riparian edge trees now lack protection from surrounding forest and are suffering from dieback, probably caused by an increase in wind velocity and a decrease in humidity. Ideal habitat for amphibians and reptiles.

Habitat 3 - Mid Open Forest on Higher Nutrient Soils

Structure: Trees up to 30 metres high with an open canopy cover. Understorey moist with a cover of lower trees, shrubs and grasses, although shrubs are less common.

Main Species Present:

Trees: *Eucalyptus pilularis*, *E. piperita*, *E. globoidea*, *E. gummifera*, *E. resinifera*, *Syncarpia glomulifera* and *Angophora floribunda* and occasionally *E. maculata*.

Lower Trees: *Allocasuarina torulosa*, *Persoonia linearis*, *Acacia irrorata*, *A. maidenii*, *Elaeocarpus reticulatus*.

Shrubs: *Pimelea linifolia*, *Leptospermum arachnoides*.

Grasses: *Themeda australis*, *Entolasia stricta*.

Remarks: This habitat forms a major component of the wildlife corridor. Large trees are present, some of which have hollows suitable as den sites for arboreal mammals and nesting sites for cockatoos and lorikeets. Some clearing of the larger trees is occurring.

4.6 Literature Review

A search of the available literature also revealed additional endangered species may be present within the study area. The field survey conducted for the project was not exhaustive and was designed only to gather a preliminary idea of what fauna species could be present, but emphasis was placed upon endangered fauna habitat. Those species considered as further likely to occur are:

- Yellow-bellied Glider *Petaurus australis*

The Yellow-bellied Glider has been recorded in the area at the following locations:

- The Tomerong Creek corridor and west of the Grange Road feeding in Spotted Gum *E. maculata* and Red Bloodwood *E. gummifera* (Mitchell McCotter - Roslyn Muston and Associates, 1990).
- The Worrowing Waterway corridor at Vincentia in Spotted Gum *E. maculata* - Bangalay *E. botryoides* x *E. saligna* (Andrews.Neil, 1993).

The observations occurred north west and east of the study area although the Tomerong Creek could be considered to be in close proximity (1 - 2 kilometres). Worrowing Waterway is approximately 8 kilometres to the east. If the proposed corridor is viable the Yellow-bellied Glider could be expected to occur within the corridor area.

- The Squirrel Glider *Petaurus norfolcensis*

The Squirrel Glider, as far as can be determined, has never been recorded from the area (Symbioses, 1993) but Mitchell McCotter - Roslyn Muston and Associates (1990) report that on the south coast of New South Wales the habitat for the Squirrel Glider is similar to that of the Yellow-bellied Glider.

- Great Pipistrelle *Falsistrellus tasmaniensis*

The Great Pipistrelle has been recorded in the locality previously (National Parks and Wildlife Service records), and Mitchell McCotter - Roslyn Muston and Associates (1990) state habitat for the species is present west of the Grange Road and Tomerong Creek corridor. Based on the ecological attributes discussed in their report, marginal habitat may be present in habitat 3.

- Greater Broad-nosed Bat *Scoteanax rueppellii*

The Greater Broad-nosed Bat has been recorded previously in the area (National Parks and Wildlife records). Symbioses (1993) has noted it may forage along tree lined creeks in the locality. It was not recorded during this survey but a forested creekline is present within the study area (Habitat 2).

- Common Bent-wing Bat *Miniopterus schreibersii*

The Common Bent-wing Bat was detected in Blackbutt forests at Vincentia (Andrews.Neil, 1993). Blackbutt forests make up the bulk of Habitat 3 and so the habitat is considered a feeding area for the species in the study area.

- Yellow-bellied Sheathtail Bat *Saccolaimus flaviventris*

The Yellow-bellied Sheathtail Bat has previously been recorded on the south coast (National Parks and Wildlife Service records) and it forages high above canopies of woodland, forest and wetland. It could possibly occur within the study area.

- Southern Brown Bandicoot *Isodon obesulus*

The Southern Brown Bandicoot was not recorded during the survey and previous surveys have not recorded its presence in the locality. Symbioses (1993) notes that it is likely to be present in the locality in woodland with shrubby ground cover. Habitat 1 partly qualifies with these attributes.

- Spotted-tailed Quoll *Dasyurus maculatus*

Although not recorded during this survey, the species is known to be abundant in the Cambewarra area north west of Nowra and within state forests south west of the study area (Symbioses, 1993). The species utilises a variety of habitats and could possibly occur within the study area.

- Square-tailed Kite *Lophoictinia isura*

The Square-tailed Kite may occur within the study area because its preferred habitat is woodland or forest. There are no previous recorded sightings of the species in the locality.

- Masked Owl *Tyto novaehollandiae*

Although not recorded during this survey, nor are there any known records of this species for the area the species prefers habitats ranging from tall wet eucalypt forest to dry woodland sometimes at the edge where cleared land occurs. Such ecological attributes are present in both habitats 1 and 3.

- Powerful Owl *Ninox strenua*

The Powerful Owl was not recorded during this survey and there are no records for its presence in the locality. Their habitat can be similar to the Masked Owl and habitat for the species occurs within the study area.

- Green and Golden Bell Frog *Litoria aurea*

The Green and Golden Bell Frog is known from swamps in the Jervis Bay area (Symbioses, 1993) and is known to inhabit creek lines especially near the ecotone of forest and woodland (Andrews.Neil, 1994).

This habitat is present in the study area although the species was not found during the survey, despite a quite intensive search for the species.

◦ The Giant Burrowing Frog *Heleioporus australiacus*

The Giant Burrowing Frog is found amongst sandstone vegetation (Payne, pers.obs.) usually in association with hanging swamps and moist heathland. At times they are found well away from creek lines but their habitat appears to be sandstone based. It is possible, but not probable, that this species could occur within the study site in habitat 1.

5.0 DISCUSSION OF DEVELOPMENT SCENARIOS

Habitat 3 (Viz, section 4.5) forms the bulk of the forest in the study area and in addition extends into the lands proposed for the wildlife corridor (Figure 1). Generally habitat 3 is in an excellent condition and retains viable wildlife habitat, although some clearing has recently taken place at grid coordinates 793154 (Huskisson 1:25000 topographic map sheet) within the proposed wildlife corridor. Other housing exists at isolated locations within the proposed Nebraska Estate lands in habitat 3. (Viz. Aerial photographs roll 1266, run 1, photos 0199 - 0198). Habitat 2 comprises the creek line vegetation and is an essential habitat for many fauna species including some of those listed on schedule 12. Habitat 1 lies to the south of the study area and is now mainly cleared for residential purposes.

The wildlife corridor as proposed by the New South Wales Department of Planning (Figure 1) lies to the north of the Nebraska Estate, although forms part of it running in an east west direction, but is variable in width. At its narrowest point near the Grange Road, the corridor is approximately 400 metres wide but as a rule ranges between 640 and 840 metres wide in other sections. Whilst habitat 3 forms the bulk of the wildlife corridor in the vicinity of the Nebraska Estate its present condition is far more pristine than the same habitat found in the Nebraska Estate lands south of the wildlife corridor boundary.

The Value of the Land Proposed for the Corridor in Terms of Fauna Habitat

In its present condition the land proposed for the wildlife corridor has a high potential for its intended purpose. Whilst the bulk of the corridor is of Blackbutt forest (Habitat 3) it is dissected by a creek line which provides a different habitat type (Habitat 2). Thus, the corridor in terms of its function is potentially effective because the quality of the habitat is high and it provides a mix of habitat types. The creek line in particular provides a habitat for some species to escape predators.

However, two main negative effects are present and two others will be imminent if the subdivision proposal and infrastructural development proceeds. Some clearing has occurred recently which will be perceived by some species as a barrier. Such species generally do not venture far from cover and only remain where a dense ground cover is present, (Soule and Gilpin, 1991) and the clearing will prevent movement through the corridor by these species because of behavioural exclusion practices. Thus, the function of the corridor will have a negative effect for these species. Secondly, the shape and width is important. Right angled bends are present due to cadastral boundaries. Ideally the corridor would function more efficiently if the "doglegs" were absent. Some bird species will perceive the changes in boundary direction as barriers to movement because such species are inflexible in their movements. The width is however ample for bird species to move along the corridor (Catterall, Green and Jones, 1991). A minimum distance of 250 metres is recommended to eliminate edge processes but a width of 500 metres is more unlikely to be dominated by edge processes and be used as a breeding habitat as well.

