Travers

bushfire & ecology

ecological constraints analysis

Rezoning Study
Lot 21 DP 862841
1590 Burragorang Road, Oakdale

April 2013
(REF: A13003F)

Ecological Constraints Analysis

1590 Burragorang Road
Oakdale, NSW

APRIL 2013

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Disclaimer:

This report has been prepared to provide advice to the client on matters pertaining to the particular and specific development proposal as advised by the client and / or their authorised representatives. This report can be used by the client only for its intended purpose and for that purpose only. Should any other use of the advice be made by any person including the client then this firm advises that the advice should not be relied upon. The report and its attachments should be read as a whole and no individual part of the report or its attachments should be interpreted without reference to the entire report.

The mapping is indicative of available space and location of features which may prove critical in assessing the viability of the proposed works. Mapping has been produced on a map base with an inherent level of inaccuracy, the location of all mapped features are to be confirmed by a registered surveyor.

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Executive Summary

This Ecological Constraints Analysis report has been prepared to identify the potential ecological constraints for the purposes of a future rezoning application at 1590 Burragorang Road, Oakdale, NSW.

Recorded Threatened Flora, Fauna and EECs

Ecological survey has been undertaken for relevant threatened flora, fauna and endangered ecological communities and populations.

In respect of matters required to be considered under the *Environmental Planning and Assessment Act 1979* and relating to the species / provisions of the *Threatened Species Conservation Act 1995*, five (5) threatened fauna species have been recorded within, or immediately adjacent to, the site including:

- Glossy Black-Cockatoo (*Calyptorhynchus lathami*)
- Square-tailed Kite (*Lophoictinia isura*)
- Masked Owl *Tyto novaehollandiae*)
- Eastern Bentwing-bat (*Miniopterus orianae oceansis*)
- Eastern Falsistrelle (*Falsistrellus tasmaniensis*)

Note that the Square-tailed Kite, Eastern Falsistrelle and Masked Owl were recorded to a 'probable' level of certainty.

No threatened flora species were recorded within the study area.

One (1) Endangered Ecological Community (EEC), Shale / Sandstone Transition Forest was recorded.

In respect of matters required to be considered under the *Environment Protection and Biodiversity Conservation Act 1999*, no threatened fauna species and no threatened flora species were recorded within the study area. One (1) Endangered Ecological Community - Shale / Sandstone Transition Forest listed under this Act was recorded within the study area.

In respect of matters relative to the *Fisheries Management Act 1994*, no suitable habitat for threatened marine or aquatic species was observed within the study area and there are no matters requiring further consideration under this Act.

Proposed Zonings

The current zoning of the site in accordance with Wollondilly LEP 2011, is RU1 - Primary Production. The proponent seeks to rezone the appropriate portions to either R2 Low Density Residential and / or R5 Large Lot residential development.

A conservation significance map has been prepared identifying low, medium, high and very high conservation significance landscape and is the basis of the defined zonings as shown in Figure 1.

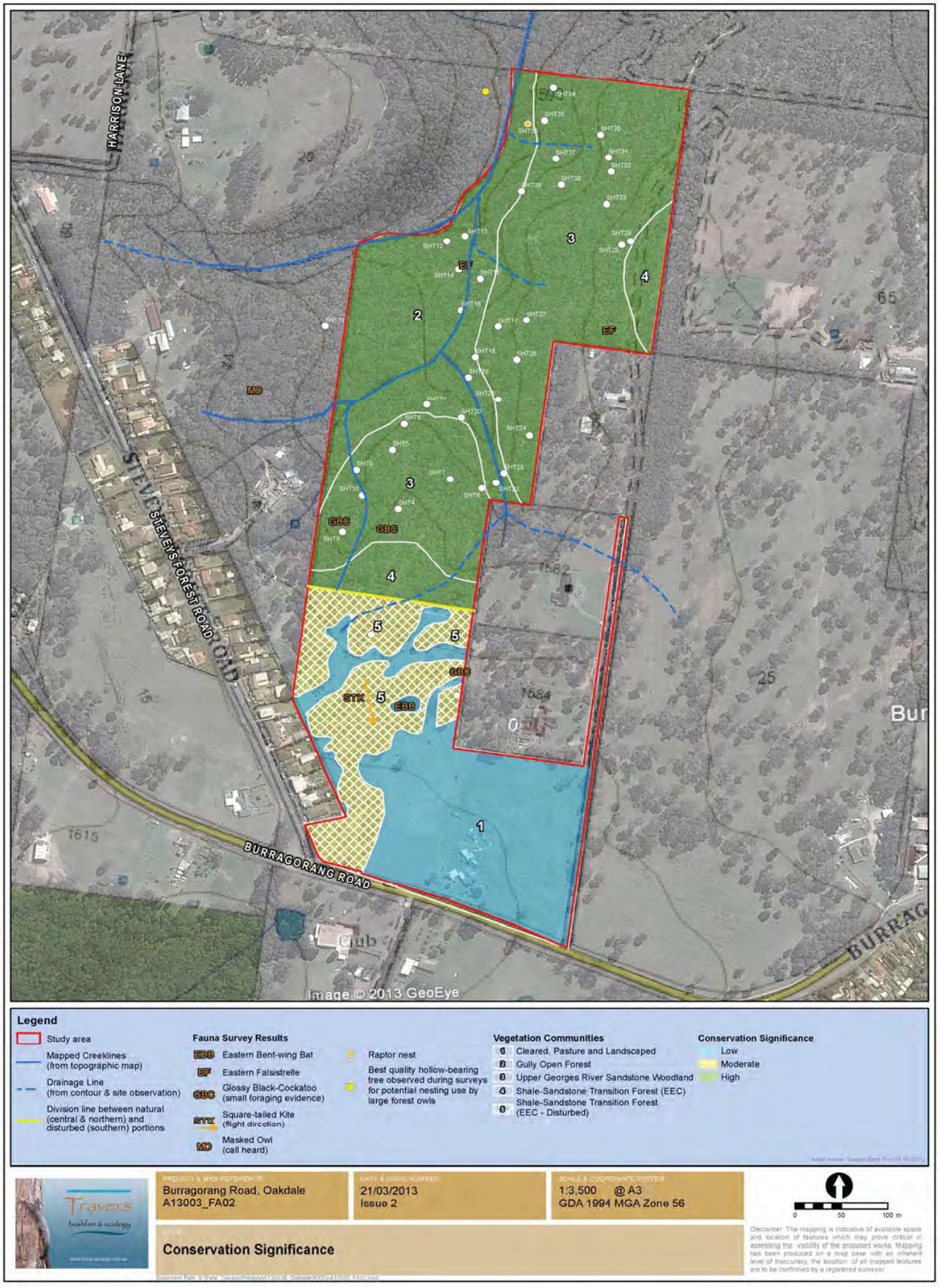

Figure 1 - Conservation Significance of Burragorang Road, Oakdale

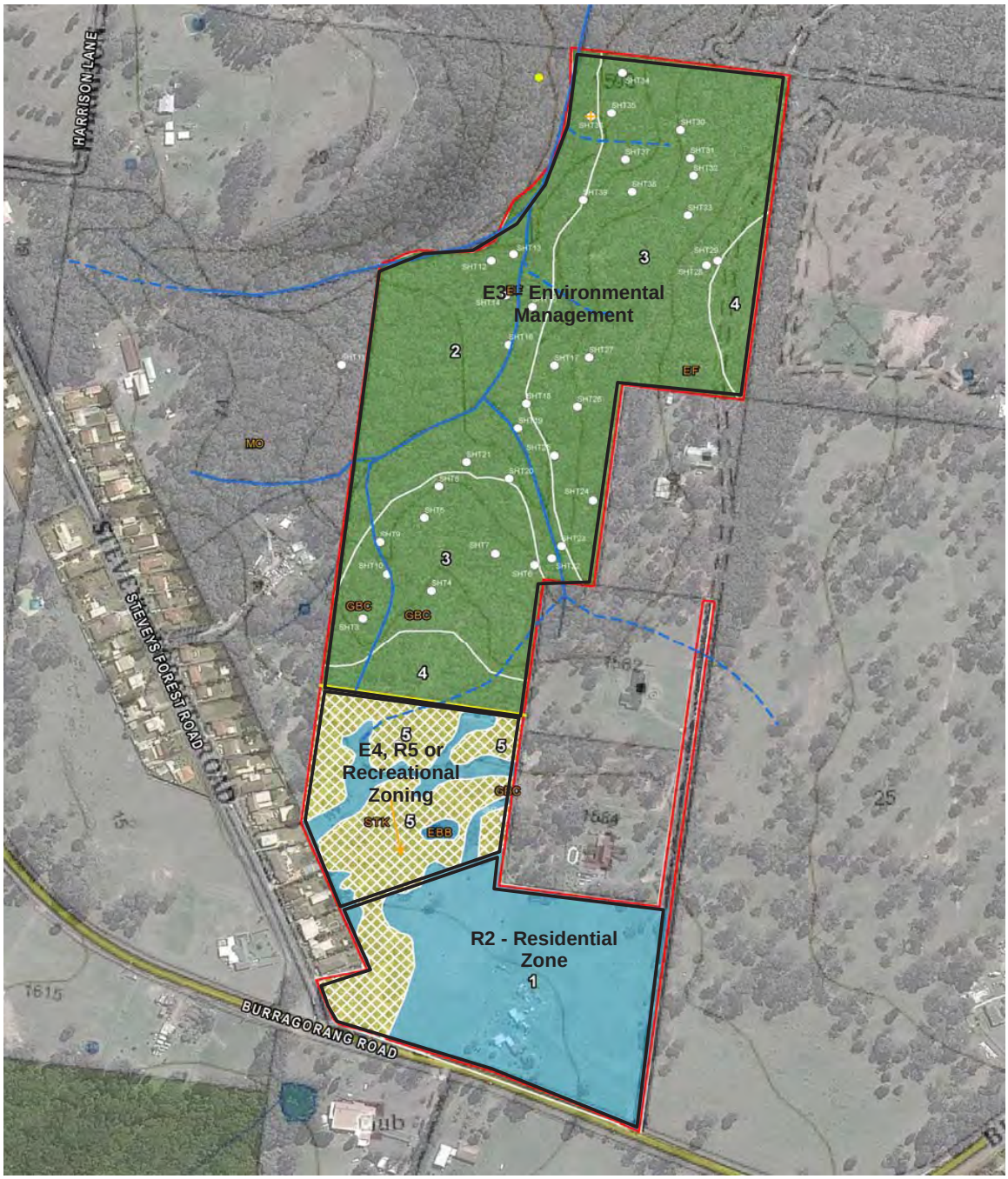

Figure 2 - Recommended Zones

The proposed zones have not been determined but we have recommended suitable zonings based on the identified ecological constraints. Based on the *Ministerial Direction 2.1 Environmental Protection Zones*, we recommend that the following zonings are suitable to the subject lands:

- **E3 Environmental Management** – in this case for lands that provide protection and buffers for watercourses and contain existing and potential threatened species habitat
- **E4 Environmental Living** – in this case for existing forested slopes that may be sensitively developed such as the existing degraded portions of the EEC, Shale / Sandstone Transition Forest, subject to offsetting provisions.

- **Residential Zones** such as R2 Low Density Residential, R3 Medium Density Residential or R5 Large Lot Residential for all cleared or low condition vegetation areas.

Figure 2, which identifies the recommended zonings is a zoning concept that minimises the losses of the EECs and provides protection for threatened species habitat and foraging areas such as Glossy Black-Cockatoo, Masked Owl and threatened micro-chiropteran bat species. It also provides catchment protection in terms of the existing local watercourses and surrounding catchment areas. However, the mapping of these zones is subject to a wide range of factors and would need to be considered in an integrated manner.

Biodiversity offsetting provisions also need to be considered and are not part of the brief for this study. In the case of the zonings proposed on Figure 2, there will be a loss of degraded EEC, Shale / Sandstone Transition Forest. This is likely to trigger the need for a biodiversity offset of equivalent value to achieve a maintain or improve outcome for EEC, Shale / Sandstone Transition Forest. The degraded portions of the EEC, Shale / Sandstone Transition Forest, are not considered to be 'low condition' i.e. capable of being removed without any offsetting. This is based on the Biometric Assessment Method used for BioBanking and offsetting purposes.

Offsetting can be provided onsite or offsite but the former is easier to achieve unless the land owner has existing lands containing similar habitat of the appropriate size and that can be conserved in perpetuity under a secure conservation agreement.

Further impact on the mapping vegetation communities would cause greater levels of offsets to be determined using a biodiversity certification or BioBanking assessment process.

Limitations of the Current Study

With respect to flora, target threatened species survey was limited to only the southern portion of the study area within existing cleared or partially managed lands, or within quadrats in the northern portion of the study area. The survey was undertaken over a consecutive two (2) day time frame in early autumn. A spring survey would be recommended within the northern portion of the study area to target threatened flora species.

The boundary between sandstone dominated vegetation and Shale / Sandstone Transition Forest vegetation is approximate and can be further defined through additional floristic quadrats in close proximity to the currently mapped boundary.

A call identified as a possible Masked Owl was heard during nocturnal surveys. Masked Owls, as with other owls, have a higher potential to respond to call-playback during the breeding period, but on average are found to respond with a 50% success rate following 4 nights' call-playback and 90% probability following 9 nights' call-playback. This species is better surveyed for presence and use of the study area during the peak breeding period of autumn to early winter. Potential owl trees have been identified and the use of these trees during the peak breeding period has not been determined through survey.

Fauna trapping surveys have not been undertaken within the study area. Trapping survey would be required within any areas of high quality habitat as indicated north of the fence line / clearance line on shown Figure 1. As the site is suitable habitat for Spotted-tailed Quoll and local drainages are suitable habitat for Giant Burrowing Frog, target survey is recommended to identify active use of the site by these threatened species.

Despite an absence of local records, the lower drainages are highly suitable habitat for Giant Burrowing Frog that would warrant further surveys in the case of any proposed development rezoning within the central and northern natural areas.

Riparian Ecology

Mapped watercourses have been investigated as part of this study. Our site investigations have identified that drainage lines extend further than currently mapped, including areas that might be suitable habitat for threatened frog species. This flora and fauna assessment report has undertaken an assessment of the ecology of the entire site including the riparian corridor. The riparian zone is vegetated by Gully Open Forest in the lower reaches and Upper Georges River Sandstone Woodland in the upper reaches. All riparian areas are generally in a good condition and do not contain any significant environmental or noxious weed incursions.

The riparian ecology is a typical upper catchment containing first and second order streams. The first order streams (to be confirmed by site inspection) typical attract a 10m vegetated riparian zone (VRZ) from the top of the nearest high bank. This typically results in a riparian corridor width of 20-40m, including an undefined channel width. The extent of the riparian zones and the mapping of these zones would need to be based on detailed contour land survey.

The conservation value in the existing vegetation onsite is a combination of its role in providing catchment protection, threatened species habitat and protection of EECs. In the event that development is proposed on adjoining lands, this parcel of land contains a significant portion of the remnant vegetation and associated fauna habitat in the local catchment. Removal of a significant portion of the existing vegetation would have an adverse impact on riparian ecology and threatened species habitat.

Within existing degraded lands, including existing drainage lines of watercourses, this could feasibly be managed as part of an urban landscape with appropriate stormwater collection and treatment measures.

Appropriateness of the Land for Rezoning

Figure 1 provides the combined ecological constraints and identifies area of low, medium and high conservation significance according to ecological surveys to date. It is considered that all previously disturbed lands to the south of the transition line between natural and disturbed habitats, as indicated on Figure 2, are suitable for rezoning for development of some kind.

Any loss in the degraded Shale / Sandstone Transition Forest or threatened species habitat would need to be offset appropriately in accordance with the *Principles for Use of Biodiversity Offsets in NSW* (NSW Office of Environment and Heritage). Consideration should be given to minimising the loss of the Shale / Sandstone Transition Forest through protection of existing trees insitu or providing a restoration offset either on or offsite.

Indirect impacts on downslope and downstream impacts may be effectively mitigated to prevent deterioration to the existing watercourses or remaining habitats in the northern portions of the site.

The moderate and high conservation significance areas are currently identified in a precautionary manner based on habitat potential for threatened species and not on current

recordings alone. Further surveys incorporating trapping effort for target owl, cockatoo and frog surveys may increase or decrease the conservation significance.

The moderate conservation significance mapped areas may be suitable for E4 Environmental Living, a recreational zone or a large Lot residential zone all of which may involve the insitu protection of trees. Beyond these areas, the high conservation significance mapped areas provide diverse, high quality habitat features, particularly on the eastern slopes. The value of this area for conservation is also based on the expansive area of these habitats, their connectivity beyond the study area to the north and potential for use by threatened species (e.g. breeding, foraging or social areas) and water quality protection.

Mitigation measures

The following mitigation measures are considered appropriate for the proposed residential and E4 Environmental Living Zones. With respect to the proposed Residential Zone, we recommend that future development be designed in accordance with:

- Water sensitive urban design principles,
- Is managed to minimise the export of sediment and implements site specific erosion controls in accordance with the *Soils and construction manual - Managing Urban Stormwater* (Landcom 2004),
- Protects waterfront lands and implements controls in accordance with the NSW DPI *Guidelines for Controlled Activities on Waterfront Land* (2012),
- Allows for the ongoing management and enhancement of remnant bushland areas in accordance with the *Cumberland Plain Recovery Plan* (2010), and
- Maintains a managed buffer (inclusive of asset protection zones) that reduces the likelihood of weed invasions and loss of native vegetation within the riparian corridor.
- Requires development applications within the Residential and E4 Environmental Living Zones to include target survey for hollow dependent threatened species such as the Masked Owl and Glossy Black-Cockatoo during the nesting seasons within affected forested areas.
- Requires development applications within the E4 Environmental Living Zone to include the identification of, and where possible, retention of hollow bearing or significant habitat trees to support hollow dependent fauna species.
- Allows for the sensitive removal of fauna within affected native vegetation areas and allows for the re-use of hollows and / or nest boxes as compensatory nesting resources within protected vegetation.

With respect to the proposed E3 Environmental Zone, we recommend that future management be designed in accordance with the following mitigation measures:

- Minimise the export of sediment and implements site specific erosion controls in accordance with the *Soils and construction manual - Managing Urban Stormwater* (Landcom 2004), and
- Protect vegetation within waterfront lands and implement controls in accordance with the *NSW DPI Guidelines for Controlled Activities on Waterfront Land (2012).*

- Provides adequate separation to watercourses for effluent treatment purposes and effectively controls and treats stormwater runoff into the creek.

- Minimises the loss of trees and associated habitat due to asset protection zones, access, building sites and services.

- Allows for the ongoing management and enhancement of remnant bushland areas in accordance with the *Cumberland Plain Recovery Plan* (2010).

- In accordance with the principles of the *Cumberland Plain Recovery Plan* (2010), we recommend that a Vegetation Management Plan (VMP) be prepared, and implemented when appropriate, outlining the best practice methods to protect and restore remnant vegetation within E3 or E2 zones.

Conclusion

The main ecological constraint within the subject lands is the Endangered Ecological Community Shale / Sandstone Transition Forest located on the plateau areas which are most likely to be subject to rezoning for development. The loss of EECs may be managed through protection of the main stands, selective clearing of vegetation rather than clear-felling, revegetation works in disturbed patches and / or closing existing tracks which would become redundant.

There appear to be no significant threatened fauna constraints within the low and moderate conservation significance areas, however, this would need to be verified with further target survey particularly for hollow dependent threatened species. A habitat tree survey and management strategy can effectively identify high quality hollows for threatened species and minimise adverse impacts by a combination of protection, relocation and nest box works.