On the other hand arboreal and ground dwelling mammals must also be considered. Greater Gliders *Petauroides volans* were observed in the corridor although the forest type indicates Yellow-bellied Gliders *Petaurus australis* could also be present but they were not seen or heard. This is based on the premise that the forests of Blackbutt grow on higher nutrient soils and as a result trees have higher foliar nutrients which are used by Yellow-bellied Gliders. Greater Gliders require a home range area of 1 - 1.5 hectares feeding on a number of specific trees of different species. The Yellow-bellied Glider, whilst it requires also a number of particular trees for its resources, has a home range covering many hectares. Both species require resources related to Winter resource availability (Kavanagh, 1984). It would appear that the size of the corridor would cover resource availability for these species especially as Spotted Gum (a Winter flowering species) occurs at the western end of the corridor (Mitchell McCotter - Roslyn Muston and Associates, 1990).

Arboreal gliders also require old growth trees as habitat trees because den sites are a critical resource (Recher et al. 1980). The field inspection revealed that hollows were present in the wildlife corridor and on the northern edge of the subject land, however, they were few and far between. This is because the forest is only mid-successional stage and trees have not reached an age where hollows are prevalent. Considering the fact that the Yellow-bellied Glider is present in the vicinity of Grange Road (Mitchell McCotter - Roslyn Muston and Associates, 1990) and along the Worroving Waterway (Andrews, Neil, 1993), the proposed corridor link has a high potential for the populations to move and interbreed.

The old growth trees are also used by large owls, parrots and lorikeets for nesting and it was observed that one such tree was being used by a group of Gang Gang Cockatoos *Callocephalon fimbriatum* for nesting. For this reason, the corridor has potential to form important habitat for this suite of species.

Both the European Fox *Vulpes vulpes* and the domestic cat *Felis catus* are present in the corridor. Foxes will predate on almost any animal species that weighs between 5 and 5500 grams (Christenson, 1980) and cats are known to kill and eat more than 100 native species of birds, 50 species of mammals, 50 species of reptiles, 3 species of amphibians and numerous invertebrate animals (Australian National Parks and Wildlife Service, 1991). They also provide a high density reservoir of breeding animals to produce feral populations. The impact on native animals from these predators could be severe in edge sections of the corridor from any development scenario and it has been suggested a forest area of 500 - 600 metres wide is required to retain a core area of native fauna and avoid predation. The wildlife corridor meets this requirement.

At present the habitat within the corridor is free of weeds and generally undisturbed. Ideally this fact enables native species to perpetuate because it is general knowledge that with an increase in exotic plant cover there is a corresponding decrease in native species.

The two imminent impacts that are likely to reduce the viability of the corridors function are the proposed Tomerong By-Pass (Mitchell McCotter - Roslyn Muston and Associates, 1990) and the proposed Nebraska State. From the maps prepared by Shoalhaven City Council it appears the Tomerong By Pass will dissect the proposed wildlife corridor at the Pacific Highway. The wildlife corridor at the Pacific Highway extends further west from this point to join the wildlife corridor proposed further north. Ultimately the corridor will function as a reserve unless fauna can access the Pacific Highway. Its size will be some 10 kilometres long or approximately 750 hectares in area. Whilst the shape is not ideal in a reserve context the condition of the bulk forest is important to provide a refuge for fauna.

Construction of a House on Each of the Lots North of Pelican Road

Construction of a dwelling on each of the lots north of Pelican Road will intrude into the wildlife corridor and would in effect reduce the width of the wildlife corridor. Depending on the location of the dwellings in each block the width of the corridor could be reduced from 840 metres to 600 metres, but near Grange Road the reduction is nearer to 400 metres.

If the approvals are conditioned so that dwellings are located with access from Nebraska Road close to the rear boundaries on lots and are sited close to Pelican Road the impact would be less since this scenario would only change the shape of the corridor to a minor degree. The width generally would be still wide enough to enable movement for bird species and to retain breeding habitat. Only near the Grange Road would some affects come into play as the width is reduced below 500 metres. It would be important to retain all old growth habitat trees on the lots to help the corridor function more effectively but if domestic predatory pets are allowed, significant edge effects on native wildlife can be expected. This scenario relies on the condition that minimal native vegetation will be removed but it is doubtful whether this can be controlled.

However, if the dwellings are allowed to be located nearer to Nebraska Road on the northern lots, the edge impacts would become larger and the shape of the corridor would change. Two noticeable doglegs would become incorporated into the corridor shape and as mentioned previously could be restrictive to the movements of certain fauna species.

Weed problem may not be a major concern with development of these lots because drainage is generally southerly and towards the development. Only isolated weed invasion should occur.

Hazard reduction burning practices however, would need to be addressed using either of the scenarios for locating dwellings. Provided there is a proper management plan enforced and burning is carried out at the required time and with the required fire frequency interval no significant impacts to the corridor would occur but it is doubtful as to whether this can be achieved. On the other hand if hazard reduction control is left to local residents and ad hoc and more frequent burning takes place the impacts could be significant for fauna movement and fauna habitat. Fire increases the risk of predation of ground dwelling mammals and leads to an increase in edge species from open forest species.

Assuming Nebraska Road is constructed as a sealed road, additional traffic would be encouraged and fauna movements would be curtailed. Some bird species will not cross barriers such as roads and slow moving reptiles are often killed by vehicles whilst sunning themselves on the warm road surface. Arboreal fauna may not be so affected provided tall trees are allowed close to the roadside and the distance between trees does not exceed 15 - 20 metres. However, electricity wires sometimes cause death to arboreal fauna (Payne, pers.obs.). Insulating wires using bundle conductors may be the only way of overcoming this problem but it would not be economically feasible in this location. Ground mammals are also killed by vehicular traffic.

A few of the lots incorporate the drainage line which is a refuge area and movement corridor for more specialised fauna. Clearing within the creek line, whilst it would not completely stop fauna movement, would curtail movement patterns for some fauna species and will eliminate others. Habitat 2 may also be occupied by some species of schedule 12 fauna or at least be suitable as feeding and breeding habitat for these species.

Development of the Lots with Access from Pelican Road leaving Nebraska Road as it is

This option is a far better scenario than the above provided conditions are implemented to site dwellings near the southern boundary on lots fronting Nebraska Road. The corridor, provided native vegetation is retained over the majority of the lots, would retain almost all of its existing width with minimal change in shape. It would therefore function almost as effectively as if all lots north of Pelican Road were undeveloped. However, the hazard reduction burning, predatory domestic pet factors and the creekline habitat would have to be similarly addressed as with the first scenario which may not be able to be achieved. Therefore the option would be considered to have some serious edge effects on the corridor.

No Development on Lots fronting Nebraska Road but Development on Lots fronting Pelican Road

Development only on lots fronting Pelican Road would be similar in impact to the scenario where access to all lots was maintained from Pelican Road. Given that the corridor would change little in shape, the width of the corridor would only change by approximately 100 metres. However, the implications of hazard reduction burning, predatory domestic pests and reduction of habitat 2 would still have an impact on native wildlife and wildlife habitat and safeguards would need to be conditioned as part of the development approval process.

No Development on Lots North of Pelican Road

This scenario is obviously the most desired option in terms of conserving the total integrity of the wildlife corridor. It maintains the maximum width, presently involves minimal clearing and retains part of the creek line habitat. Furthermore whilst impacts from domestic predatory pets would have to be considered, the hazard reduction burning is not critical and the latter can be incorporated into the overall hazard burning program for the wildlife corridor. It would retain some of the large old growth trees observed on lots fronting Nebraska Road, which may be important as fauna habitat.

Clearing

Clearing of vegetation within the corridor from the canopy tree layer to the ground vegetation layer is a most important criterion and disruption of these layers will alter wildlife movement. Clearing also destroys wildlife habitat. Most native wildlife (i.e. both forest species and edge species) still require vegetation for movement, habitat requirements (shelter) and food resources. In effect, clearing will reduce the capability of the corridor for the wildlife ecosystem to function and in particular, clearing may reduce the numbers of medium-sized ground dwelling mammals because such areas become inhabited by the European Fox *Vulpes vulpes* (Christenson, 1980).