Any future development application within vegetated landscapes would need to be accompanied by target threatened species survey and an assessment of impacts on threatened species considered via a 7 part test of significance. Any newly listed threatened species, EEC or population will also need to be assessed in accordance with the requirements of the *Environmental Planning and Assessment Act 1979*, *Threatened Species Conservation Act 1995*, the *Environment Protection and Biodiversity Conservation Act 1999* and the *Fisheries Management Act 1994*.

There are likely to be significant direct and indirect impacts from the proposal upon the EEC Shale / Sandstone Transition Forest. Stormwater outlets are also likely to impact within the riparian corridor which may result in localised impacts. Such impacts should not be addressed at the single lot development application stage but rather during the subdivision process to prevent any changes in natural riparian ecology.

List of abbreviations

APZ	asset protection zone
BPA	bushfire protection assessment
CLUMP	conservation land use management plan
DCP	Development Control Plan
DEC	NSW Department of Environment and Conservation (superseded by DECC from 4/07)
DECC	NSW Department of Environment and Climate Change (superseded by DECCW from 10/09)
DECCW	NSW Department of Environment, Climate Change and Water (superseded by OEH from 4/11)
EEC	endangered ecological community
EPA	Environmental Protection Agency
EP&A Act	*Environmental Planning and Assessment Act 1979*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
ESMP	ecological site management plan
FF	flora and fauna assessment
FM Act	*Fisheries Management Act 1994*
FMP	fuel management plan
HTA	habitat tree assessment
IPA	inner protection area
LEP	Local Environment Plan
LGA	local government area
NES	national environmental significance
NPWS	NSW National Parks and Wildlife Service
NSW DPI	NSW Department of Industry and Investment
OEH	Office of Environment and Heritage (Part of the NSW Department of Premier and Cabinet)
OPA	outer protection area
PBP	*Planning for bush fire protection 2006: A Guide for Councils, Planners, Fire Authorities and Developers*
PCL	priority conservation lands
POM	plan of management
RF Act	*Rural Fires Act*
RFS	NSW Rural Fire Service
ROTAP	rare or threatened Australian plants
SEPP 44	*State Environmental Protection Policy No 44 – Koala Habitat Protection*
SEWPAC	Federal Department of Sustainability, Environment, Water, Population and Communities
SIS	species impact statement
SULE	safe useful life expectancy
TPO	tree preservation order
TPZ	tree preservation zone
TRRP	tree retention and removal plan
TSC Act	*Threatened Species Conservation Act 1995*
VMP	vegetation management plan

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Introduction 1

This Ecological Constraints Analysis report has been prepared by *Travers bushfire & ecology* to identify potential ecological constraints associated with a proposed rezoning at 1590 Burragorang Road, Oakdale, NSW within Wollondilly LGA.

1.1 Description of project

The aims of the flora and fauna assessment are to:

- Carry out a botanical survey to describe the vegetation communities and their conditions;
- Carry out a fauna survey for the detection and assessment of fauna and their habitats;
- Complete target surveys for threatened species, populations and ecological communities;
- Prepare a flora and fauna constraints analysis in accordance with the requirements of the *Environment Protection and Biodiversity Conservation Act 1999* (*EPBC Act*), the *Threatened Species Conservation Act 1995* (*TSC Act*), the *Fisheries Management Act 1994* (*FM Act*) and guidelines issued by OEH; and
- Consider the appropriateness of the proposed zonings.

1.2 Study area

Table 1.1 provides a summary of the planning, cadastral, topographical, and disturbance details of the study area.

Table 1.1 – Site features

Location	Lot 21 DP 862841, 1590 Burragorang Road, Oakdale.
Local government area	Wollondilly
Grid reference	269500E 6226400N
Elevation	430-440m AMSL
Topography	There are gentle slopes on the southern side of the study area with slightly steeper slopes running north east. The beginning of Horse Creek watercourse is running north east from the northern boundary of the site area.
Geology	Oakdale sits on the edge of where Ashfield shale meets Hawkesbury sandstone.
Catchment and drainage	The study area drains north east towards Horse Creek which comes off Lake Burragorang and travels through the study site.
Vegetation	Forest / woodland structure in residual vegetation. Gully forest along creek lines. Cleared or managed remnants of vegetation within the southern portion.
Existing land use	Rural residential with some grazing animals.
Clearing	The majority of the southern portion of the study area has been cleared or managed, with areas of regrowth and some remnant canopy.

Figure 1 - Study area - Lot 21 DP 862841
(Source: *Spatial Information Exchange*)

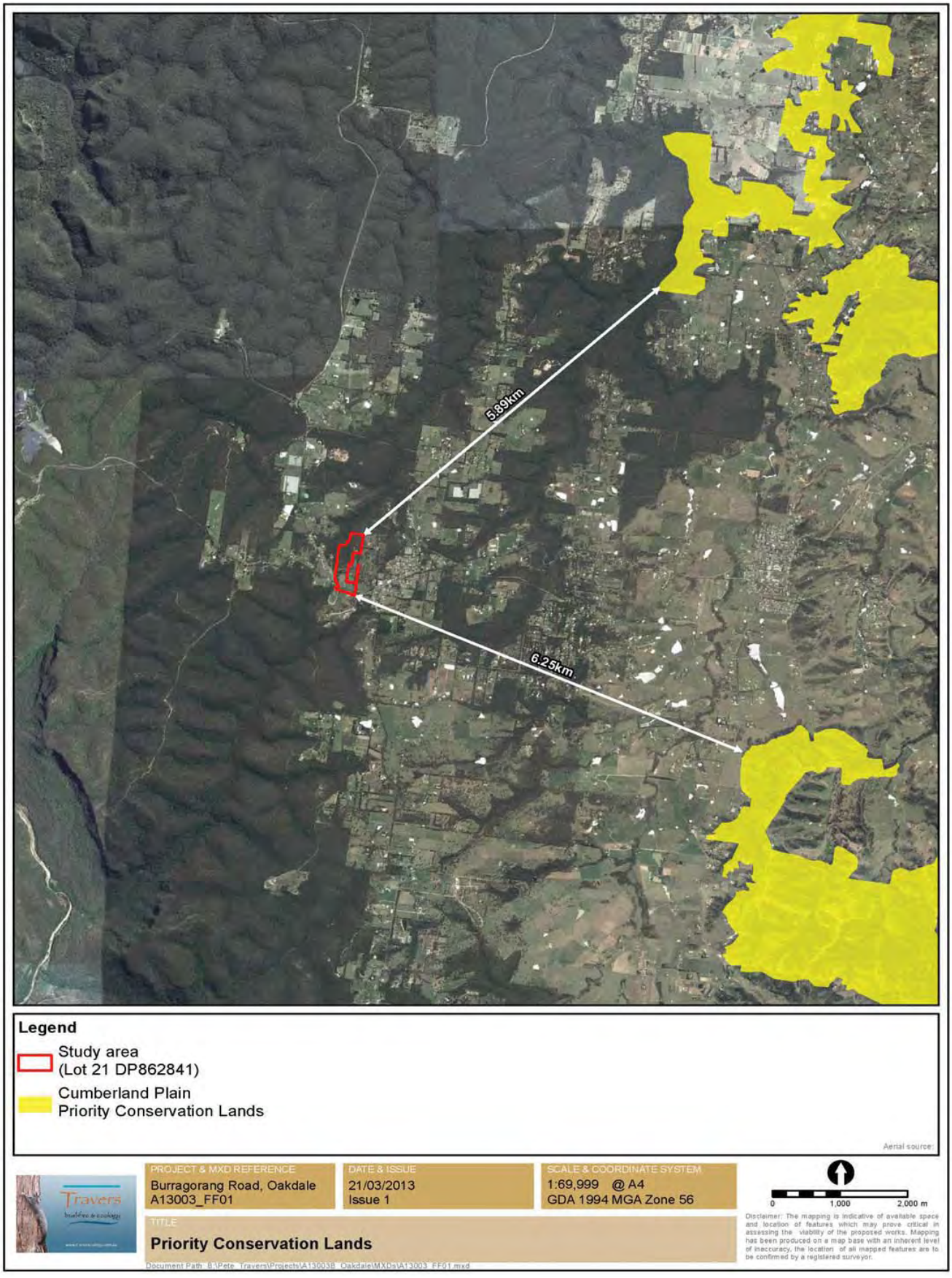

Figure 2 - Location of the nearest priority conservation lands (PCL)
(Source – Cumberland Plain Recovery Plan, 2010)

Literature Review 2

2.1 Cumberland Plain Endangered Ecological Communities: Preliminary Draft Recovery Plan

The Cumberland Plain in western Sydney is Australia's fastest growing and most populous region. Many of its unique natural attributes need special effort to maintain their values and ensure their protection. Just 13% of western Sydney's native vegetation remains in highly fragmented patches of varying size and condition. The overall objective of the *Cumberland Plain Recovery Plan* is to provide for the long term survival of the threatened biodiversity of the Cumberland Plain. It is comprised of four (4) main objectives:

- Recovery Objective 1: To build a protected area network, comprising public and private lands, focused on the priority conservation lands
- Recovery Objective 2: To deliver best practice management for threatened biodiversity across the Cumberland Plain, with a specific focus on the priority conservation lands and public lands where the primary management objectives are compatible with biodiversity conservation
- Recovery Objective 3: To develop an understanding and enhanced awareness in the community of the Cumberland Plain's threatened biodiversity, the best practice standards for its management, and the recovery program
- Recovery Objective 4: To increase knowledge of the threats to the survival of the Cumberland Plain's threatened biodiversity and thereby improve capacity to manage these in a strategic and effective manner

The recovery plan describes the necessary actions to halt further losses of vegetation and to achieve a net gain. DECCW has completed an assessment of the remnant bushland areas on the Cumberland Plain which has resulted in the identification of priority conservation lands (PCLs). The PCLs have been identified as the lands that represent the best remaining opportunities in the region to secure long-term biodiversity benefits for the lowest possible cost.

The identification of the PCLs as priorities should not be misinterpreted as underrating the significance of other remnant vegetation. While the plan promotes the PCLs as the regional priorities for the Cumberland Plain, areas of local significance (such as corridors and smaller Council reserves) are intended to complement and enhance regional conservation priorities DECCW 2010 - *Cumberland Plain Recovery Plan*).

Albeit the site is not identified as a PCL, active restoration of remnant bushland on the Cumberland Plain using best practice restoration methods is expected to be promoted and implemented in areas of conservation value to minimise further degradation of a fragmented landscape. The *Cumberland Plain Recovery Plan* contains principles and practices of best practice to be adopted.

The *Cumberland Plain Recovery Plan* also supports the use of offsets where impacts on threatened species, populations and ecological communities cannot be avoided. Offsets at a predetermined ratio increase the extent and condition of vegetation on the Cumberland Plain using assisted natural regeneration and revegetation techniques.

The site does not occur within an area described as a priority conservation land (PCL) under the *Cumberland Plain Recovery Plan* (2010). The nearest PCL occurs approximately 6km away to the north east and south east of the site (Figure 2).

The southern portion of the study area would be considered most suitable for a residential type of zoning. Some larger lots in the north eastern portion of the site that have the ability to retain a fair portion of the existing vegetation may also be considered appropriate and consistent with the objectives of the Cumberland Plain Recovery Plan. The more sensitive natural bushland areas should be zoned for environmental protection.

2.2 Native Vegetation of the Cumberland Plain, Western Sydney Vegetation Community, Condition and Conservation Significance Mapping

Vegetation Mapping of the Cumberland Plain (NPWS 2002)

The vegetation within the study area, where identified, has been mapped as Map Unit 2, Shale / Sandstone Transition Forest (High Sandstone Influence) or Map Unit 32, Upper Georges River Sandstone Woodland. The gully lines are unmapped and the cleared portion of the site is identified as cleared.

Our vegetation quadrat analysis found similar characteristics to this 2002 mapping with Sandstone Gully Forest in the lowest elevations around the drainage lines in the sheltered mid-slopes near the western study area boundary, Upper Georges River Sandstone Woodland on the mid-slopes to the plateau within approximately 100-150m of the drainage lines in the northern portion of the study area, and Shale / Sandstone Transition Forest in remnant vegetation within the southern portion of the study area and along some of the eastern boundary.

Figure 3 shows the 2002 mapping with the approximate study area boundary overlaid.

The corresponding numbers on Figure 3 refer to the following nomenclature:

- Map Unit 2 – Shale / Sandstone Transition Forest (high sandstone influence);
- Map Unit 31 – Sydney Sandstone Ridgetop Woodland; and
- Map Unit 32 – Upper Georges River Sandstone Woodland.

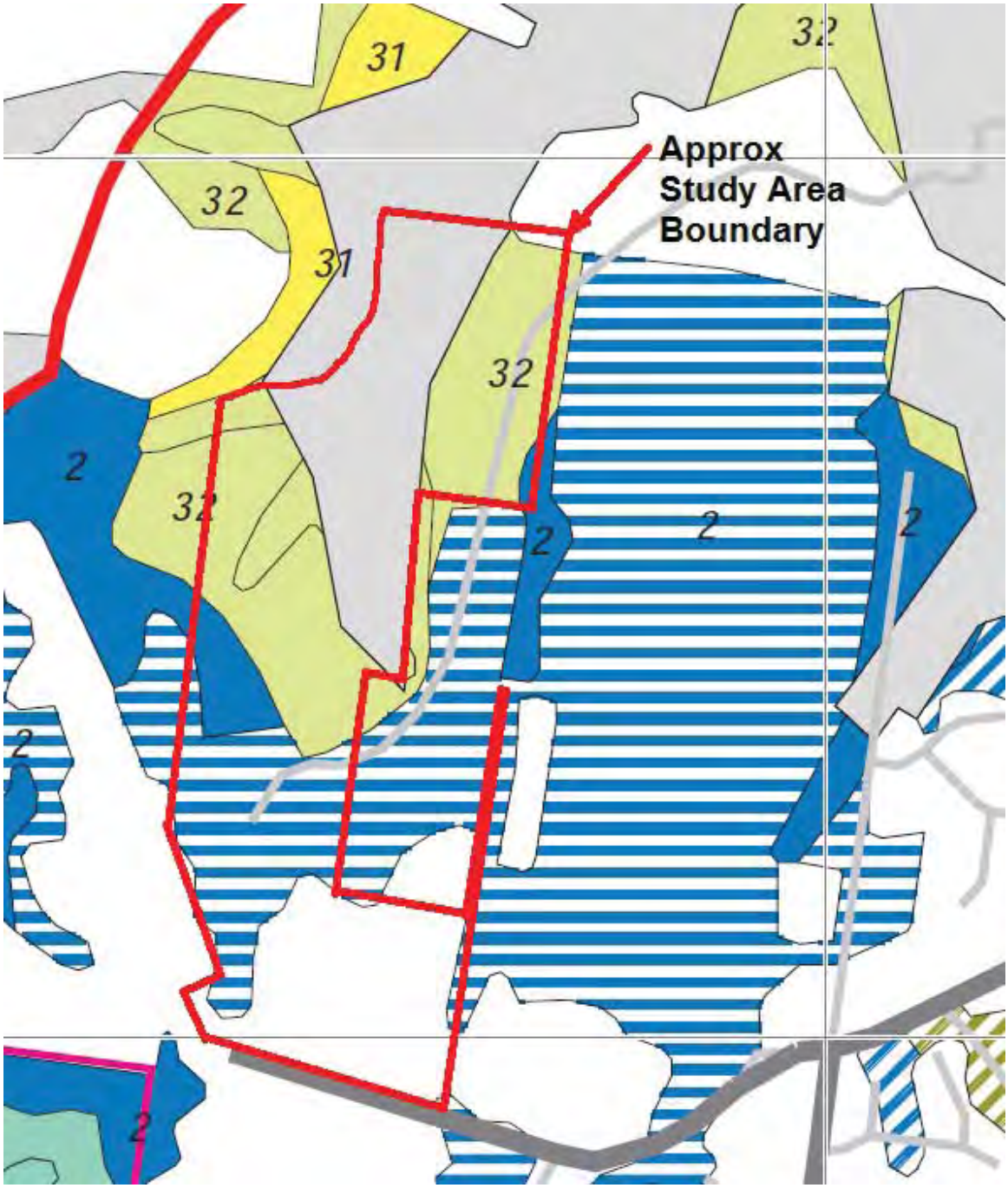

Figure 3 - Regional vegetation mapping (NPWS 2002)

2.3 Threatened and Pest Animals of Greater Southern Sydney (2007)

Threatened and Pest Animals of Greater Southern Sydney (2007) was reviewed for site relevance. Recorded threatened species within the study area to date have the following conservation significance outlined within the region:

- Masked Owl (high)
- Eastern Falsistrelle (moderately high)
- Square-tailed Kite (moderate)
- Glossy Black-Cockatoo (lower)
- Eastern Bentwing-bat (lower)

The document contains all threatened and pest species profiles as well as some non-threatened native species of high conservation concern in the region.

Statutory Framework 3

3.1 Environment Protection & Biodiversity Conservation Act 1999

The *EPBC Act* requires that Commonwealth approval be obtained for certain actions. It provides an assessment and approvals system for actions that have a significant impact on matters of *national environmental significance* (NES). These may include:

- World Heritage Properties and National Heritage Places
- Wetlands of International Importance protected by international treaty
- Nationally listed threatened species and ecological communities
- Nationally listed migratory species
- Commonwealth marine environment

Actions are projects, developments, undertakings, activities, and series of activities or alteration of any of these. An action that needs Commonwealth approval is known as a controlled action. A controlled action needs approval where the Commonwealth decides the action would have a significant effect on a matter of NES.

Where a proposed activity is located in an area identified to be of NES, or such that it is likely to significantly affect threatened species, ecological communities, migratory species or their habitats, then the matter needs to be referred to the Department of Sustainability, Environment, Water, Population and Communities (SEWPAC) for assessment. In the case where no listed federal species are located on site then no referral is required. The onus is on the proponent to make the application and not on the Council to make any referral.

A significant impact is regarded as being:

> *Important, notable, or of consequence, having regard to its context or intensity and depends upon the sensitivity, value, and quality of the environment which is impacted and upon the duration, magnitude, and geographical extent of the impacts. A significant impact is likely when it is a real or not a remote chance or possibility.*
>
> *Source: EPBC Policy Statement*

Guidelines on the correct interpretation of the actions and assessment of significance are located on the department's web site http://www.environment.gov.au/epbc/publications

3.2 Environmental Planning and Assessment Act 1979

The *NSW Environmental Planning and Assessment Act 1979* (*EP&A Act*) is the principal planning legislation for the state, providing a framework for the overall environmental planning and assessment of development proposals. Various legislation and instruments, such as the *TSC Act*, are integrated with *EP&A Act* and have been reviewed separately.

In determining a development application, the consent authority is required to take into consideration the matters listed under Section 79C of the *EP&A Act* that are relevant to the application. Key considerations include:

- Any environmental planning instrument, including drafts;
- The likely impacts of the development;
- The suitability of the site for the development;
- Any submissions made in accordance with the *EP&A Act* or regulations; and
- The public interest.

3.3 Threatened Species Conservation Act 1995

The specific requirements of the *TSC Act* must be addressed in the assessment of impacts on threatened flora and fauna, populations and ecological communities. The factors to be taken into account in deciding whether there is a significant effect are set out in Section 5A of the *EPA Act* and are based on a 7 part test of significance. Where a proposed activity is located in an area identified as critical habitat, or such that it is likely to significantly affect threatened species, populations, ecological communities, or their habitats, a Species Impact Statement (SIS) is required to be prepared.

3.4 National Parks and Wildlife Act 1974

The *NSW National Parks and Wildlife Act 1974 (NPWS Act)* provides for the establishment, management and protection of national parks and other conservation reserves, landscapes and landforms of significance, the conservation of objects, places or features of cultural value and the protection of native flora and fauna.