If clearing involves older trees with hollows, certain species which require these trees for feeding and nesting may be removed from the corridor. Such species include the large owls which are sensitive to habitat disturbance. The larger trees also provide food resources that are less abundant in forests which have younger trees (Loyn, Macfarlane, Chesterfield and Harris, 1980; Smith 1984, 1985). Older trees are also needed to supply an abundant supply of insect food for wildlife. Although some species can survive in a forest patch containing few trees with hollows (e.g. Crimson Rosella, White-throated Treecreeper) higher densities of trees with hollows are required by arboreal mammals. Sugar Gliders and Yellow-bellied Gliders require more than one hollow for shelter (Loyn Macfarlane, Chesterfield and Harris, 1980; Suckling and Macfarlane, 1983) and removal of such trees could destroy arboreal mammal habitat requirements. The trees with hollows could be occupied by a number of schedule 12 species.

Many other species require a high density of old trees for feeding irrespective of their nesting and denning requirements. The suite of species includes honeyeaters and mistletoebirds, insectivorous birds which feed from old eucalypt bark and those which feed amongst the canopy foliage. It also includes those arboreal mammals which feed on sap and invertebrates or on the canopy foliage of tall eucalypts (e.g. Yellow-bellied Glider, Greater Glider).

Recher (1994, in press) states that 30% of eucalypt forest mammals including 24 species of bats use tree hollows, cavities or crevices for shelter and of the arboreal marsupials nine are obligate tree hollow users. 35% (45 species) of forest birds use hollows or cavities for nesting and 80% (32 species) are obligate hole nesters. Tree hollows are also used by reptiles and frogs. On a regional scale, the dependence on the fauna on tree hollows can be considerable and hollows are an important resource for Australian forest vertebrates. If the trees with hollows are cleared the impact on fauna would be severe.

In the context of the overall pattern of the wildlife corridor certain bird species such as the honeyeaters and mistletoebirds fly long distances and can make use of scattered trees for feeding. Clearing may not have a great impact on these species provided it is selective. However, those species which are not as wide ranging, such as the Sugar Glider, require a high density of trees close together and thus clearing could have a high impact on their activities, if such species did occur in the vicinity of the clearing.

Other hollow dependent fauna are territorial and will not use habitat trees clustered close together but instead require random or regular distributed habitat trees (Recher, 1994).

Strips of vegetation along gullies and creeks are important for retention and should not be cleared within the wildlife corridor. These ecosystems have been shown to provide habitat for sensitive mammal and bird species (Loyn, 1985; Suckling, 1982).

If clearing is undertaken in the wildlife corridor lands then the function of the wildlife corridor and diversity of fauna species will be lost. In summary, if the wildlife corridor is to retain its function the vegetation must remain intact at the suggested width.

Critical Areas Which Should be Retained

Critical areas in the vicinity of the Nebraska Estate are the vegetated creek lines and the areas within the corridor which hold large old trees with hollows. However, such areas cannot be designated specifically at this stage and would warrant further field survey. It was noted however, that a number of such trees occurred north of Nebraska Road and north of the Island Point Road. The creek line north of Nebraska Road and draining into the Nebraska Estate lands would qualify under this criteria.

The Significance of the Nebraska Estate Area in a Reserve or Corridor Context

The wildlife corridor in the vicinity of the Nebraska Estate lands is bulk forest with some minor clearing, although it is dissected by the Grange Road and to some extent by the Island Point Road. The Pacific Highway in conjunction with the Tomerong By-Pass will provide a major constriction to wildlife movement unless strategies are put in place to provide access for fauna. Even by employing these strategies not all fauna will traverse major roadways as they perceive them as barriers to movement. However, to the east the length of the corridor is ten kilometres along and with a width in the vicinity of 600 metres gives an area of approximately 750 hectares. Although the shape is not ideal it will function as a reserve and corridor provided the bulk forest remains intact. The majority of the movement of most fauna can be anticipated between the Pacific Highway and the Jervis Bay region which is significant. Notwithstanding the length of the corridor and the fauna contained within it, not all fauna are wide ranging species that will utilise the total corridor length. Certain mammals utilise very small territorial areas although some bats and birds could utilise a major part of the length. A majority of the fauna would only utilise small sections of the total length of the corridor but because different groups occupy different territorial areas, gene exchange and population interbreeding will still occur. The Pacific Highway should not be seen as a major barrier to movement of all wildlife species, but certainly it will pose a barrier to some species.

The presence, however, of the internal road systems and any increase in the density of such roads can only lead to facilitation of movement by the European Fox into the forests to prey upon native mammals.

The value of the land proposed for the corridor in terms of fauna habitat varies. Areas within the Nebraska Estate area have a lesser value than lands to the north. In our view the land within the Nebraska Estate proposed for the wildlife corridor is not essential because there is better forested land available further north. The boundaries of the wildlife corridor in some areas have been chosen on cadastral boundaries instead of ecological boundaries (Viz. Recher, 1994 in press). If land further north can be secured for the wildlife corridor, habitat values overall would be improved and development of the Nebraska Estate could proceed but the requirements of the Endangered Species (Interim Protection) Act, 1991 would still have to be addressed. Although it has been stated that 250 metres is the most acceptable width for the corridor, a construction of a 100 metre width can be acceptable. Reducing the width to any less than this would lend it to impacts from edge processes and the loss of forest dependant birds and mammals.

6.0 FAUNA IMPACT ASSESSMENT

The Fauna Impact Assessment is addressed according to guidelines detailed under the Endangered Fauna (Interim Protection) Act, 1991. Under sections 77, 90 and 112 the seven point assessment test is undertaken to decide whether or not there is likely to be a significant effect from the proposed subdivision on the habitat of endangered fauna. The endangered fauna of concern in this study area based on the current survey and other records in the locality will be:

- o Yellow-bellied Glider *Petaurus australis*
- o Squirrel Glider *Petaurus norfolcensis*
- o Yellow-bellied Sheath-tail Bat *Saccolaimus flaviventris*
- o Great Pipistrelle *Falsistrellus tasmaniensis*
- o Greater Broad-nosed Bat *Scoteanax rueppellii*
- o Southern Brown Bandicoot *Isodon obesulus*
- o Spotted-tailed Quoll *Dasyurus maculatus*
- o Square-tailed Kite *Lophoictina isura*
- o Masked Owl *Tyto novaehollandiae*
- o Powerful Owl *Ninox strenua*
- o Green and Golden Bell Frog *Litoria aurea*
- o Giant Burrowing Frog *Heleioporous australasicus*
- o The Glossy Black Cockatoo *Calyptorhynchus lathamii*
- o The Common Bent-wing Bat *Miniopterus schreibersii*

(a) **The extent of modification or removal of habitat in relation to the same habitat type in the locality**

The area of habitat type (i.e. Blackbutt forest) is extensive, probably well in excess of 50km² whilst the area of the total subdivision area is approximately 30 hectares. The extent of modification is minor (approximately 0.6%) and if the area of the wildlife corridor within the subdivisional lands is omitted the extent of modification will be even less (0.32%). In respect of this subdivision, the issue is complicated because of the presence and location of the proposed wildlife corridor which passes through the northern portion of the subdivision. Clearing of fauna habitat in the subdivision, and within the wildlife corridor could have a functional impact on the corridor proposal.

The extent of creek habitat (habitat 2) is unknown in the locality, which incorporates the described vegetation cover, so it has been included in the above figures.

(b) **The sensitivity of the species of fauna to removal or modification of its habitat**

Yellow-bellied Glider, Squirrel Glider

The Yellow-bellied Glider has been observed in the vicinity of Tomerong Creek and along the Worroing Waterway and considering their movement capabilities are likely to range all along the corridor between the two observation points (Viz. Section 4.6). Specific resource trees for the Yellow-bellied Glider in the area are unknown but based on observational evidence is likely to be Spotted Gum *E. maculata* and Swamp Mahogany *E. robusta*, both winter flowering species. In this regard the animals range between lowland and midslope habitats. Spotted Gum in the vicinity of the subdivision occurs as isolated trees whilst Swamp Mahogany does not occur. It is also postulated that the Yellow-bellied Glider could feed on *E. saligna* x *E. botryoides* which it does in other areas and which is found throughout habitat 2. Further south in the Kioloa State Forest the Yellow-bellied Glider was found to occupy middle to late successional stage forest (Davey and Norton, 1990) where winter flowering eucalyptus occurred and where the habitat was complex.