3.5 Fisheries Management Act 1994

The *FM Act* provides a list of threatened aquatic species that require consideration when addressing the potential impacts of a proposed development. Where a proposed activity is located in an area identified as critical habitat, or such that it is likely to significantly affect threatened species, populations, ecological communities, or their habitats, an SIS is required to be prepared. A permit is required if an activity will block fish passage.

3.6 Protection of the Environment Operations Act 1997

The *NSW Protection of the Environment Operations Act 1997 (PoEO Act)* aims to protect environment quality within New South Wales, particularly in relation to reducing or mitigating pollution, whilst having regard to the need to maintain ecologically sustainable development. The *PoEO Act* allows for explicit environmental protection policies (see Section 5.12).

3.7 Clean Waters Regulations 1972

The *Clean Waters Regulations 1972* is given legal force through the *PoEO Act.* Schedule 5 Section 6(2) of the *PoEO Act* states that the standards applicable to classified waters are those standards prescribed by the *Clean Waters Regulations.* The Nepean River in the vicinity of the Menangle Park study site is classified as class 'P' waters, whilst waters downstream in the Camden region are classified as class 'C' waters. For both class 'C' and 'P' waters discharges must be by sewer, and sewerage system overflows are not permitted.

3.8 Catchment Management Act 1989

Through a network of Catchment Management Committees, the *NSW Catchment Management Act 1989 (CM Act)* aims to coordinate identification of land degradation, programs for rehabilitation and community awareness and to promote stable and productive environmental conditions. The *Warragamba Catchment Blueprint*, which commenced in 2002/03 provides strategic direction for natural resource management across the catchment over the next ten years. The *Warragamba Catchment Blueprint* identifies and sets targets with prioritised management actions and includes issues relating to natural resource and environmental management.

3.9 Sydney Regional Environmental Plan No 20 – Hawkesbury-Nepean River (No 2 –1997)

The aims of the Sydney Regional Environmental Plan No 20 – Hawkesbury-Nepean River (No 2 – 1997) are to protect the environment of the Hawkesbury-Nepean River system by ensuring that impacts from future land uses are considered in a regional context. The Menangle Park site is in within the area covered by this plan, and hence the requirements of this document are relevant. Issues that need to be considered under the regional environmental plan includes referring proposals to downstream councils likely to suffer significant adverse environmental impacts and to consider the cumulative impact of development proposals on the catchment.

3.10 Local Government Act 1993

The *NSW Local Government Act 1993 (LG Act)* provides for management of land within a local government area. Under the act plans of management must be prepared for *community land.* The plans should address a variety of factors including biodiversity conservation and management. Councils must adopt a specific plan of management for community land affected by a recovery plan, threat abatement plan or containing critical habitat identified under the *TSC Act.*

3.11 Local Government Amendment (Ecologically Sustainable Development) Act 1997

The *NSW Local Government Amendment (Ecologically Sustainable Development) Act 1997* requires that councils consider principles of ecologically sustainable development (ESD) and prepare an annual *State of the Environment* report. The principles of ESD, as defined in the act, are the precautionary principle, intergenerational equity, conservation of biological diversity, incorporation of environmental factors in valuations and pursuit of environmental goals in a cost effective fashion.

3.12 Noxious Weeds Act 1993

The objectives of the *NSW Noxious Weeds Act 1993 (NW Act)* are to identify which noxious weeds require control measures, identify control measures suitable to those species and to specify the responsibilities of both public and private landholders for noxious weed control. Two (2) noxious weed species were observed on the study site, *Rubus fruticosus* ssp. agg. and *Hypericum perforatum.* Both species are a Class 4 noxious weed

3.13 State Environmental Planning Policy No.19 – Bushland In Urban Areas

This *NSW State Environmental Planning Policy (SEPP)* aims to protect and preserve bushland within selected local government areas. The policy recognises the recreational, educational and scientific significance of such bushland and aims to protect the flora, fauna, significant geological features, landforms and archaeological relics in such areas. It encourages management to protect and enhance the quality of the bushland and facilitate public enjoyment, compatible with its conservation. The policy states that a person shall not disturb bushland zoned or reserved for public open space purposes without the consent of the council.

In the case of Wollondilly, this LGA is not bound by the provisions of SEPP 19.

3.14 State Environmental Planning Policy No. 44 – Koala Habitat Protection

This SEPP encourages the conservation and management of natural vegetation areas that provide habitat for Koalas and to ensure permanent free-living populations will be maintained over their present range. It provides a stepped process of habitat assessment, requires the preparation of Plans of Management for development applications in core Koala habitat (CKH) and supports the inclusion of areas of CKH in environmental protection zones. Koalas have been recorded in the vicinity of the study area. The vegetation in the northern portion of the study site is generally contains less than 15% of Koala feed trees listed on the schedules to the policy and thus is not considered to be potential Koala habitat (PKH). The southern portion, that containing EEC vegetation, contains the feed tree *Eucalyptus punctata* to around 15-20% maximum of all trees and is considered to be PKH. An assessment under SEPP44 is therefore required. The northern portion of the site may be considered as a transitionary movement corridor provided that there are other adjoining areas of PKH.

3.15 NSW Biodiversity Strategy 1999

The *NSW Biodiversity Strategy* has been adopted by the *New South Wales* government and aims to protect the native biological diversity of NSW and maintain ecological processes and systems through a collaborative framework of government and community efforts. It aims to achieve a variety of biodiversity outcomes, including the preparation of local *biodiversity action plans.* The strategy includes the application of the precautionary principle so that lack of full knowledge of impacts is not be used as an excuse for postponing actions.

3.16 Wollondilly Local Environment Plan 2011

The particular aims of the Wollondilly LEP are as follows:

(a) to provide for the management of natural resources and the protection of the natural landscape character,
(b) to protect, conserve and enhance the built, landscape and Aboriginal cultural heritage,
(c) to protect water quality in land that is situated within water supply catchments,
(d) to encourage development that provides for an integrated transport and infrastructure system and adequate facilities and service provision for future growth,
(e) to recognise, manage and protect rural resource lands for sustainable agriculture and extractive industry practices,

(f) to maintain the separation between towns and villages to retain their unique character and rural and natural settings.

3.16.1 Potential zonings under consideration

The current zoning of the site in accordance with Wollondilly LEP 2011, is RU1 - Primary Production (see Figure 4).

Travers bushfire & ecology considers that the following zonings may be appropriate subject to the site constraints and other planning matters.

- R2 Low Density Residential
- R5 Large Lot Residential
- E3 Environmental Management
- E4 Environmental Living

Further zonings may be appropriate in consideration of all factors, however, the above zonings appear to accommodate the identified conservation significance of the site.

In accordance with Wollondilly LEP 2011, the objectives of the proposed zonings, permitted and prohibited activities, with or without development consent, are as follows:

R2 Low Density Residential

1 Objectives of zone

- To provide for the housing needs of the community within a low density residential environment.
- To enable other land uses that provide facilities or services to meet the day to day needs of residents.

2 Permitted without consent

Home occupations.

3 Permitted with consent

Bed and breakfast accommodation; Boarding houses; Cemeteries; Child care centres; Community facilities; Dwelling houses; Educational establishments; Emergency services facilities; Environmental facilities; Environmental protection works; Exhibition homes; Exhibition villages; Flood mitigation works; Group homes;

Health consulting rooms; Home-based child care; Home businesses; Home industries; Home occupations (sex services); Neighbourhood shops; Places of public worship; Recreation areas; Residential accommodation; Roads; Sewerage systems; Signage; Veterinary hospitals; Water supply systems.

4 Prohibited

Attached dwellings; Multi dwelling housing; Residential flat buildings; rural workers' dwellings; Shop top housing; Water treatment facilities; any other development not specified in Items 2 or 3.

R5 Large Lot Residential

1 Objectives of zone

- To provide residential housing in a rural setting while preserving, and minimising impacts on, environmentally sensitive locations and scenic quality.

- To ensure that large residential allotments do not hinder the proper and orderly development of urban areas in the future.
- To ensure that development in the area does not unreasonably increase the demand for public services or public facilities.
- To minimise conflict between land uses within the zone and land uses within adjoining zones.

2 Permitted without consent
Home occupations.

3 Permitted with consent
Bed and breakfast accommodation; Cemeteries; Child care centres; Community facilities; Dwelling houses; Educational establishments; Environmental facilities; Environmental protection works; Flood mitigation works; Home-based child care; Home businesses; Home industries; Home occupations (sex services); Places of public worship; Recreation areas; Residential accommodation; Roads; Sewerage systems; Signage; Veterinary hospitals; Water supply systems.

4 Prohibited
Attached dwellings; Biosolids treatment facilities; Dual occupancies; Multi dwelling housing; Residential flat buildings; Rural workers' dwellings; Semi-detached dwellings; Shop top housing; Water recycling facilities; Water treatment facilities; Any other development not specified in Items 2 or 3.

E3 Environmental Management

1 Objectives of zone
- To protect, manage and restore areas with special ecological, scientific, cultural or aesthetic values.
- To provide for a limited range of development that does not have an adverse effect on those values.
- To maintain existing significant stands of native vegetation and wildlife corridors.
- To ensure land degradation and soil disturbance are minimised.

2 Permitted without consent
Dairy (pasture-based); Home occupations.

3 Permitted with consent
Dwelling houses; Environmental facilities; Environmental protection works; Flood mitigation works; Home-based child care; Home businesses; Home industries; Home occupations (sex services); Information and education facilities; Natural water-based aquaculture; Roads; Water recreation structures; Water supply systems.

4 Prohibited
Industries; Multi dwelling housing; Residential flat buildings; Retail premises; Seniors housing; Service stations; Warehouse or distribution centres; Any other development not specified in Items 2 or 3.

Zone E4 Environmental Living

1 Objectives of zone
- To provide for low-impact residential development in areas with special ecological, scientific or aesthetic values.
- To ensure that residential development does not have an adverse effect on those values.

- To provide for a limited range of rural land uses that do not have an adverse effect on surrounding land uses.

2 Permitted without consent
Extensive agriculture; Home occupations.

3 Permitted with consent
Cellar door premises; Dual occupancies (attached); Dwelling houses; Educational establishments; Emergency services facilities; Environmental facilities; Environmental protection works; Farm buildings; Flood mitigation works; Helipads; Home-based child care; Home businesses; Home industries; Home occupations (sex services); Information and education facilities; Natural water-based aquaculture; Recreation areas; Recreation facilities (outdoor); Roads; Roadside stalls; Rural supplies; Secondary dwellings; Sewerage systems; Signage; Tourist and visitor accommodation; Viticulture; Water recreation structures; Water supply systems.

4 Prohibited
Biosolids treatment facilities; Hotel or motel accommodation; Industries; Service stations; Serviced apartments; Sewage treatment plants; Warehouse or distribution centres; Any other development not specified in Items 2 or 3.

The appropriateness of the proposed zonings is discussed as part of this assessment. The existing zoning under the Wollondilly LEP is shown in Figure 4.

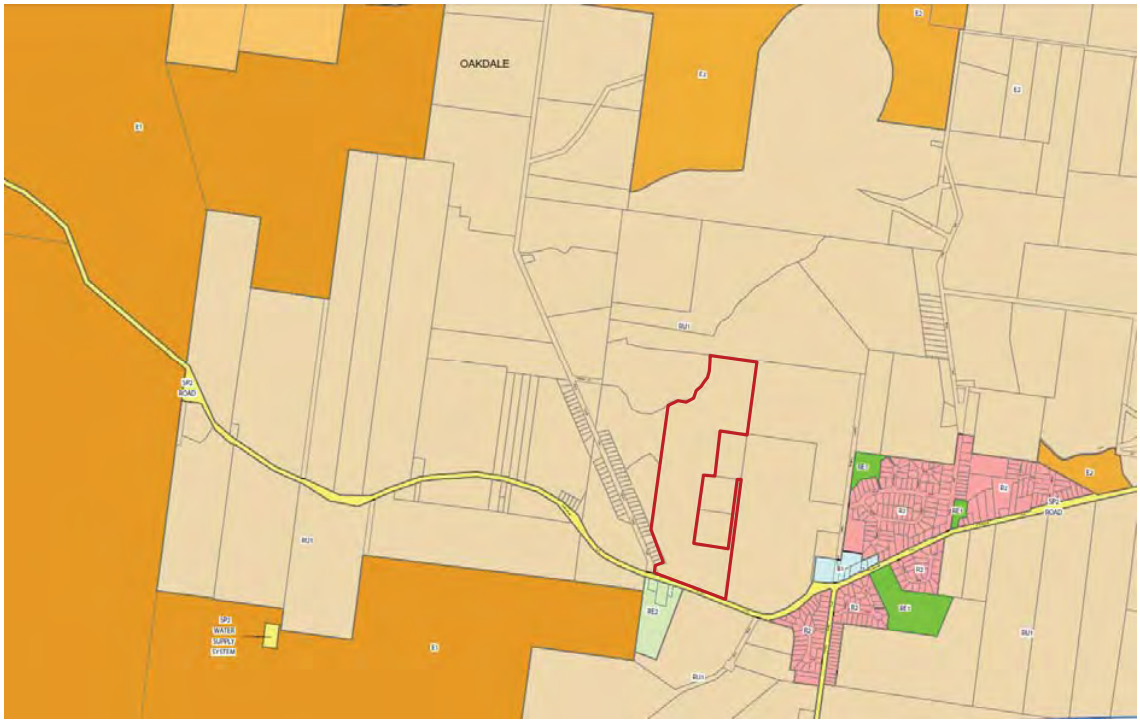

Figure 4 - Current zoning
(Source: Wollondilly Council LEP 2011)

Survey Methodology 4

4.1 Information collation, technical resources, desktop assessments, specialist identification and licences

A review of the relevant information pertinent to the study area was undertaken.

Standard Technical Resources utilised:

- *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities 2004* (working draft), Department of Environment and Conservation (DEC)
- Aerial photographs (*Google Earth Pro / Spatial Information Exchange / Near Maps*)
- Topographical maps (scale 1:25,000)
- *Threatened Species Conservation Act 1995* (*TSC Act*)
- *Fisheries Management Act 1994* (*FM Act*)
- *Environment Protection and Biodiversity Conservation Act 1999* (*EPBC Act*)
- *Rare or Threatened Australian Plants (ROTAP)*
- The natural vegetation maps for the study area including *Vegetation Mapping of the Cumberland Plain* (NPWS 2002)

Desktop Assessment:

To determine the likely and actual occurrence of flora species, fauna species and plant communities on the study area, desktop assessments were undertaken including:

- ***A literature review*** – A review of readily available literature for the area was undertaken to obtain reference material and background information for this survey.

- ***A data search*** – A search of the *Atlas of NSW Wildlife* database (OEH 2013) was undertaken to identify records of threatened flora and fauna species located within a 10km radius of the site. Searches were also undertaken on the SEWPAC website to generate a Protected Matters Report to help determine whether matters of NES or other matters protected by the *EPBC Act* are likely to occur in the area of interest. The search was broadened to a 10km radius, in accordance with the *Atlas of NSW Wildlife* database search. These two searches combined, enabled the preparation of a list of threatened flora and fauna species that could potentially occur within the habitats found on the site (Tables A2.1, A2.2 and A2.3).

Accuracy of identification:

Specimens of plants not readily discernible in the field were collected for identification. Structural descriptions of the vegetation were made according to *Specht et al* (1995).

***Licences*:**

Individual staff members of *Travers bushfire & ecology* are licensed under Clause 20 of the *National Parks and Wildlife (Land Management) Regulation 1995* and Sections 120 & 131 of the *National Parks and Wildlife Act 1974* to conduct flora and fauna surveys within service and non-service areas. NPWS Scientific Licence Numbers: S10359.

Travers bushfire & ecology is licensed under an Animal Research Authority issued by the Department of Agriculture. This authority allows *Travers bushfire & ecology* staff to conduct various fauna surveys of native and introduced fauna for the purposes of environmental consulting throughout New South Wales.

4.2 Flora survey methodology

Flora survey was undertaken for approximately 4.5hrs on 7 March, and for approximately 7hrs on 8 March, 2013.

Sixteen (16) 20x20m floristic quadrats (Figure 5) were assessed in relatively naturally vegetated portions of the study area and a target search for threatened species was undertaken for particular species where applicable within those quadrats. Target searches for threatened species were primarily undertaken only within the southern portion of the study area due to survey allocation constraints. A random meander search was undertaken in accordance with *Cropper* (1993) to create a broad species list only within the southern portion of the study area.

Three (3) flora transects were also undertaken to assist in gathering a species inventory or to assist in defining the vegetation type present.

A review of the *Atlas of NSW Wildlife* database (OEH 2013) was undertaken prior to the botanical survey to identify threatened species previously recorded within 10km of the study area to determine whether target searches were required.

4.3 Fauna survey methodology

Site survey effort accounting for techniques deployed, duration and weather conditions are outlined in Table 2.1 and shown on Figure 6.

Current standard fauna survey techniques employed by *Travers bushfire & ecology* in line with relevant survey guidelines, as well as current survey knowledge are provided in Appendix 1. Fauna survey techniques that have been tailored to the site are provided in Section 2.5.

4.4 Field survey effort

Table 4.1 – Fauna survey effort

Fauna group	Date	Weather conditions	Survey technique(s)	Survey effort / time (24hr)
Diurnal birds	30/1/13	2-8/8 cloud, no wind, no rain, temp 27-22^{o}C	Diurnal opportunistic Census Points x2	6hrs 1425 - 2025 Minimum 20 minutes each
	31/1/13	1/8 cloud, no wind, no rain, temp 26-23^{o}C	Diurnal opportunistic Census Points x6	8hrs 30min 1200 - 2030 Minimum 15 minutes each
Nocturnal birds	30/1/13	8/8 cloud, no wind, no rain, temp 22-20^{o}C	Spotlighting Call playback (Section 2.6 species)	2hrs 30min 2030 - 2300 Commenced @ 2100
	31/1/13	0/8 cloud, no wind, no rain, temp 26-23^{o}C	Spotlighting Call playback (Section 2.6 species)	1hr 30min 2030 - 2200 Commenced @ 2100
Arboreal mammals	30/1/13	8/8 cloud, no wind, no rain, temp 22-20^{o}C	Spotlighting Call playback (Section 2.6 species)	2hrs 30min 2030 - 2300 Commenced @ 2120
	31/1/13	0/8 cloud, no wind, no rain, temp 26-23^{o}C	Spotlighting Call playback (Section 2.6 species)	1hr 30min 2030 - 2200 Commenced @ 2100
Terrestrial mammals	30/1/13	8/8 cloud, no wind, no rain, temp 22-20^{o}C	Spotlighting Remote surveillance camera x2	2hrs 30min 2030 - 2300 overnight
	31/1/13	0/8 cloud, no wind, no rain, temp 26-23^{o}C	Spotlighting Remote surveillance camera x2	1hr 30min 2030 - 2200 overnight
Bats	30/1/13	8/8 cloud, no wind, no rain, temp 22-20^{o}C	Spotlighting Anabat II (Active monitoring) Anabat II (Passive monitoring) x2	2hrs 30min 2030 - 2300 2hrs 35min 2015 - 2250 Overnight from 2015
	31/1/13	0/8 cloud, no wind, no rain, temp 26-23^{o}C	Spotlighting Anabat II (Active monitoring) Anabat II (Passive monitoring) x2	1hr 30min 2030 - 2200 1hr 20min 2030 - 2150 1hr 40min 2015 - 2155
Reptiles	30/1/13	2-8/8 cloud, no wind, no rain, temp 27-22^{o}C	Habitat search, opportunistic	6hrs 1425 - 2025
	31/1/13	1/8 cloud, no wind, no rain, temp 26-23^{o}C	Habitat search, opportunistic	8hrs 30min 1200 - 2030
Amphibians	30/1/13	8/8 cloud, no wind, no rain, temp 22-20^{o}C	Spotlighting and call identification	2hrs 30min 2030 - 2300
	31/1/13	0/8 cloud, no wind, no rain, temp 26-23^{o}C	Spotlighting and call identification	1hr 30min 2030 - 2200

Table 4.2 – Flora survey effort

Flora survey	Survey technique(s)	Dates
Vegetation communities	Survey of the boundaries of all communities – field verification and aerial photographic interpretation. Vegetation condition assessment.	7/3/13, 8/3/13
Stratified sampling	20x20m quadrats in all existing bushland or remnant areas Transects in linear areas, where there was a transition in the vegetation or in cleared areas	7/3/13, 8/3/13
Target searches	Target searches in known habitats – limited to the southern portion only and within quadrats in the northern portion	7/3/13, 8/3/13

4.5 Site specific survey techniques

Diurnal birds

Eight (8) diurnal bird census points were undertaken within the study area. A minimum of 15 minutes of survey was undertaken at each census point in an area radiating out to 30-50m. Bird census points were selected to give an even spread and representation across the site and its communities (see Figure 6).