On the other hand, the Squirrel Glider is found in similar habitat especially in late successional stage forests where sap producing acacias are present (Menkhorst, Weavers and Alexander, (1988). Both species require tree hollows for denning sites.

Both species have similar requirements and both species would be sensitive to removal or modification of habitat if:

- o Feeding resource trees are removed e.g. *E. maculata*.
- o Trees with hollows are removed.
- o Underscrubbing occurs which would remove sap producing acacias.
- o Clearing causes distances between trees to be greater than 15 - 20 metres which would restrict movement of the gliders.
- o Cats and dogs become prevalent which can predate on gliders.

Essentially if any of the above factors happen the gliders would be removed from the area, if they occur. It should be particularly noted that trees of Spotted Gum are found between Pelican and Nebraska Roads whilst *Acacia irrorata* is found generally throughout habitat 3 in disturbed or recently burnt areas. Both species are likely to be notable resource trees.

Great Pipistrelle, Greater Broad-nosed Bat, Yellow-bellied Sheathtail Bat

The Great Pipistrelle is found in forests in the higher rainfall band along the New South Wales coastline although its specific habitat details are unknown. The Greater Broad-nosed Bat has a similar coastline distribution but it is known to inhabit tree lined creeks, ecotonal forest areas and rainforests (Strahan, 1983). Additionally the Yellow-bellied Sheathtail Bat is a forest dwelling species (Hall & Gordon, 1982) but all three species are known to use tree hollows for roosting.

Assuming the subdivision area will be cleared in total (looking at the worst scenario), the species would not be sensitive to this clearing if it was used as a feeding site but would be sensitive if the area was used as a roosting site. Bats are wide ranging species travelling many kilometres in a night to feed and therefore could feed within the remaining forest areas in the district. Provided large trees are present (which attract a greater abundance of insects) their feeding habitat is safe. Vestjens and Hall (1977) have shown that the Great Pipistrelle and the Greater Broad-nosed Bat feeds on a variety of insect species but moths are very important in both of their diets. Roosting sites may be at risk if large trees with hollows are removed.

Southern Brown Bandicoot, Spotted-tailed Quoll

The Southern Brown Bandicoot prefers scrubby habitats akin to heathland which are burnt from time to time. As such vegetation reaches maturity its favourable habitat is reduced and therefore optimum habitat is scrubland which is burnt forming a mosaic of habitats (Strahan, 1983). In view of this proposal the habitat for the Southern Brown Bandicoot is likely to be habitat 1 which lies adjacent to the proposed subdivision.

The Spotted-tailed Quoll is more varied in its habitat requirements, being found in woodland, forest and rainforest. It may live in caves, hollow logs or even tree hollows and therefore could occur in habitat 3 (Strahan, 1983).

The subdivision proposal is unlikely to impact the habitat of the Southern Brown Bandicoot because the majority of its likely habitat lies beyond the boundaries. However, it should be noted that habitat 1 is already zoned for residential development and the specific area of likely habitat of the Southern Brown Bandicoot in the locality is really unknown. This species is more specific than most of the other species mentioned in its habitat requirements. Therefore, in terms of this proposal the Southern Brown Bandicoot is unlikely to be sensitive to modification of habitat on the Nebraska Estate and part of the proposed wildlife corridor.

However, because the Spotted-tailed Quoll is likely to use habitat 3 the species would be sensitive to habitat modification. Food resources would have to be sought elsewhere and if denning sites are disturbed it would have to relocate to an alternative site, if this is at all possible. In summary, this species is highly sensitive to disturbance or modification of its habitat, but because the habitat area to be affected is minor, (considering the overall extent in the locality) no significant impact on the species in the locality is expected.

Square-tailed Kite

The Square-tailed Kite is a raptor which soars low over the tree canopy or through the tree canopy taking smaller birds from their nests, or taking rabbits and lizards from the forest floor or from lower vegetation layers. Nests of the Square-tailed Kite are found in tall eucalypts.

Although the species may occur in the study area, its sensitivity to modification of or removal of its habitat would depend entirely on the area of the modification. With the Nebraska proposal the modification is minor and considering the Square-tailed Kite is a wide ranging species any effect on the species from habitat removal is expected to be minor. However, the Square-tailed Kite is a species which requires tall trees for nesting and such trees are found within habitat 2 and habitat 3. Such trees should be allowed to remain with the development proposal.

Masked Owl and Powerful Owl

The Powerful Owl can inhabit tall open forest where it requires large trees with hollows for nesting. Blackbutt forests (habitat 3; O'Brien, 1990) are typical areas where the species can occur especially where wet gullies are present. It feeds on a range of arboreal mammal species including gliders, possums and bats. The Masked Owl can also occur in similar habitat (O'Brien, 1990) where Blackbutt forests with wet gullies are concerned. It is also a species requiring large hollows for nesting sites.

Smaller gliders, marsupials and rodents form the diet of the Masked Owl.

Both species are sensitive to modification of habitat if such large trees are removed and if habitat (or forest clearing) removes their food resources. Although the Powerful Owl is able to tolerate urban environments, the Masked Owl is probably unable to do so. The latter probably requires more secluded habitats. Both species are also wide ranging requiring many hectares for feeding within their home range. Whilst the extent of habitat removal with the Nebraska Estate proposal is minor, the large trees with hollows and the retention of vegetation within the wildlife corridor could be important factors for these species to survive in the locality, if they occur.

Green and Golden Bell Frog

The Green and Golden Bell Frog appears to be a declining species, the reasons for which are unknown. Although previously recorded in the area near Jervis Bay (Kevin Mills and Associates Pty Ltd, 1988), its habitat is variable occurring in the vicinity of creeks, lagoons and dams with water of variable salinity levels. However, an important factor appears to be areas of dense vegetation cover in association with a deep water body ranging from reedland, sedgeland and even forest. Cleared areas which become subject to inundation beside the vegetation are probably important breeding sites (Andrews.Neil, 1994).

Habitat 2 at the Nebraska Estate site would be the main area where the Green and Golden Bell Frog is likely to occur, due to the presence of the creek. The Green and Golden Bell Frog is a species which is highly sensitive to modification or removal of habitat but the factors concerned are not all that well understood. For example, acidification, land clearing, wetland reclamation, and the presence of Mosquito Fish are all thought to be responsible factors (Viz. Greer, 1994).

If the species occurs at the site, and habitat 2 is cleared the Green and Golden Bell Frog would be expected to decline, although it can survive in remnant urban vegetation.

The Giant Burrowing Frog

The Giant Burrowing Frog is a species which inhabits sandy deep soils usually in association with "hanging swamp" or wet heathland areas. Deep soft sandy soil is required for burrowing and permanent or seasonal water bodies are required for breeding (Payne, pers. obs. Brisbane Water National Park). Habitat 1 is likely to be the only area in the vicinity used by the Giant Burrowing Frog for burrowing but would need habitat 2 to successfully breed.

As the Giant Burrowing Frog requires specialised habitat conditions, development of habitat 2 would eliminate the species from the site. It is a species which is very sensitive to habitat modification and alteration.

Common Bent-wing Bat

The Common Bent-wing Bat is a species which roosts in caves, culverts or mines but probably feeds in a variety of habitats. Local studies so far show the species feeds amongst wetland vegetation, Blackbutt and Scribbly Gum forests (Andrews.Neil, 1993a, 1993b).

Habitat 3 is probably the main feeding area with the development proposal but as the species feeds on insects, particularly moths (Vestjens and Hall, 1977) the larger trees will support the greater abundance of insects. Although habitat 3 with this proposal is likely to be modified, provided the larger trees remain, the feeding habitat will remain. Since the species would not roost at the site and is a wide ranging species, the species would not be considered particularly sensitive to habitat modification in this context. If the total area of the Nebraska Estate area and the wildlife corridor was cleared, then it could be expected the species would not feed at the site.

Glossy Black Cockatoo

The Glossy Black Cockatoo can be very sensitive if modification or removal of habitat occurs. The birds are specific feeders on species of *Casuarina* and *Allocasuarina* and require large trees with hollows for nesting. Trees that the Glossy Black Cockatoo feed upon are usually large mature trees, often located adjacent to tracks and they tend to avoid smaller younger trees. Although many of these trees are present, if such trees are removed from the study area, the Glossy Black Cockatoo would move elsewhere. If large trees with nesting hollows are removed, the population will lose the potential to breed and would need to move to

- (c) **The time required to regenerate critical habitat, namely the whole or any part of the habitat which is essential for the survival of that species**

Yellow-bellied Glider; Squirrel Glider

Since both species require trees with nesting hollows in addition to larger trees for their food requirements, the critical resource unit is deemed to be nesting hollows. Arboreal hollow nesting species will only occupy a hollow which appears after fire, termite or fungal damage. Mackowski, (1984), Lindenmayer Norton and Tanton, (1990) states such hollows only develop and become suitable for use by these species after about 100 - 150 years.

Thus the time required to regenerate critical habitat for these species, if the larger trees are removed, can be in the order of this time period.

Both arboreal mammals use tree hollows and therefore a time period of between 100 and 150 years must be expected to regenerate critical habitat. Critical habitat in this case is deemed to be the regeneration of mature trees to an age where tree hollows can form.

Yellow-bellied Sheath-tail Bat, Great Pipistrelle, Greater Broad-nosed Bat

The three bat species could roost and feed at the site, so critical habitat is deemed to be the presence of tree hollows. Thus, larger trees with hollows may take as long as 100 - 150 years to regenerate. Their habitat requirements are similar to the Yellow-bellied Glider and Squirrel Glider.

Southern Brown Bandicoot, Spotted-tailed Quoll

Critical habitat for the Southern Brown Bandicoot appears to be scrubland with a particular fire frequency. Although such areas would need to be identified, between five and eight years would be required as the fire frequency interval to successfully regenerate vegetation to scrubland. The burning program would need to be undertaken in a mosaic pattern to provide a range of habitats if the Southern Brown Bandicoot occurs in the locality.

As the Spotted-tailed Quoll is more varied in its habitat requirements, critical habitat must be assumed to include tree hollows. Caves do not occur in the vicinity although hollow logs are common. A time period of between 100 and 150 years must be considered to regenerate critical habitat for the Spotted-tailed Quoll.

Square-tailed Kite

Critical habitat for the Square-tailed Kite must include the regeneration of forest to a stage where tall large eucalypts occur. It is estimated a time period of between fifty and eighty years would be required to regenerate critical habitat to this stage.

Masked Owl and Powerful Owl

Critical habitat for these two species must incorporate large trees with nesting hollows and therefore a time period between 100 and 150 years will be required to regenerate critical habitat.

Green and Golden Bell Frog

If the water habitat of the Green and Golden Bell Frog becomes contaminated critical habitat for the species may not be able to be re-established to allow the perpetuation of the species. Catchment impacts are sometimes irreversible once a catchment becomes developed. Poorer quality water unsuitable to the Green and Golden Bell Frog is usually the outcome.

The Giant Burrowing Frog

The same principles stated for the Green and Golden Bell Frog apply to the Giant Burrowing Frog. Habitat destruction may not be able to be reinstated but this will depend on the type of catchment development. If the burrowing habitat of the species is removed or altered it would not be able to be reinstated.

Common Bent-wing Bat

As the Common Bent-wing Bat would only use the area as a feeding ground, the forest with the larger trees would be considered critical habitat. Therefore a time period of approximately eighty years would be required to regenerate critical habitat.

Glossy Black Cockatoo

The time required to regenerate trees of *Casuarina spp.* to mature forms would take at least 20 years. Where trees with nesting hollows are involved a time between 100 and 150 years may be required depending on the fire time interval and fire frequency (Mackowski, 1984).

- (d) **The effect on the ability of the fauna population to recover, including interactions between the subject land and adjacent habitat that may influence the population beyond the area proposed for development or activities.**

Yellow-bellied Glider, Squirrel Glider

The population of these two species may not be able to recover if large trees with hollows are removed, clearing of trees occurs so that movement is restricted, and if food resource trees (sap site trees) are removed. A combination of these factors will mean populations of the species will not be able to recover and therefore large tracts of forest will be needed to conserve populations.

In effect the proposed wildlife corridor will play an important role in this regard and the interaction between the development proposal and the wildlife corridor proposal may determine the future outcome of these arboreal mammal populations. Clearing within the corridor, as distinct from clearing within the development, may eliminate populations from the area. Under the latter circumstances, populations of the species would not be able to recover. If the development area alone were only to be cleared, leaving the sap site trees and large trees with hollows to remain with connecting corridors, it is suggested these species would remain in the locality.

Yellow-bellied Sheath-tail Bat, Great Pipistrelle, Greater Broad-nosed Bat

Since the area of interest does contain trees with hollows, removal of such trees would cause a decline in populations of these species in the vicinity. The populations would not be able to recover until such time the trees regrew and hollows formed. This fact also applies to the large trees with hollows within the wildlife corridor. If the adjacent wildlife corridor land is reduced to these trees the amount of suitable habitat for the bat species would be correspondingly reduced.

Southern Brown Bandicoot, Spotted-tailed Quoll

The subdivision of the Nebraska Estate area is likely to eradicate the habitat of the Southern Brown Bandicoot and populations would not be able to recover. Habitat suitable for this species is habitat 1 which is beyond the extent of development being considered for this proposal.

The ability of the Spotted-tailed Quoll to recover will depend on the extent of habitat clearance. If the subdivision area and the wildlife corridor area are to be cleared the Spotted-tailed Quoll would not be able to recover but if the corridor area remains with understorey vegetation, the species could still survive. The understorey vegetation component is important to prevent competition with the European Fox *Vulpes vulpes*.

Square-tailed Kite

The survival of the Square-tailed Kite will depend upon retention of the forest and retention of tall large eucalypts. If habitat 2 is cleared the Square-tailed Kite could not be expected to inhabit this area and if the wildlife area is cleared similar circumstances will occur. The wildlife corridor would play an important role towards maintaining habitat for this species in the locality.

Masked Owl and Powerful Owl

The Masked Owl and Powerful Owl are species requiring large trees with hollows. Both species would not be able to recover if such trees are removed and clearing alters their feeding habitats to the extent that smaller mammals, gliders and possums are removed from the area. The retention of endangered species habitat therefore depends upon the retention of larger tracts of vegetation for these two species.

Green and Golden Bell Frog

If development proceeds within the catchment the Green and Golden Bell Frog is unlikely to recover. This species appears to be declining, and although the specific reasons for this are unknown, catchment influences are known to be partly the cause.

Giant Burrowing Frog

Similar principles apply to the Giant Burrowing Frog, where if the catchment is developed, the species is unlikely to recover.

Common Bent-wing Bat

The development is not likely to adversely impact the Common Bent-wing Bat. The species will be able to recover because the area is used for feeding only and is a wide ranging species. If either the catchment or the wildlife corridor are cleared the population would move elsewhere to feed, provided the alternate feeding sites are within adequate range of its roosting sites.

Glossy Black Cockatoo

If all the *Casuarina* trees were cleared with the development then the population would move elsewhere, but quite possibly would find refuge within the area of the proposed wildlife corridor. The population would not return until its food trees had re-established.

(e) Any proposal to ameliorate the impacts

Yellow-bellied Glider, Sugar Glider

For both of these species to survive in the locality the proposed wildlife corridor needs to be retained intact with any large trees with hollows. Furthermore, resource trees and movements of the species need to be identified to determine overall habitat patterns. Part of their movement pattern may incorporate the development area in which case additional tracts of vegetation would be required to facilitate movement.

Yellow-bellied Sheath-tail Bat, Great Pipistrelle and Greater Broad-nosed Bat

Critical habitat for these species in the area of interest are trees with hollows and feeding areas along the creek (Habitat 2). In order to keep their habitat intact all large trees with hollows should be retained and the creek corridor should remain vegetated.

Southern Brown Bandicoot, Spotted-tailed Quoll

There can be no proposals to ameliorate impacts for the Southern Brown Bandicoot as the habitat is most likely to occur south of the main drainage line. However, with respect to the Spotted-tailed Quoll the vegetation within the wildlife corridor with understorey and including trees with hollows will need to remain intact.