Census points were also commenced in locations where bird activity was apparent, as often different small bird species are found foraging together. Opportunistic diurnal bird survey was conducted between census points and whilst undertaking other diurnal surveys.

Target searches for signs of Glossy Black-Cockatoo (*Calyptorhynchus lathami*) activity were carried out. Seeding *Allocasuarina* trees located within the study area were searched for chewed cones indicating foraging activity.

Nocturnal birds

Given the suitability of habitat present, Masked Owl (*Tyto novaehollandiae*), Powerful Owl (*Ninox strenua*), Barking Owl (*Ninox connivens*), Sooty Owl (*Tyto tenebricosa*) and Bush Stone-curlew (*Burhinus grallarius*) were targeted by call-playback techniques.

Arboreal and terrestrial mammals

Given the suitability of habitat present, Koala (*Phascolactos cinereus*), Yellow-bellied Glider (*Petaurus australis*) and Squirrel Glider (*Petaurus norfolcensis*) were targeted by call-playback techniques.

Significant Habitat Trees

Significant habitat trees are defined as trees containing large hollows suitable for use by owls and / or containing a number of good quality hollows typically consisting of more than one (1) medium (10-30cm) sized hollow. A tree may also be considered significant where evidence of use by select fauna is found, such as Yellow-bellied Glider sap feed tree, raptor nest, or owl roost.

Data such as the number of hollows present in each size category (or other reason for selection), tree species, diameter at breast height, canopy spread and overall height were collected. A summary of significant habitat tree results is provided in Table 6.3.

4.6 Survey limitations

It is important to note that field survey data collected during the survey period is representative of species occurring within the study area for that occasion. Due to effects of fire, breeding cycles, migratory patterns, camouflage, weather conditions, time of day, visibility, predatory and / or feeding patterns, increased species frequency or richness may be observed within the study area outside the nominated survey period. Habitat assessments based on the identification of micro-habitat features for various species of interest, including regionally significant and threatened species, have been used to minimise the implications of this survey limitation.

Flora survey limitations

Time constraints on the survey allocated meant a reduction in survey effort. The more likely areas of future development were allocated a higher focus of survey effort whereby random meander, target threatened species searches and stratified sampling were conducted. Within areas more likely to remain as indigenous bushland, only stratified sampling was undertaken.

With respect to flora, target threatened species survey was limited to only the southern portion of the study area within existing cleared or partially managed lands, or within quadrats in the northern portion of the study area. The survey was undertaken over a consecutive two (2) day time frame within the early stages of autumn. A spring survey would be recommended to undertake target threatened flora species within the northern portion of the study area.

The boundary between sandstone dominated vegetation and Shale / Sandstone Transition Forest vegetation is approximate and would be more appropriately defined through the addition of further quadrats in close proximity to the currently mapped boundary.

Given that less intense survey methodology was utilised for the northern portion of the study area, the extent of the flora species list is likely to be larger than the one provided in Table 5.1. Two hundred and eight (208) species were identified within the study area during the March 2013 survey.

Fauna survey limitations

A call identified as a possible Masked Owl was heard during nocturnal surveys. Masked Owls, as with other owls, have a higher potential to respond to call-playback during the breeding period, but on average are found to respond with a 50% success rate following 4 nights' call-playback and 90% probability following 9 nights' call-playback. This species is better surveyed for presence and use of the study area during the peak breeding period of autumn to early winter. Potential owl trees have been identified, survey for use of these trees during the peak breeding period has not been undertaken.

Fauna trapping surveys have not been undertaken within the study area. Trapping survey would be required within any areas north of the division line between natural and disturbed portions (as indicated on Figure 6 & 8), given the potential for use by Spotted-tailed Quoll.

Despite an absence of local records, the lower drainages are highly suitable habitat for Giant Burrowing Frog and further surveys would be warranted in the case of any proposed development rezoning within the central and northern natural areas.

Survey Results 5

5.1 Flora results

5.1.1 Flora species

The plants observed within the vegetation communities of the study area are listed in the Table 5.1 below.

Table 5.1 – Flora observations for the study area

Family	Scientific Name	Common Name
Trees		
Mimosaceae	*Acacia elata*	Cedar Wattle
Mimosaceae	*Acacia mearnsii*	Black Wattle
Mimosaceae	*Acacia parramattensis*	Parramatta Wattle
Casuarinaceae	*Allocasuarina littoralis*	Black She-oak
Casuarinaceae	*Allocasuarina torulosa*	Forest Oak
Myrtaceae	*Angophora costata*	Smooth-barked Apple
Myrtaceae	*Angophora floribunda*	Rough-barked Apple
Proteaceae	*Banksia serrata*	Old Man Banksia
Cunoniaceae	*Callicoma serratifolia*	Black Wattle
Cunoniaceae	*Ceratopetalum apetalum*	Coachwood
Myrtaceae	*Corymbia gummifera*	Red Bloodwood
Cyatheaceae	*Cyathea australis*	Rough Tree-fern
Eleocarpaceae	*Elaeocarpus reticulatus*	Blueberry Ash
Myrtaceae	*Eucalyptus crebra*	Narrow-leaved Ironbark
Myrtaceae	*Eucalyptus globoidea*	White Stringybark
Myrtaceae	*Eucalyptus longifolia*	Woollybutt
Myrtaceae	*Eucalyptus piperita* subsp. *piperita*	Sydney Peppermint
Myrtaceae	*Eucalyptus punctata*	Grey Gum
Myrtaceae	*Eucalyptus sieberi*	Silvertop Ash
Myrtaceae	*Eucalyptus sparsifolia*	Narrow-leaved Stringybark
Santalaceae	*Exocarpos cupressiformis*	Native Cherry
Bignoniaceae	*Jacaranda mimosifolia**	Jacaranda
Myrtaceae	*Melaleuca styphelioides*	Prickly-leaved Tea Tree
Meliaceae	*Melia azedarach* var. *australasica*	White Cedar
Oleaceae	*Notelaea longifolia*	Mock Olive
Pittosporaceae	*Pittosporum undulatum*	Sweet Pittosporum
Myrtaceae	*Syncarpia glomulifera*	Turpentine
Proteaceae	*Xylomelum pyriforme*	Woody Pear
Shrubs		
Mimosaceae	*Acacia floribunda*	Sally Wattle
Mimosaceae	*Acacia implexa*	Hickory
Mimosaceae	*Acacia longifolia* var. *longifolia*	Sydney Golden Wattle
Mimosaceae	*Acacia myrtifolia*	Red Stem Wattle
Mimosaceae	*Acacia terminalis*	Sunshine Wattle

Table 5.1 – Flora observations for the study area

Family	Scientific Name	Common Name
Mimosaceae	*Acacia ulicifolia*	Prickly Moses
Epacridaceae	*Acrotriche divaricata*	Ground-berry
Araliaceae	*Astrotricha latifolia*	Broad-leaf Star-hair
Proteaceae	*Banksia spinulosa*	Hairpin Banksia
Rutaceae	*Boronia ledifolia*	Sydney Boronia
Fabaceae	*Bossiaea heterophylla*	Variable Bossiaea
Fabaceae	*Bossiaea rhombifolia*	-
Pittosporaceae	*Bursaria spinosa*	Native Blackthorn
Asteraceae	*Cassinia aculeata*	Dolly Bush
Goodeniaceae	*Dampiera purpurea*	Purple Dampiera
Fabaceae	*Daviesia ulicifolia*	Gorse Bitter Pea
Fabaceae	*Dillwynia floribunda* var. *floribunda*	Parrot Pea
Fabaceae	*Dillwynia retorta* var. *retorta*	Eggs and Bacon
Sapindaceae	*Dodonaea triquetra*	Hop Bush
Epacridaceae	*Epacris pulchella*	NSW Coral Heath
Apocnynaceae	*Gomphocarpus fruticosus**	Narrow Leaf Cotton Bush
Fabaceae	*Gompholobium latifolium*	Broad-leaf Wedge-pea
Fabaceae	*Gompholobium minus*	Dwarf Wedge-pea
Proteaceae	*Grevillea mucronulata*	Green Spider Flower
Fabaceae	*Hovea linearis*	-
Fabaceae	*Indigofera australis*	Native Indigo
Proteaceae	*Isopogon anemonifolius*	Flat-leaved Drumsticks
Myrtaceae	*Kunzea ambigua*	Tick Bush
Proteaceae	*Lambertia formosa*	Mountain Devil
Myrtaceae	*Leptospermum parvifolium*	Small-leaved Tea-tree
Epacridaceae	*Leucopogon ericoides*	-
Epacridaceae	*Leucopogon juniperinus*	Prickly Beard-heath
Epacridaceae	*Leucopogon muticus*	-
Oleaceae	*Ligustrum sinense**	Small-leaved Privet
Proteaceae	*Lomatia silaifolia*	Crinkle Bush
Fabaceae	*Mirbelia rubiifolia*	-
Asteraceae	*Ozothamnus diosmifolius*	White Dogwood
Proteaceae	*Persoonia lanceolata*	Lance-leaved Geebung
Proteaceae	*Persoonia levis*	Broad-leaved Geebung
Proteaceae	*Persoonia linearis*	Narrow-leaved Geebung
Proteaceae	*Persoonia mollis* subsp. *nectens*	-
Euphorbiaceae	*Phyllanthus hirtellus*	Thyme Spurge
Pittosporaceae	*Pittosporum revolutum*	Yellow Pittosporum
Fabaceae	*Podolobium ilicifolium*	Prickly Shaggy Pea
Rhamnaceae	*Pomaderris elliptica*	-
Fabaceae	*Pultenaea ferruginea*	-
Faboideae	*Pultenaea linophylla*	-
Fabaceae	*Pultenaea polifolia*	-
Fabaceae	*Pultenaea scabra*	-
Fabaceae	*Pultenaea villosa*	-
Rosaceae	*Rubus fruticosus* sp. agg.*	Blackberry Complex
Epacridaceae	*Styphelia laeta* subsp. *latifolia*	Five Corners
Groundcovers		
Orchidaceae	*Acianthus fornicatus*	Pixie Caps
Asteraceae	*Actinotus minor*	Lesser Flannel Flower

Table 5.1 – Flora observations for the study area

Family	Scientific Name	Common Name
Adiantaceae	*Adiantum aethiopicum*	Common Maidenhair
Asteraceae	*Ageratina adenophora**	Crofton Weed
Poaceae	*Anisopogon avenaceus*	Oat Speargrass
Poaceae	*Aristida ramosa*	Wire Grass
Poaceae	*Aristida vagans*	Three-awn Speargrass
Epacridaceae	*Astroloma humifusum*	Cranberry Heath
Poaceae	*Austrodanthonia caespitosa*	
Poaceae	*Austrostipa pubescens*	Tall Speargrass
Poaceae	*Axonopus fissifolius**	Narrow-leafed Carpet Grass
Restionaceae	*Baloskion gracile*	-
Asteraceae	*Bidens pilosa**	Cobbler's Pegs
Blechnaceae	*Blechnum cartilagineum*	Gristle Fern
Asteraceae	*Brachycome angustifolia*	-
Acanthaceae	*Brunoniella australis*	Blue Trumpet
Dicksoniaceae	*Calochlaena dubia*	Rainbow Fern
Gentianaceae	*Centaurium erythraea**	Pink Stars
Sinopteridaceae	*Cheilanthes sieberi*	Rock Fern
Asteraceae	*Chrysocephalum apiculatum*	Common Everlasting
Asteraceae	*Cirsium vulgare**	Spear Thistle
Commelinaceae	*Commelina cyanea*	Native Wandering Jew
Asteraceae	*Conyza bonariensis**	Flaxleaf Fleabane
Asteraceae	*Conyza sumatrensis**	Fleabane
Cyperaceae	*Cyathochaeta diandra*	-
Poaceae	*Cynodon dactylon*	Common Couch
Cyperaceae	*Cyperus eragrostis**	Umbrella Sedge
Cyperaceae	*Cyperus gracilis*	-
Goodeniaceae	*Dampiera stricta*	Blue Dampiera
Phormiaceae	*Dianella caerulea* var. *producta*	Blue Flax Lily
Phormiaceae	*Dianella revoluta* var. *revoluta*	Spreading Flax Lily
Convolvulaceae	*Dichondra repens*	Kidney Weed
Poaceae	*Digitaria sanguinalis**	Crab Grass
Blechnaceae	*Doodia aspera*	Rasp Fern
Droseraceae	*Drosera peltata*	Sundew
Poaceae	*Echinopogon caespitosus* var. *caespitosus*	Tufted Hedgehog Grass
Poaceae	*Ehrharta erecta**	Panic Veldtgrass
Cyperaceae	*Eleocharis* sp.	-
Restionaceae	*Empodisma minus*	-
Poaceae	*Entolasia marginata*	Bordered Panic
Poaceae	*Entolasia stricta*	Wiry Panic
Asteraceae	*Epaltes australis*	-
Poaceae	*Eragrostis brownii*	Brown's Lovegrass
Poaceae	*Eragrostis curvula**	African Lovegrass
Asteraceae	*Euchiton sphaericus*	Cudweed
Cyperaceae	*Gahnia clarkei*	Tall Saw-sedge
Geraniaceae	*Geranium homeanum*	Northern Cranesbill
Haloragaceae	*Gonocarpus tetragynus*	Poverty Raspwort
Haloragaceae	*Gonocarpus teucroides*	Raspwort
Goodeniaceae	*Goodenia hederacea* subsp. *hederacea*	Ivy-leaved Goodenia

Table 5.1 – Flora observations for the study area

Family	Scientific Name	Common Name
Asteraceae	*Helychrysum rutidolepis*	-
Asteraceae	*Helichrysum scorpioides*	-
Dilleniaceae	*Hibbertia aspera*	Rough Guinea Flower
Dilleniaceae	*Hibbertia diffusa*	-
Violaceae	*Hybanthus monopetalus*	Slender Violet
Apiaceae	*Hydrocotyle peduncularis*	Pennywort
Clusiaceae	*Hypericum perforatum**	St Johns Wort
Asteraceae	*Hypochaeris radicata**	Flatweed
Poaceae	*Imperata cylindrica* var. *major*	Blady Grass
Juncaceae	*Juncus usitatus*	Common Rush
Asteraceae	*Lagenifera stipitata*	-
Anthericaceae	*Laxmannia gracilis*	Slender Wire Lily
Cyperaceae	*Lepidosperma laterale*	Variable Sword-sedge
Lindsaeaceae	*Lindsaea linearis*	Screw Fern
Lindsaeaceae	*Lindsaea microphylla*	Lacy Wedge-fern
Lomandraceae	*Lomandra filiformis*	Wattle Mat-rush
Lomandraceae	*Lomandra glauca*	-
Lomandraceae	*Lomandra longifolia*	Spiky-headed Mat-rush
Lomandraceae	*Lomandra multiflora* var. *multiflora*	Many-flowered Mat-rush
Lomandraceae	*Lomandra obliqua*	Twisted Mat-rush
Fabaceae	*Medicago polymorpha**	Burr Medic
Poaceae	*Microlaena stipoides* var. *stipoides*	Weeping Grass
Poaceae	*Oplismenus aemulus*	Basket Grass
Poaceae	*Oplismenus imbecillis*	-
Oxalidaceae	*Oxalis corniculata**	Yellow Wood Sorrel
Oxalidaceae	*Oxalis perennans*	-
Poaceae	*Panicum simile*	Two Colour Panic
Poaceae	*Paspalum urvillei**	Vasey Grass
Iridaceae	*Patersonia glabrata*	Leafy Purple-flag
Iridaceae	*Patersonia sericea*	Wild Iris
Poaceae	*Pennisetum clandestinum**	Kikuyu
Euphorbiaceae	*Phyllanthus tenellus**	-
Thymelaeaceae	*Pimelea linifolia* subsp. *linifolia*	Slender Rice Flower
Plantaginaceae	*Plantago lanceolata**	Ribwort
Poaceae	*Poa labillardieri* var. *labillardieri*	Tussock Grass
Rubiaceae	*Pomax umbellata*	Pomax
Lobeliaceae	*Pratia purpurascens*	Whiteroot
Dennstaedtiaceae	*Pteridium esculentum*	Bracken
Orchidaceae	*Pterostylis longifolia*	-
Polygonaceae	*Rumex crispus**	Curled Dock
Goodeniaceae	*Scaevola ramosissima*	Purple Fan Flower
Asteraceae	*Senecio madagascariensis**	Fireweed
Poaceae	*Setaria parviflora**	-
Malvaceae	*Sida rhombifolia**	Paddy's Lucerne
Asteraceae	*Sigesbeckia orientalis*	Indian Weed
Solanaceae	*Solanum nigrum**	Black Nightshade
Solanaceae	*Solanum prinophyllum*	Forest Nightshade
Stackhousiae	*Stackhousia viminea*	-
Phormiaceae	*Stypandra glauca*	Nodding Blue Lily
Asteraceae	*Taraxacum officinale**	Dandelion

Table 5.1 – Flora observations for the study area

Family	Scientific Name	Common Name
Elaeocarpaceae	*Tetratheca thymifolia*	Black-eyed Susan
Orchidaceae	*Thelymitra pauciflora*	Slender Sun Orchid
Poaceae	*Themeda australis*	Kangaroo Grass
Fabaceae	*Trifolium repens**	White Clover
Scrophulariaceae	*Verbascum virgatum**	Twiggy Mullein
Verbenaceae	*Verbena bonariensis**	Purpletop
Verbenaceae	*Verbena litoralis**	Coastal Verbena
Asteraceae	*Vernonia cinerea* var. *cinerea*	-
Plantaginaceae	*Veronica plebeia*	Creeping Speedwell
Asteraceae	*Vittadinia cuneata var. cuneata*	Fuzzweed
Campanulaceae	*Wahlenbergia gracilis*	Australian Bluebell
Xanthorrhoaceae	*Xanthorrhoea arborea*	Broad-leaf Grass Tree
Xanthorrhoaceae	*Xanthorrhoea media*	-
Apiaceae	*Xanthosia pilosa*	Woolly Xanthosia
Apiaceae	*Xanthosia tridentata*	Rock Xanthosia
Asteraceae	*Xerochrysum bracteatum*	Golden Everlasting
Vines		
Pittosporaceae	*Billardiera scandens* var. *scandens*	Apple Dumplings
Lauraceae	*Cassytha pubescens*	Common Devil's Twine
Ranunculaceae	*Clematis aristata*	Old Man's Beard
Fabaceae	*Desmodium varians*	-
Luzuriagaceae	*Eustrephus latifolius*	Wombat Berry
Fabaceae	*Glycine clandestina*	Twining Glycine
Fabaceae	*Hardenbergia violacea*	False Sarsparilla
Fabaceae	*Kennedia rubicunda*	Dusky Coral Pea
Caprifoliaceae	*Lonicera japonica**	Japanese Honeysuckle
Passifloraceae	*Passiflora edulis**	Common Passionfruit
Smilacaceae	*Smilax glyciphylla*	Sarsaparilla
Epiphytes		
Loranthaceae	*Amyema pendulum*	Mistletoe
* denotes exotic species		

5.1.2 Vegetation communities

Five (5) vegetation communities were identified within the study area through ground truthing. Those observed were:

- Gully Open Forest (*E. piperita, A. costata, S. glomulifera*);
- Upper Georges River Sandstone Woodland (*A. costata, C. gummifera, E.sieberi*);
- Shale / Sandstone Transition Forest (*E. punctata, S. glomulifera*);
- Cleared, Pasture and Landscaped; and
- Dam with Occasional Sedges.