Square-tailed Kite

The habitat of the Square-tailed Kite may be retained if habitat 2 is kept intact and large eucalypts are retained in the development area and the wildlife corridor remains intact.

Masked Owl and Powerful Owl

The habitat of the Masked Owl and Powerful Owl may be able to be retained if the wildlife corridor vegetation remains intact and all large trees with hollows are allowed to remain within the development area.

Green and Golden Bell Frog

If the development proceeds within the catchment there can be no proposal to ameliorate the impacts on the habitat of the Green and Golden Bell Frog.

Giant Burrowing Frog

If the development proceeds within the catchment there can be no proposals to ameliorate the impacts on the habitat of the Giant Burrowing Frog.

Common Bent-wing Bat

For the feeding area of the Common Bent-wing Bat to perpetuate the wildlife corridor would need to remain intact. In particular, the larger eucalypts should be retained.

Glossy Black Cockatoo

For the habitat of the Glossy Black Cockatoo to remain trees of *Casuarina sp.* and *Allocasuarina sp.* must be retained for their food resources and large trees with hollows must be retained for their nesting activities.

(f) Whether the land is currently being assessed for wilderness by the Director of National Parks and Wildlife Service under the Wilderness Act, 1987

There are currently no plans to assess the land in the vicinity of the Nebraska Estate for wilderness purposes.

(g) Any adverse effect on the survival of that species of protected fauna or of populations of that fauna

Yellow-bellied Glider, Squirrel Glider

If the wildlife corridor cannot be retained intact the populations of the Gliders in the locality may be adversely affected.

Yellow-bellied Sheathtail Bat, Great Pipistrelle, Greater Broad-nosed Bat

If the large trees with hollows cannot be retained then the species may not roost at the site. On the other hand, all three species are wide ranging and may be able to relocate elsewhere.

Southern Brown Bandicoot, Spotted-tailed Quoll

The Southern Brown Bandicoot is now unlikely to occur in the vicinity of the proposed subdivision so there are no additional impacts expected on the survival of the species. However, with respect to the Spotted-tailed Quoll, the subdivision proposal is not expected to have any adverse impacts but if the wildlife corridor is cleared the Spotted-tailed Quoll would be expected to move from the vicinity. This could have adverse impacts on the survival of the species in the locality.

Square-tailed Kite

The Square-tailed Kite is unlikely to occur in the vicinity of the subdivision if total clearing occurs. It would only remain in the locality if the vegetation within the proposed wildlife corridor is kept intact.

Masked Owl and Powerful Owl

The Masked Owl and Powerful Owl could be adversely affected in the vicinity if large trees with hollows are removed from within the subdivision area and from the proposed wildlife corridor.

Green and Golden Bell Frog

The Green and Golden Bell Frog is unlikely to survive in the locality if the subdivision proposal proceeds and the vegetation within the wildlife corridor is cleared. These factors would adversely affect the population of this species in the locality.

Giant Burrowing Frog

The Giant Burrowing Frog is unlikely to occur in the vicinity so the subdivision proposal is unlikely to have any additional adverse impacts on the species in the locality.

Common Bent-wing Bat

The subdivision proposal is unlikely to adversely impact on the survival of the population in the vicinity provided the wildlife corridor is kept intact.

Glossy Black Cockatoo

The Glossy Black Cockatoo population should not be adversely affected by the subdivision proposal provided the wildlife corridor remains intact. The wildlife corridor contains sufficient areas of *Casuarina* sp. and *Allocasuarina* sp. and large trees with hollows which can be used for their resources.

7.0 DISCUSSION OF THE FAUNA IMPACT ASSESSMENT

The fauna impact assessment is based on limited field survey supplemented by a review of the literature. Although only two endangered species were recorded, the literature suggests at least fourteen (14) species listed on schedule 12 may occur in the locality. Whilst this may be the case, the assessment is based on the fact that all of these species may occur in the study area, but not in all cases can their habitats be precisely defined. In addition, because of the short time of the field survey, only limited data on fauna and microhabitats present at the site is available.

The wildlife corridor passes through the northern part of the Nebraska Estate. The position of this corridor places an interacting and opposing factor in respect of the development of the Nebraska Estate. On the one hand the development of the Nebraska Estate will require clearing of vegetation, but on the other hand, the capability of the corridor can only be maintained if the vegetation remains without disturbance. One way of overcoming this matter is to either reduce the extent of development on the proposed Nebraska Estate lands (by way of maintaining the wildlife corridor) or incorporating a more flexible approach by moving the corridor boundary to the north. The two planning scenarios in their present locations are not compatible.

Of the species listed on schedule 12 and expected to occur in the study area (14 species) at least eleven of those species are considered to be wide ranging. The species would feed at the site, but there is potential for the species to roost at the site in the tall large trees present as well. It is important therefore to retain these trees with any development but as most of the large trees are Blackbutt *Eucalyptus pilularis*, dwellings should not be constructed within their driplines. Large trees of Blackbutt are prone to "Summer branch drop" which can cause damage to dwellings. One method of conserving such trees is to avoid development near the trees, which will then also conserve habitat.

In terms of the development area, habitat 2 is also important because it concerns the habitat of endangered fauna which are not wide ranging. The Green and Golden Bell Frog *Litoria aurea*, could well be present in habitat 2 and will need further investigation in Spring - Summer. The verification of this species presence or absence will be an important component when preparing a fauna impact statement for areas within the development. The short time of the survey prohibited a full investigation of habitat 2, although at the locations where the survey was able to be conducted, the species could not be found or heard.

Therefore, considering the development scenarios (Viz. Section 5.0), the option that eliminates development north of Pelican Road is considered the most appropriate. Conservation of this area will keep the wildlife corridor intact and lessen the impact on a number of endangered fauna habitats. If this scenario is adopted it will lessen the need for preparing fauna impact statements. If development is considered for lots north of Pelican Road then further survey will be required in relation to the following matters:

- Location of areas of Spotted Gum *E. maculata* and the potential of these sites to be utilised by the Yellow-bellied Glider and Squirrel Glider. The need for treed corridors to these areas must also be addressed.
- What impacts would clearing within the wildlife corridor have on particular endangered fauna habitat, considering the width of the corridor will be narrowed.
- Location of areas of large trees with hollows and the potential of these trees to be utilised by endangered fauna.

These matters would need to be appropriately addressed through a fauna impact statement. Lots located south of Pelican Road in habitat 3 would not require the preparation of a fauna impact statement because this area is generally cleared regrowth forest.

Habitat 2 is the creek line corridor which is likely to be used as a refuge for specialised fauna and furthermore could be the habitat of the Green and Golden Bell Frog *L. aurea* and several of the bat species. Development on these lots will require further survey which could be appropriately addressed through a fauna impact statement. The development of habitat 2 could impose a barrier to movement, eliminate feeding areas and eliminate the habitat altogether of some endangered fauna species.

Once a decision is made to the development scenario, it should be considered as to whether the fauna impact statement should be undertaken on a lot by lot basis or as a one off fauna impact statement covering the required area. In our opinion the latter is more appropriate in the first instance because it considers the habitat in the study area as a whole and in relation to the wildlife corridor. Applying a fauna impact statement on an individual lot basis would be meaningless because the issue of endangered fauna habitat cannot be addressed in a total context for the study area.

To overcome many of the development problems being encountered by Council, the wildlife corridor can be moved further north. Better habitat lies further north which can offset any loss with the development at the northern section of the Nebraska Estate. Rather than set the wildlife corridor boundary to a cadastral boundary, include lands of higher ecological value located further north.

In summary, it is our opinion that the subdivision, in part, should proceed, but only south of Pelican Road, if the wildlife corridor is to remain in its present position. The location of the wildlife corridor is an integral component of fauna planning in the locality. However, development could proceed north of Pelican Road if an adjustment can be made to the boundaries of the wildlife corridor further north to offset the loss of endangered fauna habitat.

8.0 CHANGES TO THE ENDANGERED SPECIES (INTERIM PROTECTION) ACT

The existing Endangered Species (Interim Protection) Act 1991 has now been extended to 1 October 1995. On 15 September 1993, the Bill, which has been subject to public comment since May 1993, was referred to a Parliament Legislation Committee. The Committee is to examine the range of proposals which have been put forward since May 1993.