Gully Open Forest (*E. piperita, A. costata, S. glomulifera*)

- Area – 4.4ha
- Canopy dominants – *Eucalyptus piperita, Angophora costata* and *Syncarpia glomulifera* to a height of up to 45m. The taller trees occur closest to the creek line. The projected foliage cover is around 40-55%.

- Mid-storey vegetation moderate and diverse. There is a different mix of species on one side of the drainage line to the other, likely to be attributable to the aspect. Common species include *Elaeocarpus reticulatus, Callicoma serratifolia, Acacia elata, Allocasuarina torulosa, Xylomelum pyriforme, Ceratopetalum gummiferum, Persoonia linearis, Leptospermum parvifolium* and *Dodonaea triquetra.* The height of the shrubby vegetation is usually 1-4m with particular shorter tree species up to 20m tall. The projected foliage cover varies between 25-50%. The immediate creek line vegetation may exceed the average up to 70% where it gets heavily dominated by the *Callicoma.*
- Groundcovers are moderate to dense consisting of a range of grasses, herbs / shrubs, ferns and vines. The common grass species is *Entolasia stricta.* Common herbs / small shrubs include *Phyllanthus hirtellus, Bossiaea rhombifolia, Pimelea linifolia, Goodenia hederacea, Lomandra longifoila, Gonocarpus* spp., *Xanthosia pilosa* and *Dampiera purpurea.* Common ferns include *Calochlaena dubia, Adiantum aethiopicum* and *Pteridium esculentum.* Common vines include *Hardenbergia violacea, Kennedia rubicunda, Billardiera scandens* and *Glycine clandestina.*
- Impacts – the vegetation comprising this vegetation community is in very good condition. None of the three (3) quadrats contained any exotic plant species. There were patches of exotic species such *Ageratina adenophora* in the core of the drainage line, but they were not widespread. There is evidence of recent fire, however, it has less impacts on the lowest elevations of the site.

Photo 1 – Gully forest vegetation near Quadrat 8

Upper Georges River Sandstone Woodland (*A. costata, C. gummifera, E.sieberi*)

- Area – 8.1ha
- Canopy dominants – *Angophora costata, Corymbia gummifera* and *Eucalyptus sieberi* to a height of approximately 15-25m. The projected foliage cover is around 25-35%.

- Mid-storey vegetation is sparse to moderate. It has been impacted through previous clearing and cattle grazing. Average projected foliage cover ranges from 15-35%. Common species include *Leptospermum parvifolium*, *Kunzea ambigua, Banksia serrata*, *Lambertia formosa, Persoonia* spp., *Bossiaea rhombifolia, Acacia terminalis, Banksia spinulosa, Grevillea mucronulata* and *Dodonaea triquetra.*
- Groundcovers are sparse to moderate consisting of a range of grasses, herbs / shrubs, ferns and vines. Common grass species include *Entolasia stricta, Austrostipa pubescens* and *Anisopogon avenaceus.* Common herbs / small shrubs include *Pomax umbellata, Pimelea linifolia, Lomatia silaifolia, Phyllanthus hirtellus, Epacris pulchella, Goodenia hederacea, Lomandra* spp., *Xanthosia pilosa* and *Patersonia* ssp.. Common ferns include *Pteridium esculentum.* Common vines include *Billardiera scandens* and *Hardenbergia violacea.*
- Impacts – the vegetation is in very good condition with no weeds recorded in any quadrat. There were some weeds noted along the existing track in the north eastern portion of the study area, however, they did not extend more than a few metres into the bushland. The recent fire has led to a reduction of species in the shrub layer, in particular Banksias, and there is lower than average groundcover in many spot locations throughout the remnant.

Photo 2 – Upper Georges River Sandstone Woodland near quadrat 2

Shale / Sandstone Transition Forest (*E. punctata, S. glomulifera*)

- Area – 4.3 ha (1.6ha high quality and 2.7ha diminished quality).
- Canopy dominants – *E. punctata, S. glomulifera* to a height of approximately 18-25m. Less common species include *E. crebra, E. longifolia, C. gummifera* and *E. sparsifolia.* The projected foliage cover is around 20-35%.
- Mid-storey vegetation is sparse to dense (variable). It has been impacted through previous clearing and cattle grazing. Common species include *Exocarpos cupressiformis, Hibbertia aspera*, *Leucopogon muticus, Kunzea ambigua, Persoonia linearis, Pimelea linifolia, Dodonaea triquetra, Bursaria spinosa* and *Allocasuarina littoralis.*
- Groundcovers are moderate in density consisting of a range of grasses, herbs / shrubs and vines. Common grass species include *Entolasia stricta, Microlaena*

stipoides and *Oplismenus aemulus.* Common herbs/small shrubs include *Lomatia silaifolia, Pimelea linifolia, Phyllanthus hirtellus, Goodenia hederacea, Chrysocephalum apiculatum* and *Lomandra* spp.. Common vines include *Billardiera scandens* and *Glycine clandestina.*

- Impacts – parts of this community are affected by recent fire. There has been previous clearance and cattle grazing. Some remnants, in particularly within a 100m radius of the dam are in some state of regrowth.

Photo 3 – Shale / Sandstone Transition Forest looking southward towards the dam

Photo 4 – Grazed remnant Shale / Sandstone Transition Forest at Quadrat 16 near the corner of Burragorang Road and Stevey's Forest Road

Cleared, Pasture and Landscaped

- Area – 5.1ha.
- Contains very limited proportions of native species. The transect undertaken across one of the paddocks had 95% or more coverage by exotic species.
- Impacts – grazing and clearing.

Dam with Occasional Sedges

- Area – 0.05 ha.
- Contains only an *Eleocharis* species.
- Impacts – algal blooms and ducks.

Photo 5 – Cleared paddock looking south west from the lane way on the western boundary

Photo 6 – The dam looking south east

5.2 Fauna results

Fauna species observed throughout the duration of fauna surveys are listed in Table 3.2 below.

Table 5.2 – Fauna observations for the study area

Common name	Scientific name	Method Observed
Birds		**Jan 2013**
Australian Magpie	*Gymnorhina tibicen*	O C
Australian Owlet-nightjar	*Aegotheles cristatus*	C
Australian Raven	*Corvus coronoides*	O C
Australian Wood Duck	*Chenonetta jubata*	O C
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	O C
Brown Thornbill	*Acanthiza pulsilla*	O C
Collared Sparrowhawk	*Accipiter cirrhocephalus*	O^{PR}
Common Blackbird *	*Turdus merula*	O C
Common Bronzewing	*Phaps chalcoptera*	O
Common Koel	*Eudynamys scolopacea*	C
Common Myna *	*Acridotheres tristis*	O C
Crested Pigeon	*Ocyphaps lophotes*	O
Crimson Rosella	*Platycerus elegans*	O C
Eastern Rosella	*Platycercus eximius*	O C
Eastern Spinebill	*Acanthorhynchus tenuirostris*	O C
Eastern Whipbird	*Psophodes olivaceus*	O C
Eastern Yellow Robin	*Eopsaltria australis*	O C
Galah	*Cacatua roseicapilla*	C
Grey Butcherbird	*Cracticus torquatus*	C
Grey Fantail	*Rhipidura fuliginosa*	O C
Laughing Kookaburra	*Dacelo novaeguineae*	C
Magpie-lark	*Grallina cyanoleuca*	C

Common name	Scientific name	Method Observed
Masked Owl [TS]	*Tyto novaehollandiae*	C[PR]
Noisy Miner	*Manorina melanocephala*	O C
Pacific Black Duck	*Anas superciliosa*	O
Pied Currawong	*Strepera graculina*	C
Rainbow Lorikeet	*Trichoglossus haematodus*	O C
Red Junglefowl *	*Gallus gallus*	C
Sacred Kingfisher	*Todiramphus sanctus*	O C
Silvereye	*Zosterops lateralis*	O C
Southern Boobook	*Ninox novaeseelandiae*	C
Square-tailed Kite [TS]	*Lophoictinia isura*	O[PR]
Striated Thornbill	*Acanthiza lineata*	O C
Sulphur Crested Cockatoo	*Cacatua galerita*	O C
Superb Fairy-wren	*Malurus cyaneus*	O C
Variegated Fairy-wren	*Malurus lamberti*	O C
Welcome Swallow	*Hirundo neoxena*	O
White-browed Scrubwren	*Sericornis frontalis*	O C
White-throated Needletail	*Hirundapus caudacutus*	O
White-throated Treecreeper	*Cormobates leucophaeus*	O C
Wonga Pigeon	*Leucosarcia melanoleuca*	C
Yellow-tufted Honeyeater	*Licherostomus melanops*	O C
Yellow-faced Honeyeater	*Lichenostomus chrysops*	O C
Yellow-tailed Black-Cockatoo	*Calyptorhynchus funereus*	O C
Mammals		
Domesticated Cat *	*Felis cattus*	S
Common Wombat	*Vombatus ursinus*	O
Domesticated Dog *	*Canis familiaris*	C
Domesticated Sheep	*Ovis aries*	O
Eastern Bentwing-bat [TS]	*Miniopterus orianae oceansis*	A
Eastern Falsistrelle [TS]	*Falsistrellus tasmaniensis*	A[PR]
Eastern Freetail-bat	*Mormopterus ridei*	A
Euro	*Macropus robustus*	O
Gould's Wattled Bat	*Chalinolobus gouldii*	A
Horse *	*Equus caballus*	O
Large Forest Bat	*Vespadelus darlingtoni*	A
Long-eared Bat	*Nyctophilus sp*	A[PR]
Little Forest Bat	*Vespadelus vulturnus*	A
White-striped Mastiff-bat	*Austronomus australis*	A
Reptiles		
Copper-tailed Skink	*Ctenotus taeniolatus*	O
Delicate Skink	*Lampropholis delicata*	O
Eastern Blue Tongue Lizard	*Tiliqua scincoides*	I
Eastern Water Skink	*Eulamprus quoyii*	O
Grass Skink	*Lampropholis guichenoti*	O
Red-Bellied Black Snake	*Pseudechis porphyriacus*	O
Red-throated Skink	*Acritoscincus platynotum*	O
Amphibians		
Bleating Tree Frog	*Litoria dentata*	C
Common Eastern Froglet	*Crinia signifera*	C
Dwarf Tree Frog	*Litoria fallax*	C
Eastern Banjo Frog	*Limnodynastes dumerilii dumerilii*	O C
Laughing Tree Frog	*Litoria tyleri*	C
Peron's Tree Frog	*Litoria peronii*	H C

Common name	Scientific name	Method Observed
Smooth Toadlet	*Uperoleia laevigata*	C
Striped Marsh Frog	*Limnodynastes peronii*	C
Spotted Marsh Frog	*Limnodynastes tasmaniensis*	C
Mollusc		
Common Garden Snail *	*Helix aspersa*	H

Note: * indicates introduced species
[TS] indicates threatened species

All species listed are identified to a high level of certainty unless otherwise noted as:
[PR] indicates species identified to a 'probable' level of certainty
[PO] indicates species identified to a 'possible' level of certainty

A	-	Anabat II/SD-1	C	-	Call identification
O	-	Observation	P	-	Call-playback response
T	-	Trap (*Elliott*, cage, etc)	H	-	Habitat search
S	-	Spotlight	I	-	Scat, track or sign identification

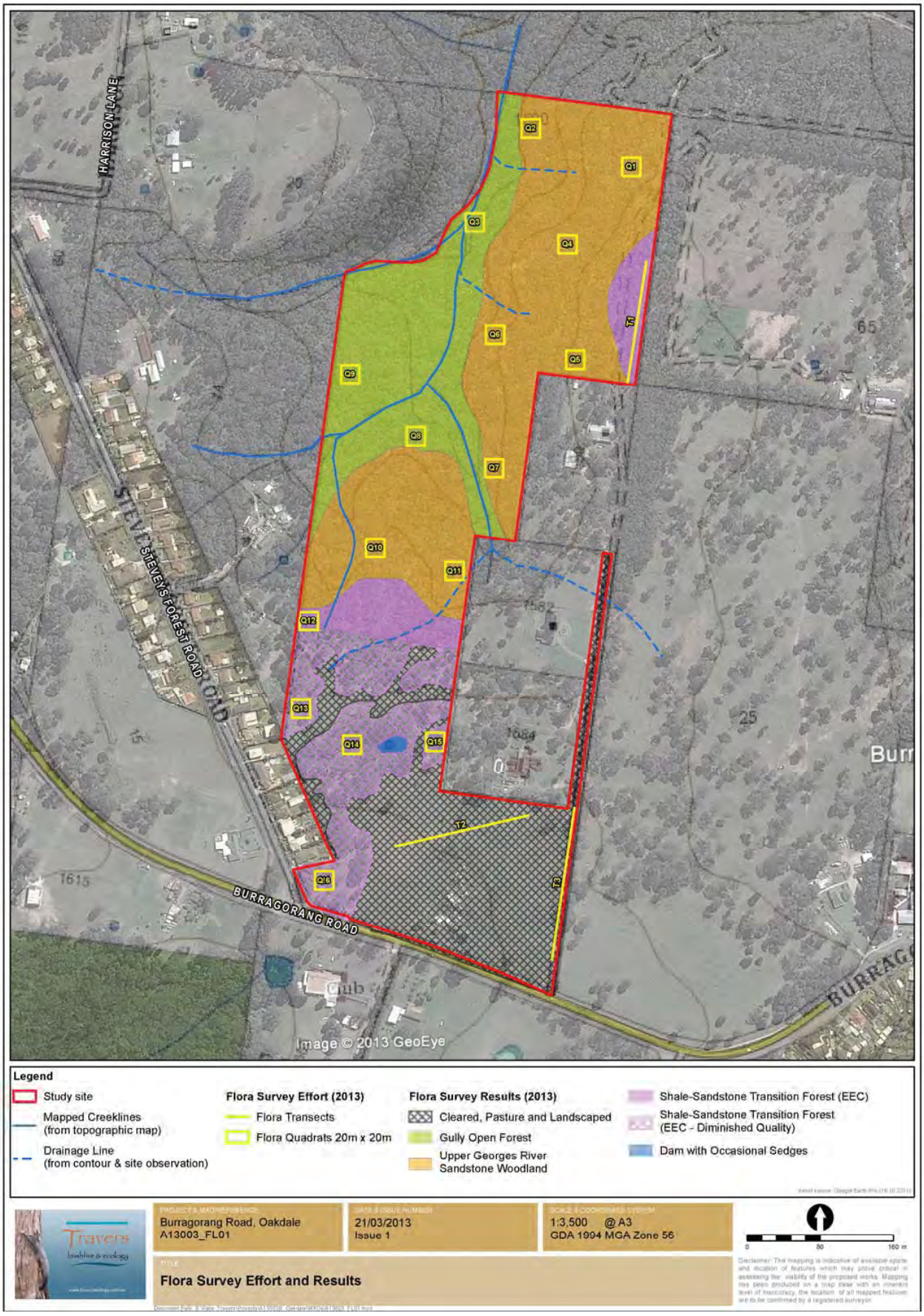

Figure 5 - Vegetation survey effort and results

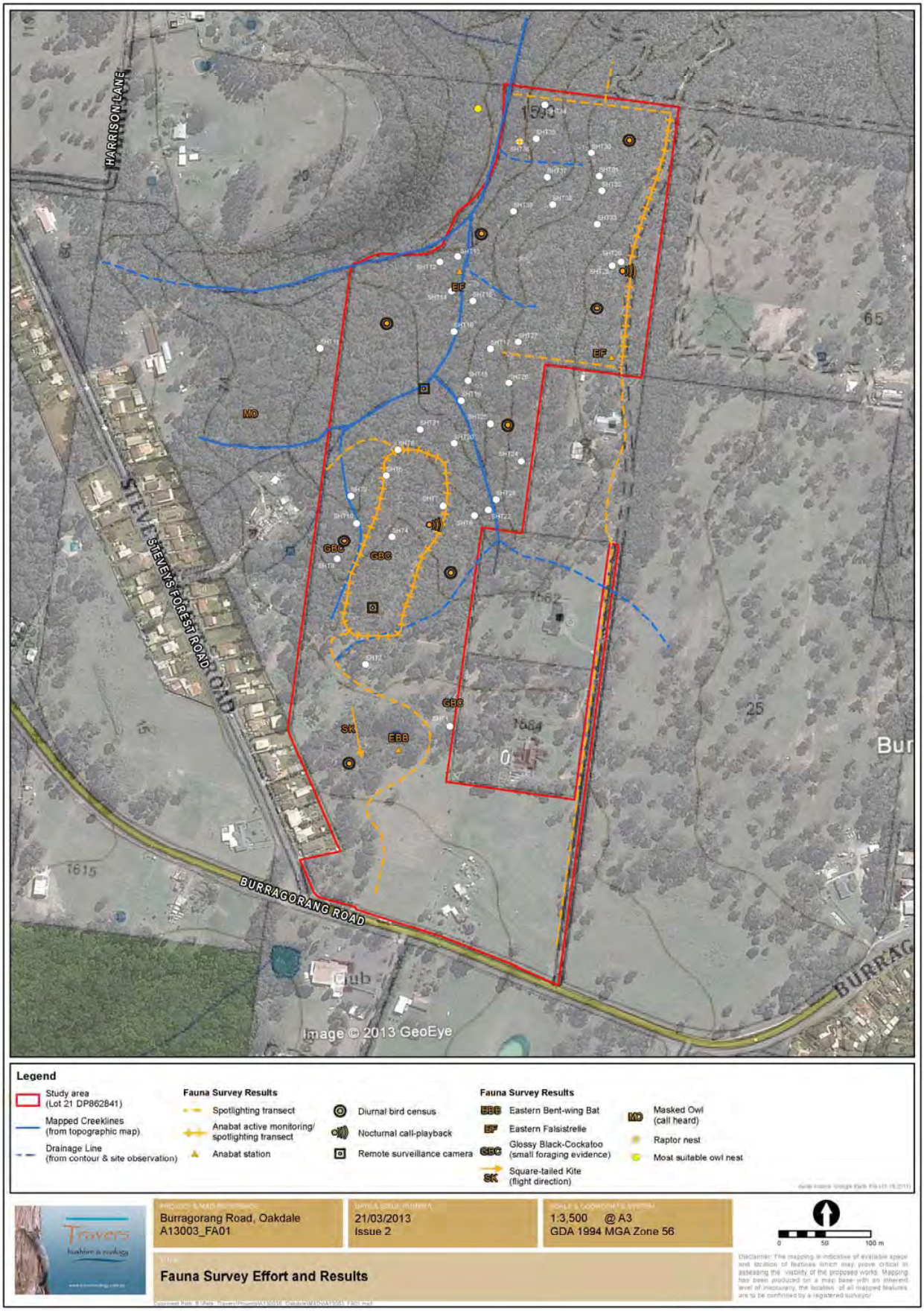

Figure 6 - Fauna survey effort and results

Ecological Discussion 6

6.1 Flora

A total of two hundred and eight (208) species were identified during the botanical field survey.