The opposition is proposing amendments to the "Endangered and Other Threatened Species Conservation Bill" presently introduced before Parliament by the Member for Manly. The amendments are:

- Proposals for staged recovery plans with a two year deadline for endangered species and a three year deadline for vulnerable species.
- Extension of the legislation to cover plants and plant communities.
- Exemption from the licensing process if a local environmental plan, conservation agreement or recovery plan is prepared.

- Consultation with landowners, local communities and conservation organisations regarding the development of recovery plans.
- Inclusion of a list of potentially vulnerable species which will require monitoring.
- The power to issue stopwork orders to prevent development that is likely to significantly affect the environment of endangered or other protected fauna.
- The preparation of a fauna impact statement for a general licence.

In terms of how the proposed amendments will affect rural development of the Nebraska Estate, possible implications are:

- If rare or threatened plant species are present the current survey did not deal with those issues. More survey would be required to comply with that section of the proposed legislation.
- A local environmental plan may need to be prepared in respect of the feeding habitat of the Common Bent-wing Bat *Miniopterus schreibersii*. If this involved safeguarding the wildlife corridor as a feeding habitat then no recovery plan or conservation agreement would need to be prepared. On the other hand it may be pertinent to prepare a local environmental plan for the wildlife corridor in anticipation of the proposed changes.
- Consultations with local landowners and local conservation groups would need to take place to obtain their views and thoughts of the presence of endangered species. This was not undertaken during the current survey and it is still possible to undertake this process and take their views into consideration through public exhibition.
- The list of potentially vulnerable species is not yet available. These cannot be taken into consideration but it is possible the Greater Glider will be on that list. If so the future legislation could affect the outcome of the development depending what is the intention of the legislation regarding potentially threatened species.
- If the issues already mentioned are not dealt with, the National Parks and Wildlife Service can issue a stopwork order over the development. This would, however depend on the retrospective date of the legislation.
- The preparation of a fauna impact statement with respect to the issue of a general licence is not yet well understood. This matter can only be dealt with as more details on the intended legislation are made available.

9.0 CONCLUSIONS AND RECOMMENDATIONS

In our view, lands located within the Nebraska Estate which form part of the wildlife corridor do not have high ecological attributes compared to those located north of Island Point Road. The Nebraska Estate lands are not essential to the wildlife corridor if the corridor can be widened to the north. However, it should be noted that endangered fauna habitat occurs within the lands proposed for development in Nebraska Estate.

The literature review of previous studies in the area and the limited field survey has revealed fourteen fauna species as listed on schedule 12 of the National Parks and Wildlife Act, 1974, may occur in the vicinity of the Nebraska Estate. Many of the species are wider ranging fauna and likely to be infrequent visitors to the area whilst there are others which are highly likely to be present. Two species, although addressed in this report are highly unlikely to be present.

The location of the Nebraska Estate forms part of the wildlife corridor proposed by the New South Wales Department of Planning. Residential development is incompatible with the concept of a wildlife corridor because clearing of vegetation within the corridor will reduce the capability of the corridors function. Therefore it is recommended that if the boundaries of the corridor cannot be altered then residential development should not proceed north of Pelican Road. If in the event that development is to proceed on lots north of Pelican Road then endangered fauna habitat will be disturbed and a fauna impact statement should be prepared. It is not considered necessary to undertake follow up survey and report preparation for development on lots south of Pelican Road in habitat 3.

The creek line corridor is likely to be habitat for the Green and Golden Bell Frog and development of lots within habitat 2 should require follow up survey targeting this species. A fauna impact statement may be required in the event that this species is found.

It is considered that rezoning can proceed on lands shown as habitat 3 south of Pelican Road. Lands to the north of Pelican Road and those within habitat 2 (the creek line) should not be rezoned until further survey is conducted and a fauna impact statement is prepared.

The implications of changes to the Endangered Species (Interim Protection) Act are not definite at this stage and no further action should be taken to incorporate those proposed changes until definite information is gazetted.

Clearing is not recommended in any area where the wildlife corridor is proposed. If clearing does occur the capability of the corridors function will be lost. Critical areas are the creek lines where some species can seek refuge. Protection of creek lines also affords a degree of catchment protection.

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APPENDIX 1
FAUNA SPECIES LIST

Birds

Accipitridae

Grey (White) Goshawk *Accipiter novaehollandiae*

Cacatuinae

Glossy Black-Cockatoo *Calyptorhynchus lathami*

(Listed on schedule 12 of the National Parks and Wildlife Act, 1974)

Yellow-tailed Black-Cockatoo *Calyptorhynchus funereus*

Gang Gang Cockatoo *Callocephalon fimbriatum*

Polyteliiinae

Australian King Parrot *Alisterus scapularis*

Platycercinae

Crimson Rosella *Platycercus elegans*

Eastern Rosella *Platycercus eximius*

Cuculidae

Fan-tailed Cuckoo *Cuculus flabelliformis*

Shining Bronze-Cuckoo *Chrysococcyx lucidus*

Common Koel *Eudynamys scolopacea*

Strigidae

Southern Boobook *Ninox novaeseelandiae*

Campephagidae

Black-faced Cuckoo-shrike *Coracina novaehollandiae*

Muscicapidae

Eastern Yellow Robin *Eopsaltria australis*

Rufous Whistler *Pachycephala rufiventris*

Grey Shrike-thrush *Colluricincla harmonica*

Grey Fantail *Rhipidura fuliginosa*

Acanthizidae

Yellow-throated Scrubwren *Sericornis citreogularis*

White-browed Scrubwren *Sericornis frontalis*

White-throated Gerygone *Gerygone olivacea*

Brown Thornbill *Acanthiza pusilla*

Buff-rumped Thornbill *Acanthiza reguloides*

Yellow (Little) Thornbill *Acanthiza nana*

Climacteridae

White-throated Treecreeper *Cormobates leucophaea*

Meliphagidae

Red Wattlebird *Anthochaera carunculata*

Yellow-faced Honeyeater *Lichenostomus chrysops*

Eastern Spinebill *Acanthorhynchus tenuirostris*

Ptilonorhynchidae

Satin Bowerbird *Ptilonorhynchus violaceus*

Cracticidae

Grey Butcherbird *Cracticus torquatus*
Pied Currawong *Strepera graculina*

Corvidae

Australian Raven *Corvus coronoides*

Mammals

Petauridae

Greater Glider *Petauroides volans*
Sugar Glider *Petaurus breviceps*

Pteropodidae

Grey-headed Flying-fox *Pteropus poliocephalus*

Rhinolophidae

Eastern Horseshoe-bat *Rhinolophus megaphyllus*

Molossidae

Little Northern Mastiff-bat *Mormopterus loriae*

Vespertilionidae

Common Bent-wing Bat *Miniopterus schreibersii*
(Listed on schedule 12 of the National Parks and Wildlife Act, 1974)
Chocolate Wattled Bat *Chalinolobus morio*
Gould's Wattled Bat *Chalinolobus gouldii*
Little Forest Bat *Vespadelus vulturnus*

Felidae

Feral Cat *Felis catus*

Amphibians

Limnodynastes

Brown-striped Frog *Limnodynastes peronii*

Paracrinia

Haswell's Frog *Paracrinia haswelli*

Ranidella

Common Eastern Froglet *Ranidella signifera*

Litoria

Bleating Tree Frog *Litoria dentata*
Freycinet's Frog *Litoria freycineti*
Peron's Tree Frog *Litoria peronii*