No threatened flora species were observed, however the study thus far is considered to have limitations upon the level of survey undertaken within the northern portion of the study area for threatened species. The southern portion of the site where previous clearing has been undertaken has been searched more thoroughly.

All species are listed in Table 5.1.

6.1.1 Threatened flora species

TSC Act – A search of the *Atlas of NSW Wildlife* database (OEH 2013) indicated a list of species that have been recorded within a 10km radius of the study area. A review of the schedules of the *EPBC Act* indicated the potential for a list of threatened flora species to also occur within a 10km radius of the site. These species have been considered for habitat presence and potential to occur within Appendix 2.1 (Appendix 2).

Based on the habitat assessment within Appendix 2, it is considered that the study area provides varying levels of potential habitat for the following state listed threatened flora species:

Scientific Name DATABASE SOURCE	**TSC Act**	**EPBC Act**	**Potential to occur**
Acacia bynoeana EPBC	E1	V	Very low
Acacia pubescens OEH	V	V	✓
Persoonia hirsuta OEH	E1	E	low
Pimelea curviflora var. *curviflora* EPBC	V	V	Very low

Note: Full habitat descriptions for these species are provided in Appendix 2.

Despite the varying level of potential habitat for these aforementioned species, none were observed during the March 2013 field survey. The relatively recent fire in the northern portion of the site may attribute a lower than average biodiversity in the short term until particular species recover from a fire event. It may also be the case that threatened flora species may have been present prior to the fire (sandstone species) but are not currently present, given a lack of recovery time.

The intensity of the threatened species survey was limited in the northern portion of the site where the fire has occurred, limited due to survey time constraints) to largely the quadrats and the random meander in between each.

Further target survey would be required, preferably out of the winter months.

6.1.2 Endangered flora populations

There are no known endangered populations within the Wollondilly LGA or recorded within a 10km radius of the study area.

6.1.3 Endangered ecological communities

Sixteen (16) quadrats were assessed to determine the presence or absence and quality of EECs.

The quadrat data was compared against *Tozer* (2003) to see the number of indicative species occurring within the quadrats.

For comparative purposes, the following map units (*Tozer,* 2003) were assessed:

- Map unit 2 – Shale / Sandstone Transition Forest (high sandstone influence)
- Map unit 33 – Western Sandstone Gully Forest
- Map unit 31 – Sydney Sandstone Ridgetop Woodland
- Map unit 32 – Upper Georges River Sandstone Woodland.

Table 6.1 - EEC analysis

	Total No. Native Species	Vegetation Type Most Similar to Tozer	Decision
Quadrat 1	25	Map Unit 32	Non-EEC
Quadrat 2	34	Map Unit 32	Non-EEC
Quadrat 3	37	Map Unit 33	Non-EEC
Quadrat 4	32	Map Unit 32	Non-EEC
Quadrat 5	42	Map Unit 32	Non-EEC
Quadrat 6	42	Map Unit 32	Non-EEC
Quadrat 7	43	Map Unit 32	Non-EEC
Quadrat 8	42	Map Unit 33	Non-EEC
Quadrat 9	40	Map Unit 33	Non-EEC
Quadrat 10	35	Map Unit 32	Non-EEC
Quadrat 11	38	Map Unit 32	Non-EEC
Quadrat 12	60	Map Unit 2	Shale / Sandstone Transition Forest EEC
Quadrat 13	46	Map Unit 2	Shale / Sandstone Transition Forest EEC
Quadrat 14	46	Map Unit 2	Shale / Sandstone Transition Forest EEC
Quadrat 15	35	Map Unit 2	Shale / Sandstone Transition Forest EEC
Quadrat 16	26	Map Unit 2	Shale / Sandstone Transition Forest EEC
Transect 1	51	Map Unit 2 (borderline to Map Unit 32)	Shale / Sandstone Transition Forest EEC
Transect 2	4	Cleared	Non-EEC
Transect 3	36	Map Unit 2	Shale / Sandstone Transition Forest EEC

Based upon the quadrat analysis, the vegetation within the southern portion of the study area was found to be Shale / Sandstone Transition Forest, as well as that on the very eastern edge of the site in the north-eastern corner on the plateau. Upper and mid-slope vegetation was consistent with Tozer's description of Upper Georges River Sandstone Woodland whilst the gully vegetation was most consistent with the description for Western Sandstone Gully Forest.

6.1.4 Vegetation constraints analysis

The EEC occurs primarily within the area that appears to be most suitable for development, that being the southern portion of the study area. This area has had previous clearing and the mid-storey is reduced or in a state of regrowth.

Presently there is a fence line which separates the high quality and diminished quality Shale / Sandstone Transition Forest. The diminished quality remnants are most suitable for future development given that they are disturbed and away from other ecological constraints such as riparian zones, steep topography and higher density fauna habitat values.

The diminished value Shale / Sandstone Transition Forest is suitable for R2 or R5 development. The APZ for this may extend into the higher quality remnant provided further target species searches are undertaken.

The north-eastern portion of the study area may be suitable for an E3 zoning of two (2) lots of approximately 1.5ha each. Again, a brief threatened flora species search is required.

All remnant parts of the site, west and north west are suitable for an E2 zoning – Environmental Conservation and Protection. These areas are somewhat constrained by riparian influences and some steep slopes or rocky outcrops. They are further constrained by unique habitat values such as significant habitat trees and Glossy Black-Cockatoo foraging areas.

The loss of EEC vegetation would be a necessary consideration at a state and national level and the proponent would need to submit mitigation measures that reduce direct and indirect impacts and consider potential offsetting or revegetation works to compensate for such loss.

6.2 Fauna

All fauna species recorded during survey(s) are listed in Table 5.2.

6.2.1 Fauna habitat

The fauna habitats present within the site are identified within Table 6.2.

Table 6.2 – Observed fauna habitat

Topography				
Flat ✓	Gentle ✓	Moderate ✓	Steep ✓	Drop-offs
Vegetation structure				
Closed Forest	Open Forest ✓	Woodland ✓	Heath	Grassland ✓
Disturbance History				
Fire ✓	Under-scrubbing ✓	Cut and fill works ✓		
Tree clearing ✓	Grazing ✓			

Soil Landscape				
DEPTH:	Deep	Moderate ✓	Shallow ✓	Skeletal
TYPE:	Clay ✓	Loam ✓	Sand ✓	Organic
VALUE:	Foraging ✓	Denning ✓	Roosting	Digging ✓
WATER RETENTION:	Well Drained ✓	Damp / Moist ✓	Water logged	Swamp / Soak

Rock Habitat				
CAVES:	Large	Small	Deep	Shallow
CREVICES:	Large	Small ✓	Deep	Shallow ✓
ESCARPMENTS:	Winter / late sunny aspects ✓		Shaded winter / late aspects ✓	
OUTCROPS:	High Surface Area Hides	Med. Surface Area Hides ✓	Low Surface Area Hides ✓	
SCATTERED / ISOLATED:	High Surface Area Hides	Med. Surface Area Hides	Low Surface Area Hides ✓	

Feed Resources				
FLOWERING TREES:	Eucalypts ✓	Corymbias ✓	Melaleucas ✓	
	Banksias ✓	Acacias ✓	Angophoras ✓	
SEEDING TREES:	Allocasuarinas ✓	Conifers		
WINTER FLOWERING EUCALYPTS:	C. maculata	E. crebra ✓	E. globoidea ✓	E. sideroxylon
	E. squamosa	E. grandis	E. multicaulis	E. scias
	E. robusta	E. tereticornis	E. agglomerata	E. siderophloia
FLOWERING PERIODS:	Autumn ✓	Winter	Spring ✓	Summer ✓
OTHER:	Mistletoe ✓	Figs / Fruit	Sap / Manna ✓	Termites ✓

Foliage Protection			
UPPER STRATA:	Dense	Moderate ✓	Sparse ✓
MID STRATA:	Dense	Moderate	Sparse ✓
PLANT / SHRUB LAYER:	Dense ✓	Moderate ✓	Sparse ✓
GROUNDCOVERS:	Dense ✓	Moderate ✓	Sparse ✓

Hollows / Logs			
TREE HOLLOWS:	Large ✓	Medium ✓	Small ✓
GROUND HOLLOWS:	Large ✓	Medium ✓	Small ✓

Vegetation Debris			
FALLEN TREES:	Large ✓	Medium ✓	Small ✓
FALLEN BRANCHES:	Large ✓	Medium ✓	Small ✓
LITTER:	Deep	Moderate ✓	Shallow ✓
HUMUS:	Deep	Moderate ✓	Shallow ✓

Drainage Catchment					
WATER BODIES	Soak(s) ✓	Dam(s) ✓	Drainage line(s) ✓	Creek(s) ✓	River(s)
RATE OF FLOW:	Still ✓	Slow ✓	Rapid ✓		
CONSISTENCY:	Permanent ✓	Perennial ✓	Ephemeral ✓		
RUNOFF SOURCE:	Urban / Industrial	Parkland	Grazing ✓	Natural ✓	
RIPARIAN HABITAT:	High quality ✓	Moderate quality ✓	Low quality ✓	Poor quality	

Artificial Habitat			
STRUCTURES:	Sheds	Infrastructure	Equipment
SUB-SURFACE	Pipe / Culvert(s)	Tunnel(s)	Shaft(s)
FOREIGN MATERIALS:	Sheet ✓	Pile / Refuse ✓	

6.2.2 Habitat trees

A complete assessment of the location of habitat trees, and the size of hollows within, was not conducted as part of surveys undertaken. The available size range and quality of hollows were noted during site visits.

Locations and data on significant habitat trees were collected during the fauna survey. These are trees containing large hollows suitable for use by forest owls and / or containing a number of good quality hollows typically consisting of more than one medium (10-30cm) sized hollow.

A tree may also be considered significant where evidence of use by select fauna is found such as a Yellow-bellied Glider sap feed tree, raptor nest, or owl roost.

Data such as the number of hollows present in each size category (or other reason for selection), tree species, diameter at breast height, canopy spread and overall height were collected. A summary of significant habitat tree data for relocating purposes is provided in Table 4.3. Figures 6 provides locations of significant habitat trees.

Table 6.3 – Significant habitat tree data

Tree No	Common Name	Scientific Name	DBH (cm)	Spread (m)	Height (m)	Vigour (%)	Hollows and Other Habitat Features Recorded
SHT1	Grey Gum	E. punctata	90	13	22	80	2x 0-5cm branch, 1x10-15cm broken trunk, 1x 10-15cm branch (good quality with wear around), 1x 30-35cm broken trunk (not suitable for large forest owl)
SHT2	Red Mahogany	E sparsifolia or E. globoidea	75	11	24	80	1x 10-15cm trunk (good quality with wear around)
SHT3	Grey Gum	E. punctata	70	14	28	70	scratches on trunk, 1x 0-5cm branch, 5x 5-10cm branch, 2x 10-15cm branch, 1x 15-20cm branch, 1x 25-30cm broken trunk
SHT4	Sydney Peppermint	E piperita	75	10	16	60	1x 10-15cm branch (good quality), 1x 15-20cm trunk (good quality with wear around), 1x 15-20cm branch (good quality)
SHT5	Sydney Peppermint	E piperita	90	14	25	55	1x 35-40cm broken trunk, 1x 35-40cm trunk (good quality)
SHT6	Smooth-barked Apple	A costata	60	8	19	45	1x 5-10cm branch, 1x 25-30cm trunk (good quality), 1x 40-45cm trunk base
SHT7	Sydney Peppermint	E piperita	105	20	30	60	1x 10-15cm branch (good quality), 1x 15-20cm branch
SHT8	stag	stag	100	1	8	0	1x 45-50cm broken trunk
SHT9	Sydney Peppermint	E piperita	70	15	32	55	2x 10-15cm branch
SHT10	Sydney Peppermint	E piperita	105	19	36	75	2x 5-10cm trunk (good quality with wear around), 1x 10-15cm trunk (good quality with bedding material, 1x 20-25cm trunk (good quality)
SHT11	Sydney Peppermint	E piperita	100	7	27	20	1x 40-45cm broken trunk
SHT12	stag	stag	70	5	18	0	1x 20-25cm broken trunk, 2x 20-25cm branch
SHT13	Sydney Peppermint	E piperita	70	10	20	20	1x 50+cm broken trunk
SHT14	Smooth-barked Apple	A costata	50	4	22	5	3x 10-15cm broken trunk
SHT15	Smooth-barked Apple	A costata	70	5	9	5	1x 40-45cm broken trunk
SHT16	Sydney	E piperita	30/45	21	38	55	2x 10-15cm trunk

Tree No	Common Name	Scientific Name	DBH (cm)	Spread (m)	Height (m)	Vigour (%)	Hollows and Other Habitat Features Recorded
	Peppermint		/80				
SHT17	stag	stag	65	1	22	0	1x 45-50cm broken trunk (good quality)
SHT18	Smooth-barked Apple	A costata	75	5	16	5	1x 40-45cm broken trunk
SHT19	Red Bloodwood	C gummifera	60	9	27	50	1x 15-20cm trunk, 1x 25-30cm branch
SHT20	Terpentine	S glomulifera	130	13	26	45	1x 40-45cm trunk split
SHT21	Red Bloodwood	C gummifera	80	13	47	60	1x 10-15cm branch, 115-20cm branch,
SHT22	stag	stag	55	5	20	0	2x 10-15cm branch, 1x 15-20cm broken trunk
SHT23	Sydney Peppermint	E piperita	110	23	38	70	2x 10-15cm trunk (good quality), 1x 20-25cm trunk (good quality with perch wear around base
SHT24	Smooth-barked Apple	A costata	55	8	27	70	3x 10-15cm branch
SHT25	Sydney Peppermint	E piperita	60/65	17	19	65	1x 10-15cm trunk (good quality with wear around), 1x 15-20cm branch (good quality)
SHT26	stag	stag	75	4	15	0	1x 30-35cm broken trunk
SHT27	stag	stag	65	4	13	0	1x 15-20cm branch, 1x 30-35cm broken trunk
SHT28	Smooth-barked Apple	A costata	65	6	15	15	1x 20-25cm broken trunk, 1x 30-35cm broken trunk
SHT29	stag	stag	70	1	8	0	1x 40-45cm broken trunk
SHT30	Smooth-barked Apple	A costata	65	5	9	10	1x 30-35cm broken trunk
SHT31	Sydney Peppermint	E piperita	80	11	14	15	1x 20-25cm broken trunk, 1x 25-30cm branch
SHT32	Red Bloodwood	C gummifera	90	13	19	30	1x 25-30cm branch, 1x 25-30cm trunk
SHT33	Smooth-barked Apple	A costata	55	18	24	15	2x 10-15cm branch, 1x 10-15cm trunk (good quality)
SHT34	Sydney Peppermint	E piperita	60/70	21	28	75	4x 10-15cm branch (good quality)
SHT35	Sydney Peppermint	E piperita	25/30 /110	22	35	25	2x 10-15cm branch (good quality), 1x 15-29cm broken trunk
SHT36	Smooth-barked Apple	A costata	100	21	45	85	raptor nest, 2x 15-20cm branch (good quality)
SHT37	Sydney Peppermint	E piperita	75	16	24	35	1x 10-15cm branch, 1x 20-25cm branch (good quality)
SHT38	Red Bloodwood	C gummifera	70	13	30	65	1x 5-20cm branch, 1x 25-30cm broken trunk
SHT39	stag	stag	85	24	35	0	2x 5-10cm branch, 2x 10-15cm branch, 1x 15-20cm branch

One (1) tree identified as containing the best quality hollow for large forest owls was identified, not within the site itself but nearby to the west, on the other side of Horse Creek. This tree is located with significant setbacks to any potential areas for rezoning development within the site. The time of survey was not during or near breeding periods for these owls or for the Glossy Black-Cockatoo and therefore the absence of recorded activity surrounding all potential nesting trees would not suggest non-use of such important habitat.

6.2.3 Vegetation connectivity and wildlife corridors

The southern extent of the study area adjacent to Burragorang Road and Stevey's Forest Road has been cleared or underscrubbed for agricultural purposes (mainly grazing) surrounding the existing homestead. The remaining central and northern portions of the study area contain natural vegetation which provides direct connective values to extensive similar areas of high quality natural habitat that widens further to the north along Horse Creek and into Burragorang State Recreation Area.

Whilst this is the major natural corridor from the site, the site also provides one of a few fragmented connectivity options across Burragorang Road and Stevey's Forest Road towards the south, particularly for birds. The site therefore does provide for north-south movement of select fauna groups. A less direct option further north via the west (Figure 7) provides less fragmentation.

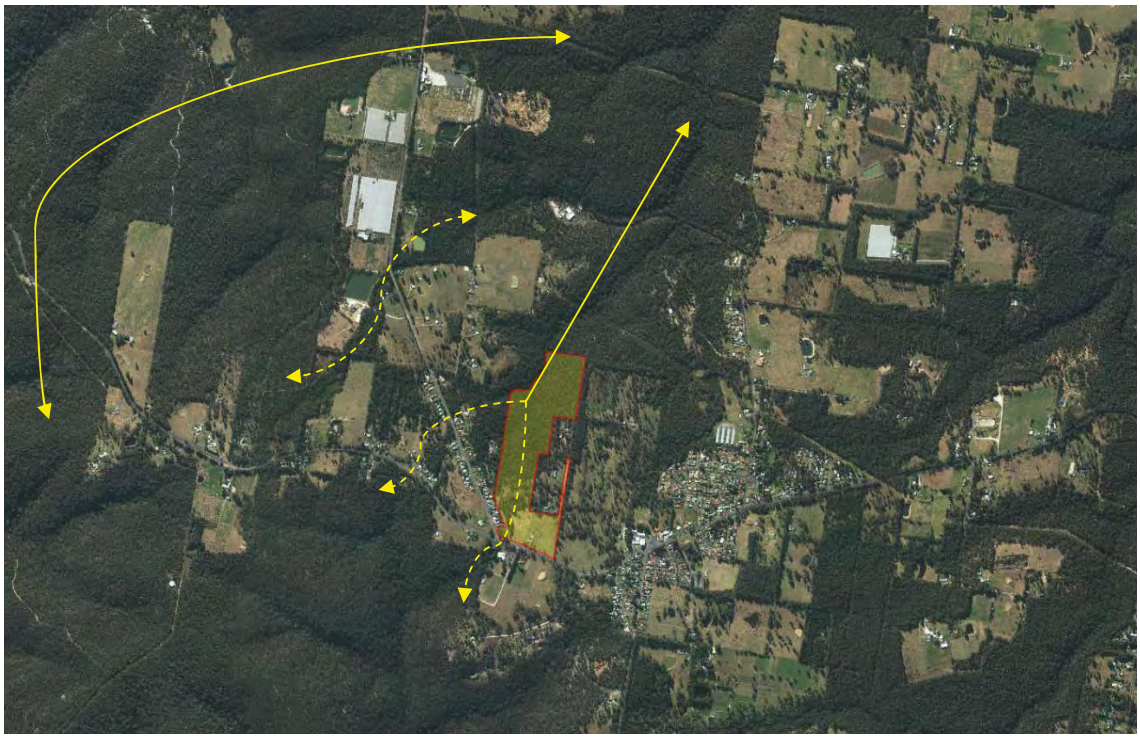

Figure 7 - Local Connectivity

Rezoning options are not likely to provide development pressures on the north western extent of the study area and therefore rezoning in the southern portions for development will not remove the only option for north-south movements.

6.2.4 Local fauna matters

There are no locally significant fauna species identified on the Wollondilly Shire Council website.

6.2.5 Threatened fauna species

A search of the *Atlas of NSW Wildlife* database (OEH 2013) provided a list of threatened fauna species previously recorded within a 10km radius of the study area. A review of the schedules of the *EPBC Act* identified a list of threatened fauna species or species habitat also likely to occur within a 10km radius of the study area. These species have been considered for habitat presence and potential to occur within Table A2.2 (Appendix 2).