Reptiles

Lampropholis

Common Skink *Lampropholis delicata*

REVISED FLOODLINE

← EXTENT OF RURAL
LOTS in DP 9699



Figure 1

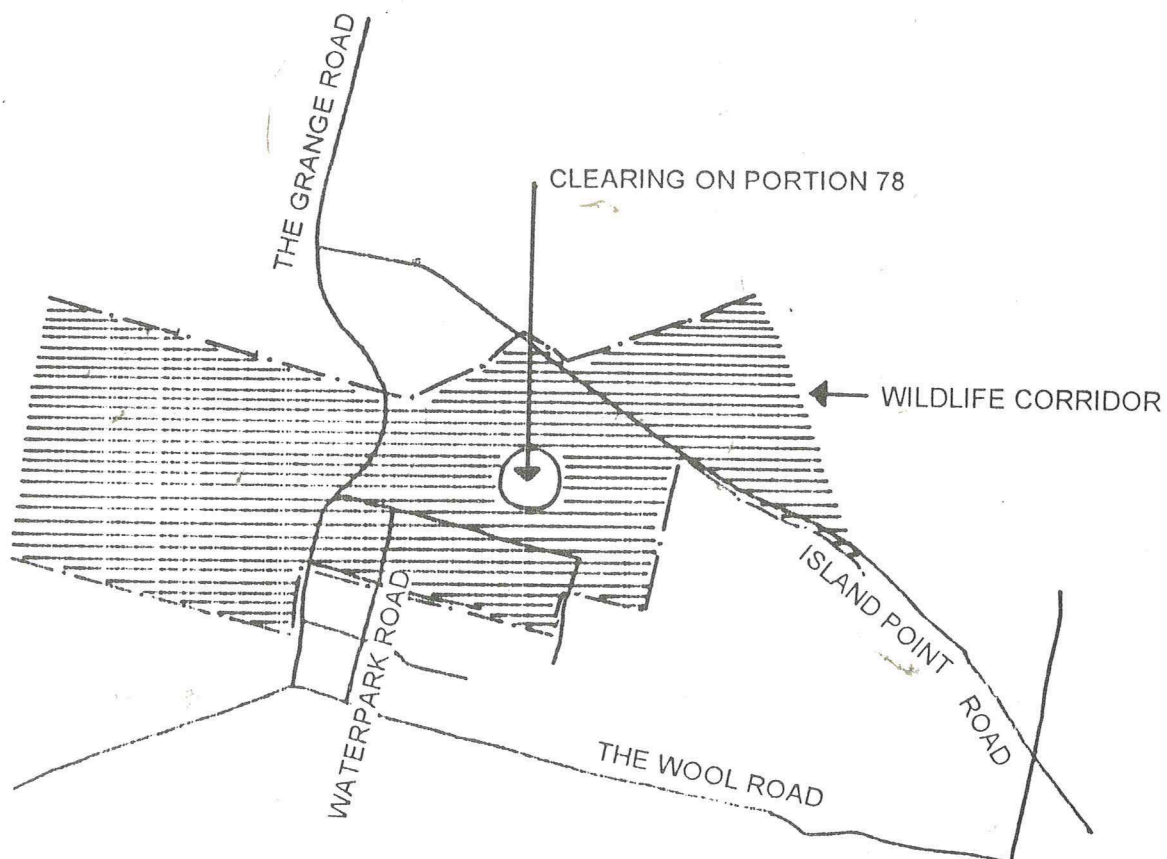
VEGETATION MAP

NEBRASKA ESTE

Nebraska Estate - Shoalhaven City Council

Andrews, Neil Architects, Planners, Landscape Consultants
207 Albany St Nth, Gosford NSW 2250
Ph: 043 24 3633 Fax: 043 24 3771 December 1993

- Woodland - Red Bloodwood - Turpentine - White Stringybark
- Open Forest - Bangalay x Bluegum
- Open Forest - Blackbutt - Sydney Peppermint - Red Mahogany
- Proposed Wildlife Corridor



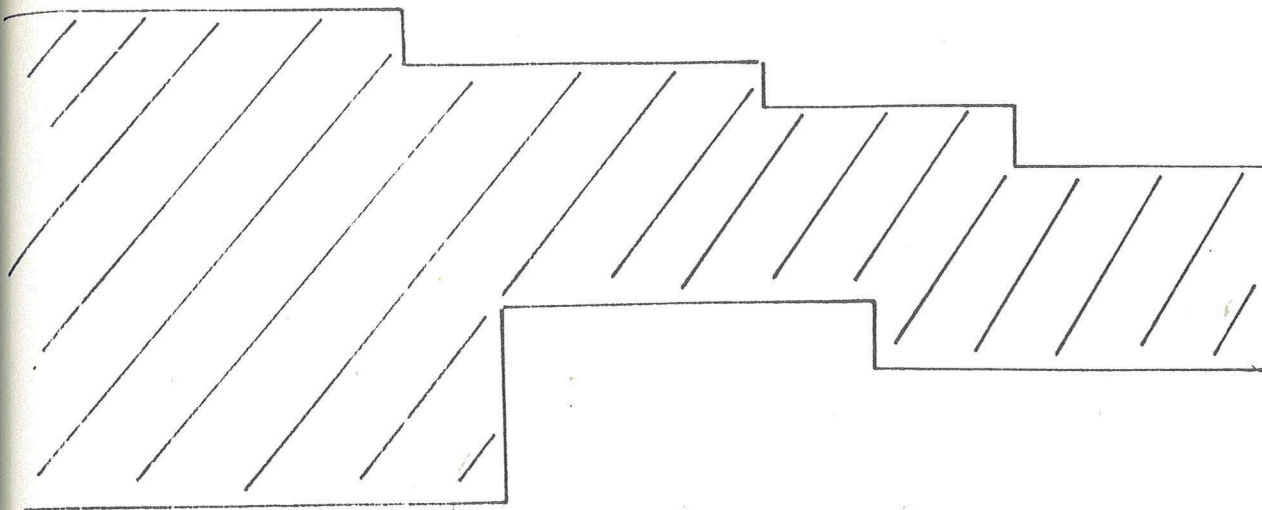
NORTH
SCALE 1:25 000

Figure 2

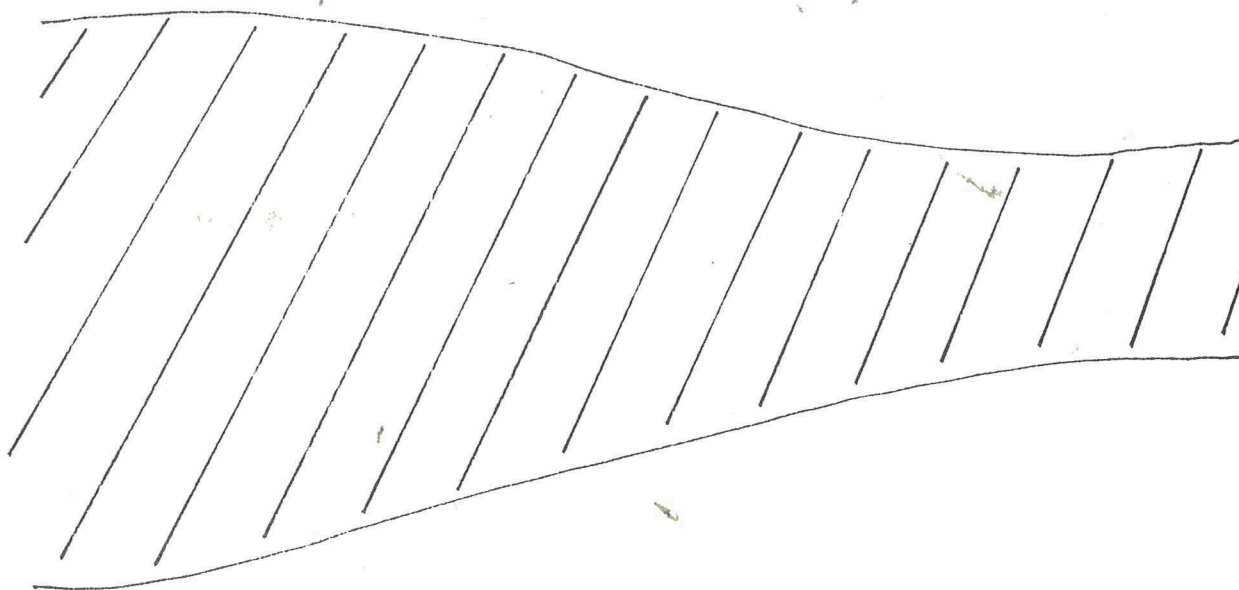
MAP SHOWING RECENT CLEARING IN
THE PROPOSED WILDLIFE CORRIDOR

Nebraska Estate - Shoalhaven City Council

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The pattern above shows the boundary of the wildlife corridor with a number of doglegs. This is unsuitable because some species perceive the dogleg as a barrier to movement.



The boundary is more appropriate if it is straight because doglegs are eliminated.

Figure 3

SUGGESTED BOUNDARY ARRANGEMENTS FOR WILDLIFE CORRIDORS

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