Based on the habitat assessment within Appendix 2, it is considered that the study area provides varying levels of potential habitat for the following state and nationally listed threatened fauna species:

Table 6.4 - Potential threatened fauna habitat

COMMON NAME	TSC Act	EPBC Act	Potential to occur
Square-tailed Kite	V	-	Recorded
Glossy Black-Cockatoo	V	-	Recorded
Masked Owl	V	-	Recorded
Eastern Bentwing-bat	V	-	Recorded
Giant Burrowing Frog	V	V	✓
Little Eagle	V	-	✓
Gang-gang Cockatoo	V	-	✓
Barking Owl	V	-	✓
Powerful Owl	V	-	✓
Varied Sittella	V	-	✓
Spotted-tailed Quoll	V	E	✓
Large-eared Pied Bat	V	V	✓
Red-crowned Toadlet	V	-	low
Littlejohn's Tree Frog	V	V	low
Broad-headed Snake	E	V	low
Swift Parrot	E	E	low
Sooty Owl	V	-	low
Black-chinned Honeyeater	V	-	low
Scarlet Robin	V	-	low
Yellow-bellied Glider	V	-	low
Grey-headed Flying-fox	V	V	low
East-coast Freetail Bat	V	-	low
Large-footed Myotis	V	-	low
Greater Broad-nosed Bat	V	-	low
Speckled Warbler	V	-	unlikely
Regent Honeyeater	E4A	E	unlikely
Koala	V	-	unlikely
Squirrel Glider	V	-	unlikely
Long-nosed Potoroo	V	V	unlikely
Brush-tailed Rock-wallaby	E	V	unlikely

Note: Full habitat descriptions for these species are provided in Appendix 2

Five (5) state listed threatened fauna species, being Glossy Black-Cockatoo (*Calyptorhynchus lathami*) and Square-tailed Kite (*Lophoictinia isura*), Masked Owl (*Tyto novaehollandiae*), Eastern Bentwing-bat (*Miniopterus orianae oceansis*) and Eastern Falsistrelle (*Falsistrellus tasmaniensis*) were recorded during survey including. The Square-tailed Kite, Eastern Falsistrelle and Masked Owl were recorded to a 'probable' level of certainty.

Other species to note

Three (3) species not recorded during survey but requiring further mention, based on nearby local records, are the Gang-gang Cockatoo and Spotted-tailed Quoll.

The site provides suitable roosting, foraging, denning or breeding habitat for these two hollow dependent species. Significant habitat trees providing such high quality habitat areas are indicated on Figure 6.

FM Act – It is considered that the lower drainages within the study area provide unlikely habitat for threatened aquatic species based on creek characteristics and previous records. Any potential threatened fish habitat will not be potentially impacted as a result of rezoning and therefore, the provisions of this act do not require any further consideration.

6.2.6 Protected migratory species

The EPBC Act Protected Matters Report provides additionally listed terrestrial, wetland and marine migratory species of national significance likely to occur, or with habitat for these species likely to occur, within a 10km radius of the study area. These migratory species are considered for potential habitat in Table A2.3 (Appendix 2). Threatened migratory species are considered for potential habitat in Table A2.2 (Appendix 2).

No protected migratory species were recorded during survey.

6.2.7 Endangered fauna populations

There are no endangered fauna populations within the Wollondilly LGA.

6.2.8 SEPP 44 Koala Habitat Protection

SEPP 44 Koala Habitat Protection applies to land within LGAs listed under Schedule 1 of the policy. In addition, Part 2 of the policy outlines a three (3) step process to assess the likelihood of the land in question being PKH or CKH. Part 2 applies to land which has an area of greater than 1ha or has, together with any adjoining land in the same ownership, an area of more than 1ha.

The study area is required to be considered under SEPP 44 as it falls within the Wollondilly LGA, which is listed on Schedule 1 of this policy. In addition, the total study area is greater than 1ha, hence Part 2, Development Control of Koala Habitats, of the policy applies.

PKH is defined as land where at least 15% of the total number of trees in the upper or lower strata constitutes any of the tree species listed in Schedule 2 of the Policy.

CKH is defined as an area of land with a resident population of Koalas, evidenced by attributes such as breeding females (i.e. females with young) and recent sightings of, and historical records, a population.

Step 1 – Is the land PKH?

One (1) Koala food tree species, Grey Gum (*Eucalyptus punctata),* as listed on Schedule 2 of SEPP 44, was recorded within the study area. This tree species comprised a maximum of 15%-20% of the total number of trees within the Shale / Sandstone Transition Forest community and therefore these areas are classified under SEPP 44 as PKH.

The areas of PKH are located in the uppermost extent of slopes and plateau areas subject to development pressures immediately adjacent to existing clearings and residences. The remaining majority of the study area within mid-slopes and gully natural habitats does not support PKH under the definitions of SEPP 44 and would at most be regarded as potential transient habitat during dispersal.

Step 2 – Is the land CKH?

No Koalas were directly observed at the time of fauna survey, which included diurnal searches of trees, spotlighting and call response to playback. In addition, there was no

secondary evidence of Koala habitation in the area. Searches for secondary indications of Koalas included observations for scratchings on trees and scats beneath trees.

A search of the *Atlas of NSW Wildlife* (OEH 2013) database found two (2) records of Koala habitation within a 10km radius of the study area. Neither of these records were within 7km of the study area, or were within recent years. It is therefore considered that the study area does not comprise CKH and as such no further matters relevant to this policy would apply.

6.2.9 Fauna constraints analysis

Square-tailed Kite *(Limosa limosa)*

The Square-tailed Kite inhabits the coastal forested and wooded lands of tropical and temperate Australia (*Marchant & Higgins* 1993). The Square-tailed Kite is a specialist hunter of passerines, especially honeyeaters and insects in the tree canopy, picking most prey items from the outer foliage (*Marchant & Higgins* 1993).

It is considered that the study area provides suitable nesting / breeding, roosting and foraging habitat for the Square-tailed Kite. The Square-tailed Kite was recorded to a 'probable' level of certainty during survey, observed briefly in flight directly overhead. The square tail was not obvious as this individual appeared to be in moult and the outside tail feathers were not fully developed. The species was identified based on flight behaviour (low gliding directly over the canopy) and white patches just within the base of the primary underwing feathers.

Searches for significant habitat trees throughout the study area located one raptor nest which is consistent with the nest structure and location preferred by this species. Interestingly, a small raptor identified as a probable Collared Sparrowhawk was observed flying in a direction away from this nest at the time of discovery. Another raptor nest of the size utilised by Square-tailed Kite may be present within the remaining portions of the study area.

Despite the Square-tailed Kite being observed above the disturbed portions which are considered most suitable for rezoning development, this species is not considered to provide a constraint to rezoning within these areas.

Further surveys to obtain a more conclusive identification and locate nesting activity within the study area would be recommended where rezoning for development is proposed north of the transition line between natural and disturbed habitats (see Figure 5).

Glossy Black-Cockatoo *(Calyptorhynchus lathami)*

The Glossy Black-Cockatoo inhabits mountain forests, coastal woodland, open forest and trees bordering watercourses where there are substantial stands of *Allocasuarina*. They feed almost exclusively on the fruit of *Allocasuarina* species (*Lindsey* 1992). They choose trees with larger cone crops but show no sign of selecting trees on the basis of cone size, concentrating foraging in trees with a high ratio of total seed weight to cone weight. (*Clout* 1989). They breed in hollow trees or stumps, usually in eucalypts.

It is considered that the study area provides suitable nesting / breeding, roosting and foraging habitat for the Glossy Black-Cockatoo. The Glossy Black-Cockatoo was recorded during survey by evidence of foraging in three (3) separate locations within the study area.

The recorded locations were within the southern portions of the site, one of these located within the potential future development landscape. Despite this, many foraging opportunities

occur throughout the study area and removal of a recorded foraging location would not be a constraint to development.

Removal of a nesting hollow, on the other hand, would be regarded as a significant constraint. Only one significant habitat tree identified during surveys within the disturbed southern portions of the site contained a hollow with suitable size characteristics for nesting. Whilst this tree was located next to a recorded foraging tree, it is not considered an ideal nesting location, based on the disturbed surrounds and other quality options identified within the site.

Survey was undertaken outside of the breeding period (March - August) when local breeding pairs may be active a long way away from the nesting hollow. Further survey during the nesting period would be recommended where any proposed rezoning for development is to proceed north of the transition line between natural and disturbed habitats, indicated on Figure 8, and where such development is within 50m of any identified remaining significant habitat tree. Otherwise this species is not likely to offer a constraint to any rezoning for development south of the transition line indicated on Figure 8.

This same conclusion may be applied to the Gang-gang Cockatoo which has been previously recorded in the nearby locality and has likely utilised the available habitat within the study area.

Masked Owl *(Tyto novaehollandiae)*

The Masked Owl is known to utilise forest margins and isolated stands of trees within agricultural land. The Masked Owl is distributed most widely along forested areas of coast, escarpment and tablelands, although it occurs at lower population densities in drier forests and woodlands of NSW western slopes. It is most frequently encountered in open forest with a sparse understorey or ground cover, or at the ecotone between closed forest and open forest or woodland. This species is often found in heavily disturbed forest where its prey of small and medium sized mammals can be readily obtained. The Masked Owl is dependent upon hollow bearing trees all year round requiring old mature trees with large hollows for breeding and as diurnal roosting sites.

Roosts selected include hollows in dead, but more commonly live, eucalypts, dense foliage in gullies or caves and recesses in cliffs. Roosting hollows can be situated anywhere between gully and upper slopes and characteristics are the same as for nesting hollows. Pairs are faithful to a traditional nesting hollow, but may also use alternate hollows in the breeding territory in different years (*Schode and Mason* 1980, *Kavanagh and Murray* 1996, *Kavanagh and Murray* 1996, *Kavanagh* 2002, *Mooney* 1997, *Higgins* 1999).

It is considered that the study area provides suitable nesting / breeding, roosting and foraging habitat for the Masked Owl. The Masked Owl was recorded to a ‘probable’ level of certainty during survey. A greater level of certainty could not be applied as the species was only identified from a single call heard to the west of the study area. There was also no other obvious signs of owl activity within the study area, such as whitewash. Such activity was targeted during checks of significant habitat trees containing suitably sized roosting / nesting hollows.

The location of a nesting or roosting hollow for this species would be regarded as a significant constraint to rezoning for development. Such important hollows usually require adequate setbacks to prevent disturbance of breeding activity. No significant habitat trees were identified as suitable for this species within the disturbed southern portions of the site.

Survey was undertaken outside of the peak breeding period (autumn-winter). Further survey during this period would be recommended where any proposed rezoning for development is to proceed north of the transition line between natural and disturbed habitats, indicated on Figure 8, and where such development is within 50m of any identified remaining significant habitat tree. Otherwise, this species is not likely to offer a constraint to any rezoning for development south of the transition line indicated on Figure 8.

Eastern Falsistrelle *(Falsistrellus tasmaniensis)*

The Eastern Falsistrelle inhabits warm to cool temperate moist and dry open forests (*Strahan* 1995) with a preference for wet high altitude forests and being less common on ridge-tops where fertility is low (*Law , Herr & Phillips* 2008). It is one of the larger and less common forest bats, with wing morphology indicating it to be a highly mobile species with a large foraging range with recordings up to 12km from roosting sites (*Herr, Law & Phillips* 2008) and home ranges up to 136ha (*Churchill* 2008).

Flight is not very manoeuvrable and as such foraging takes places in open stuctures or along trails in forest environs. It hunts beetles but also moths and bugs. The Eastern Falsistrelle roosts mainly in tree hollows, occasionally utilising caves and abandoned buildings (*Parnaby* 1992; *Phillips et al.* 1985). Roosts in trees are generally in hollow trunks of eucalypt trees in colonies of 3 to 80 (*Churchill* 2008). Cave roosting is recorded at Jenolan Caves, NSW, with occasional roosts also recorded in old wooden structures (*Churchill,* 2008). Colonies are usually entirely male or female for reasons currently unknown.

It is considered that the study area provides suitable nesting / breeding, roosting and foraging habitat for the Eastern Falsistrelle. The Eastern Falsistrelle was recorded to a 'probable' level of certainty during survey from two passive Anabat recording stations located in the northern portions of the study area. Both recording locations only recorded a few call-sequences and, in the absence of spotlighting the recorded microbat during active monitoring, no further level of certainty could be applied.

The location of a roosting hollow for this species would be regarded as a significant constraint to rezoning for development, however, locating such hollows are almost impossible without employing exhaustive survey methods. Accordingly, hollow dependent threatened microbat species are usually assessed according to the available remaining habitat resources within a recorded area. In this regard, there is much suitable remaining habitat both within the study area (particularly along the riparian lines) and the natural surrounding open forests.

Therefore, this species is not likely to offer a constraint to any rezoning for development within areas identified as having low or medium conservation significance on Figure 8.

Eastern Bentwing-bat *(Miniopterus orianae oceanensis)*

The Eastern Bentwing-bat forages above and below the canopy within open forests and woodlands, feeding on small flying insects, predominantly moths (*Dwyer* 1995). The Eastern Bentwing-bat is known to roost in a range of habitats including stormwater channels, under bridges, occasionally in buildings, old mines and, in particular, caves (*Dwyer* 1995). Caves are an important resource for this species, particularly for breeding where maternity caves must have suitable temperature, humidity and physical dimensions to permit breeding (*Dwyer* 1995). Roost sites in tree hollows have not been reported within the literature reviewed.

This species has not been identified as utilising culverts for maternity roosts. Maternity roosts rather are occupied by up to 100 000 females with only twelve (12) maternity roosts known throughout the species range (*Hoy & Hall* 2008).

It is considered that the study area provides suitable foraging, possible suitable roosting and even possible suitable breeding habitat for the Eastern Bentwing-bat. The Eastern Bentwing-bat was recorded by *Anabat,* foraging over the dam located in the southern portion of the study area.

Caves suitable for roosting may be present along the eastern escarpment areas however no such suitable caves were observed during surveys. It is certain that such potential roosting and possible breeding caves are not present within any areas identified as having a low or moderate conservation significance on Figure 8. Therefore, this species is not likely to offer a constraint to any rezoning for development within these areas. Foraging habitat will remain throughout the study area and surrounding locality, both within the natural and disturbed landscapes.

6.3 Conservation significance

Areas of low, medium and high conservation significance have been identified on Figure 8. A line of division between the southern disturbed portions and the central-northern natural portions has been indicated on this figure.

The conservation significance of the landscape is based on a number of factors including

- Presence of an EEC and its conservation status
- Size, location and connectivity of existing remnants
- Presence of threatened species records (Masked Owl, Glossy Black-Cockatoo and threatened micro-chiropteran species) and potential habitat for threatened species.
- Presence of hollows that suit hollow dependent threatened species
- Proximity to watercourses and associated gully vegetation
- Level of existing disturbance
- Catchment protection and presence of steeper slopes

Low conservation significance lands are either cleared OR highly disturbed landscapes that have no specific habitat except open pastures or exotic vegetation. This area is suitable for higher density developments.

Moderate conservation significance areas include lands that contain the EEC, Shale /Sandstone Transition Forest in a degraded form. These areas may be suitable to environmentally sensitive or large lot development, subject to provision of biodiversity offsets either on or offsite.

High conservation significance lands are those that contain recorded or potential habitat for threatened species, form part of the larger high quality catchment remnant, provide connectivity between the good quality EEC, Shale / Sandstone Transition Forest and the riparian landscape and provide catchment protection for watercourses or steeper slopes. Target threatened flora and fauna surveys within the outer high conservation significance areas during key flowering and breeding seasons may yield further lands for environmentally sensitive development.

The high conservation significance areas are typically naturally vegetated areas that provide connective value and a range of habitat features for threatened species. Such habitat features include:

- Sandstone rocky habitats with a northern to western aspect most suitable for rocky habitat reptile species.
- The majority of significant habitat tree resources providing potential nesting, roosting or denning habitat for threatened owls, cockatoos and arboreal mammals.
- Directly surrounding extensive habitat areas surrounding significant habitat features providing connectivity to the north and south (via the west).
- High quality riparian habitat for breeding by frogs and foraging by other species.

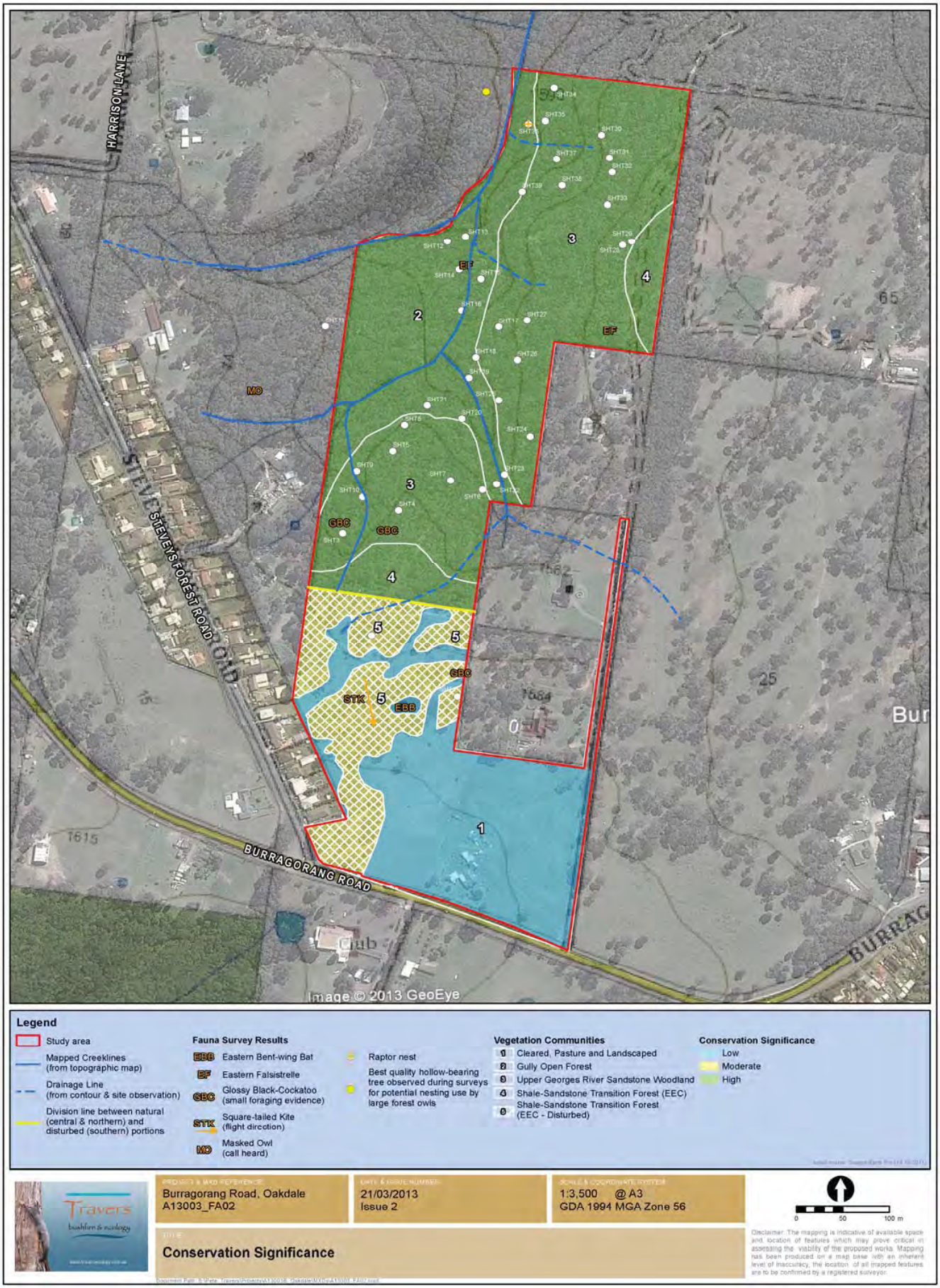

Figure 8 - Conservation Significance of Burragorang Road, Oakdale

- Structural diversity of the understorey, mid-storey and canopy providing varying roosting and foraging opportunities for a range of bird species including birds of prey.
- Spring, summer and winter flowering resources.

6.4 Mitigation measures

The following mitigation measures are considered appropriate for the proposed Residential and E4 Environmental Living zones. With respect to the proposed Residential Zone, we recommend that future development be designed in accordance with:

- Water sensitive urban design principles,

- Is managed to minimise the export of sediment and implements site specific erosion controls in accordance with the *Soils and construction manual - Managing Urban Stormwater* (Landcom 2004),

- Protects waterfront lands and implements controls in accordance with the NSW DPI *Guidelines for Controlled Activities on Waterfront Land* (2012),

- Allows for the ongoing management and enhancement of remnant bushland areas in accordance with the *Cumberland Plain Recovery Plan* (2010), and

- Maintains a managed buffer (inclusive of APZs) that reduces the likelihood of weed invasion and loss of native vegetation within the riparian corridor.

- Requires development applications within the Residential and E4 Environmental Living Zones to include target survey for hollow dependent threatened species such as the Masked Owl and Glossy Black-Cockatoo during the nesting seasons within affected forested areas.

- Requires development applications within the E4 Environmental Living Zone to include the identification of, and where possible, retention of hollow bearing or significant habitat trees to support hollow dependent fauna species.

- Allows for the sensitive removal of fauna within affected native vegetation areas and allows for the re-use of hollows and / or nest boxes as compensatory nesting resources within protected vegetation.

With respect to the proposed E3 Environmental Zone, we recommend that future management be designed in accordance with the following mitigation measures:

- Minimise the export of sediment and implements site specific erosion controls in accordance with the *Soils and construction manual - Managing Urban Stormwater* (Landcom 2004), and

- Protect vegetation within waterfront lands and implement controls in accordance with the NSW DPI *Guidelines for Controlled Activities on Waterfront Land (2012).*

- Provides adequate separation to watercourses for effluent treatment purposes and effectively controls and treats stormwater runoff into the creek.

- Minimises the loss of trees and associated habitat due to APZs, access, building sites and services.

- Allows for the ongoing management and enhancement of remnant bushland areas in accordance with the *Cumberland Plain Recovery Plan* (2010).

- In accordance with the principles of the *Cumberland Plain Recovery Plan (2010)*, we recommend that a Vegetation Management Plan (VMP) be prepared and implemented when appropriate that outlines the best practice methods to protect and restore remnant vegetation within E3 or E2 Zones.

Conclusions & Recommendations 7

7.1 Conclusions

The document identifies potential ecological constraints for future assessment consideration under Section 5A of the *EPA Act* and Matters of National Significance under the *EPBC Act*. This assessment determines if future development of the site is likely to have a significant effect on threatened species, populations and / or EECs.

EPA Act and TSC Act

In respect of matters required to be considered under the *EPA Act* and relating to the species / provisions of the *TSC Act.*

- Five (5) threatened fauna species being, Glossy Black-Cockatoo (*Calyptorhynchus lathami*) and Square-tailed Kite (*Lophoictinia isura*), Masked Owl (*Tyto novaehollandiae*), Eastern Bentwing-bat (*Miniopterus orianae oceansis*) and Eastern Falsistrelle (*Falsistrellus tasmaniensis*) were recorded within or in close proximity to the study area.

- No threatened flora species were recorded within the study area. There are few records of threatened species in the local area.

- One (1) EEC being Shale / Sandstone Transition Forest was recorded within the study area.

- No endangered populations have been observed or considered likely to occur.

EPBC Act

In respect of matters required to be considered under the *EPBC Act:*

- No threatened fauna species were recorded within, or in close proximity to, the study area.

- No protected migratory fauna species listed under the *EPBC Act* were recorded within, or in close proximity to, the study area.

- No threatened flora species were recorded within the study area.

- One (1) EEC being Shale / Sandstone Transition Forest was recorded within the study area.

- No endangered populations were recorded within the study area.

FM Act

FM Act – It is considered that the lower drainages within the study area provide unlikely habitat for threatened aquatic species based on creek characteristics and previous records. Any potential threatened fish habitat will not be potentially impacted as a result of rezoning and therefore, the provisions of this act do not require any further consideration.

7.2 Recommendations

Flora survey limitations

Flora survey was undertaken over a consecutive two (2) days in the early autumn. A spring survey session is recommended to target threatened flora species within the northern portion of the study area in particular. Spring survey will expand the current flora list and provide a higher degree of confidence in the threatened species absent or present within the site.

The boundary between the Upper Georges River Sandstone Woodland and Shale / Sandstone Transition Forest is approximate and can be more accurately located by undertaking further quadrats in close proximity to the currently mapped boundary. The need to undertake the survey will depend on whether existing natural bushland areas are proposed for any development purpose.

Fauna survey limitations

A call identified as a possible Masked Owl was heard during nocturnal surveys. Masked Owls, as with other owls, have a higher potential to respond to call-playback during the breeding period but lower outside of the breeding period. This species is better surveyed for presence and use of the study area during the peak breeding period of autumn to early winter. If detected during the breeding period, a breeding location is expected to be within or in close proximity to the land. If not detected, breeding by an owl species can be excluded from the site. Whilst potential owl trees have been identified on the land, fauna survey has not been undertaken during the peak breeding period which may cast a different light on the conservation significance of existing hollows.

Fauna trapping surveys have not been undertaken within the study area. Trapping survey would be required within any natural areas, given the potential for use by Spotted-tailed Quoll.

Despite an absence of local records, the lower drainage reaches are highly suitable habitat for Giant Burrowing Frog. Further surveys are warranted if any form of development rezoning is proposed within the central and northern natural bushland areas.

Proposed Zoning

Based on the *Ministerial Direction 2.1 Environmental Protection Zones*, we recommend that the following zonings are suitable to the subject lands:

- **E3 Environmental Management** – in this case for lands that provide protection and buffers for watercourses and contain existing and potential threatened species habitat
- **E4 Environmental Living** – in this case for existing forested slopes that may be sensitively developed such as the existing degraded portions of the EEC, Shale / Sandstone Transition Forest, subject to offsetting provisions.

- **Residential Zones** such as R2 Low Density Residential, R3 Medium Density Residential or R5 Large Lot Residential for all cleared or low condition vegetation areas.

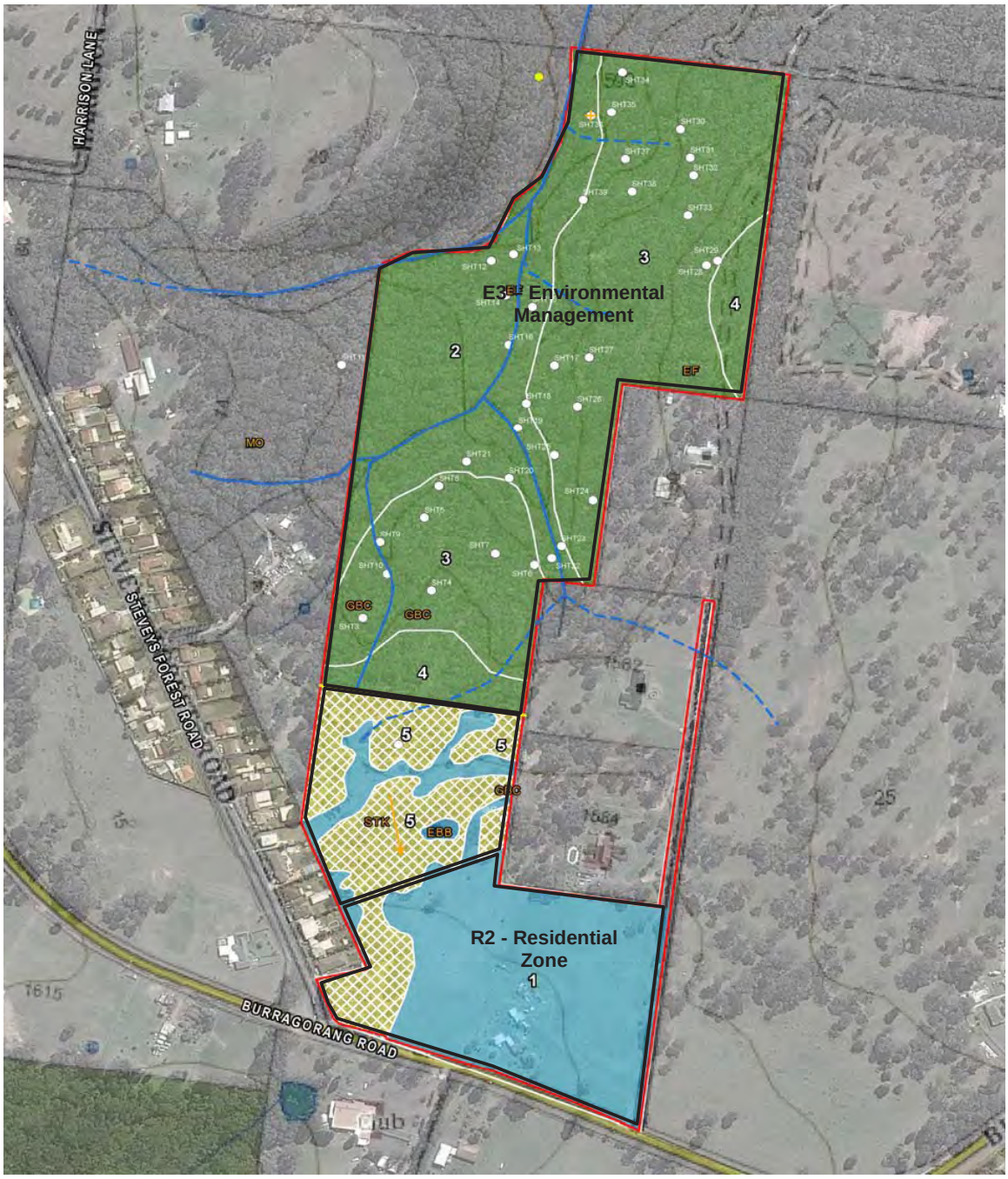

Figure 9 - Recommended Zones

Given the results of the ecological survey thus far, the degraded portions of Shale / Sandstone Transition Forest and cleared areas within the southern portion of the study area appear to be suitable for residential development. The north eastern vegetated portion of the site may be considered suitable for E3 or R5 development, however, access to this area

would be a planning issue subject to planning proposals on adjoining lands. The use of the north eastern portions of the land would be subject to target threatened species survey in spring and during key breeding periods of threatened fauna.

All zonings or applications that involve the removal of the EEC Shale / Sandstone Transition Forest or existing natural bushland areas would be subject to biodiversity offsetting due to the removal of either the EEC or potential threatened species a habitat. The site contains limited lands for restoration offsetting purposes but may also be utilised as a protection offset in accordance with the *Principles for Use of Biodiversity Offsets in NSW* (NSW Office of Environment and Heritage).

Indirect impacts on downslope and downstream impacts may be effectively mitigated to prevent deterioration to the existing watercourses or remaining habitats in the northern portions of the site.

The moderate and high conservation significance areas are currently identified in a precautionary manner based on habitat potential for threatened species and not on current recordings alone. Further surveys incorporating trapping effort for target owl, cockatoo and frog surveys may increase or decrease the conservation significance of natural bushland areas.

The moderate conservation significance mapped areas may be suitable for E4 Environmental Living, a recreational zone or a large lot residential zone all of which may involve the insitu protection of trees. Beyond these areas, the high conservation significance mapped areas provide diverse, high quality habitat features, particularly on the eastern slopes. The value of this area for conservation is also based on the expansive area of these habitats, their connectivity beyond the study area to the north and potential for use by threatened species (e.g. breeding, foraging or social areas) and water quality protection.

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Standard Survey Methodology

A1

The survey methods outlined within this Appendix are standard techniques employed by *Travers bushfire & ecology.* The fauna survey techniques deployed for each specific site are outlined within the survey effort table in the main body of this report. The techniques selected will depend upon the site characteristics and extent of available habitat as well as restrictions such as available survey time and weather conditions.

If any additional or target survey techniques for fauna species are undertaken, beyond the standard methods outline within this Appendix, the details of these will be described within the main body of this report.

1 Standard survey techniques

1.1 Diurnal birds

Diurnal birds are typically identified visually and / or by calls during diurnal surveys. Habitat searches to identify nests, feathers, eggs, or signs of foraging may be utilised more specifically for identifying threatened diurnal bird species.

Visual observations are made more accurate with the use of binoculars and where necessary or practical, with the use of a spotting scope. Binoculars are carried by the fauna surveyor at all times during nocturnal and diurnal fauna surveys. A birding field guide is always available in the field when required for verifications.

Calls are identified in the field by the fauna surveyor. If an unknown call is heard it is cross-matched to comprehensive bird call reference libraries taken into the field. A call library of birds occupying the NSW coastal areas is also stored into a mobile phone for a quick reference. This phone is carried into the field at all times and may be used for call-playback methods and recording calls for later analysis.

Diurnal bird census points may be undertaken at large sites where the total area may not be effectively covered during the survey period or as a measure to ensure focused bird only survey.

1.2 Nocturnal birds

Searches for evidence of owl roosts, key perches and potential owl roosting / breeding hollows are made during diurnal site searches. Whitewash, feathers or regurgitated pellets give key information. Pellets are sent for analysis of contents to assist in identification where necessary.

The presence of nocturnal birds during the nocturnal period is first determined by quiet listening after dusk for calls by individuals emerging from diurnal roosts. Following this and provided no calls are heard call-playback techniques are employed for threatened species that have suitable habitat present.

Threatened nocturnal birds known to provide response to call-playback techniques include Masked Owl (*Tyto novaehollandiae*), Powerful Owl (*Ninox strenua*), Barking Owl (*Ninox connivens*), Sooty Owl (*Tyto tenebricosa*), Grass Owl (*Tyto capensis*), Black Bittern (*Ixobrychus flavicollis*), Australian Bittern (*Botaurus poiciloptilus*) and Bush Stone-curlew (*Burhinus grallarius*).

Each call is typically played for 5 minute periods with 5 minute intervals of quiet listening for a response. This is followed with spotlighting and periods of quiet listening throughout the nocturnal survey.

Separation distances between broadcasting stations during a single night of survey are advised for different species within survey guidelines. These include 1km between owl calls and 3km between Bush Stone-curlew calls. Subsequent to this separate broadcasting stations will be deployed on the same night where sites of significant size are surveyed. Separations for bitterns are not advised and these may be broadcast at a number of stations along suitable habitat areas.

Stag-watching will be undertaken where suitable large hollows for owl nesting / roosting show signs of activity or are located within development areas. Stag-watching of nesting trees should be undertaken during the recognised nesting period for owls with potential to occur.

1.3 Arboreal mammals

Arboreal mammals may be surveyed using *Elliott* type A, B and/or C traps, small and / or large hair tubes, spotlighting, call-playback techniques, scat searches or searches for other signs of activity.

Baiting and layout for *Elliott* trapping and hair tubing are typically incorporated into terrestrial trapping and hair tubing effort unless where target survey is undertaken. Standard baiting and layout is therefore described in Section A1.3.2 below within terrestrial survey methods. Where gliders are targeted the standard bait mix may be additionally laced with a nectarivor powder mix used for feeding captive birds. Where Brush-tailed Phascogales are targeted the standard bait mix may be additionally laced with an insectivore powder mix. Where Eastern Pygmy Possum is targeted the bait mix will be more heavily laced with honey.

Elliott traps for arboreal captures are placed onto tree-mounted platforms that are attached to the trunk 2-3m above the ground at an incline to facilitate drainage during inclement weather. Plastic sleeves are placed around or over traps when there is a possibility of wet weather in the forecast. Arboreal hair tubes are attached to the trunk of trees using rubber bands with the tube entry facing down preventing water entry.

For all arboreal traps and hair tubes a mixture of honey and water is sprayed onto the trunk up to 8m above the trap and around the trap as a lure. Where Eastern Pygmy Possum is targeted a high concentrate honey-water mix is also sprayed from the base of trunk up and along connective branches.

Arboreal traps and hair tubes are placed in trees selected to bias target species. These are often flowering or sap flow trees for gliders, rough-barked trees for the Brush-tailed Phascogale and Banksias for the Eastern Pygmy Possum.

Where habitat is suitable, the presences of Koala (*Phascolactos cinereus*), Yellow-bellied Glider (*Petaurus australis*) and Squirrel Glider (*Petaurus norfolcensis*) may be targeted by call-playback techniques. Calls are played for 5 minute periods during nocturnal surveys. This is followed by quiet listening and spotlighting.

1.3.1 Koala survey

Koala survey is undertaken where the site is considered to provide potential habitat under the definitions of *SEPP 44 Koala Habitat Protection* or in the presence of feed trees listed in Appendix 1 of the Recovery Plan for the Koala. Habitat may also be defined according to locally prepared Koala Plans of Management.

SEPP 44 is applied to land within LGAs listed under Schedule 1 of the policy. Part 2 is applied to land which has an area of greater than 1ha or has, together with any adjoining land in the same ownership, an area of more than 1ha.

To determine PKH under the definitions of SEPP 44 an estimate of the percentage density of each tree species within vegetation communities is determined by averaging the percentage of stems counted. PKH is defined as land where at least 15% of the total number of trees in the upper or lower strata constitutes any of the tree species listed in Schedule 2 of the policy.

Where Koala habitat is considered to be present, the site will be surveyed on foot, with known Koala food trees being inspected for signs of use. Trees are inspected for characteristic scratch and claw marks on the trunk and scats around the base of each tree. Koalas may also be targeted during nocturnal survey involving call-playback techniques and spotlighting.

For large sites, Koala search quadrats may be employed within portions of communities where feed trees are present at suitable densities. All Koala feed trees within quadrats are searched for signs of activity including characteristic claw marks on the trunk and faecal pellets around the base. Pellet searches are undertaken according to the tree base search methods described in *Phillips & Callaghan* (2008). Search quadrats are less labour intensive than the Spot Assessment Technique (SAT) techniques described below but may only be an initial survey effort to determine presence/absence.

Where any Koala activity is recorded the complete SAT described by *Phillips & Callaghan* (2008) may be undertaken as a measure of Koala activity. This technique may also be employed in the first instance as an indicator of presence/absence, particularly where a site has potential Koala activity based on previous records.

For any survey technique the location and density of Koala droppings, if found, are documented.

1.4 Terrestrial mammals

Various traps may be used to survey for the presence of terrestrial mammals. These include *Elliott* trapping, medium and large cage trapping, small and large hair tubing and pitfall traps. Other survey methods for terrestrial mammals include the use of camera surveillance, spotlighting and activity searches.

Arboreal and terrestrial *Elliott* traps and hair tubes are placed in grids or more commonly along trap-lines of 5-10 traps separated by distances of 20-50m depending on site size and variation of habitat. Trap or hair tube sizes selected at each trap station may alternate or may have an emphasis on certain sizes according to target species.

Selection of terrestrial *Elliott* trap, cage trap, hair tube or pitfall trap locations have an emphasis on nearby foliage, runways, shelters and signs of activity.

Standard bait mix for all *Elliott* traps, medium cage traps and hair tubes is a mixture of rolled oats, honey and peanut butter. Standard bait mix may be supplemented with sardines in large hair tubes or cage traps to simultaneously target Spotted-tailed Quoll. Cage traps may also be baited solely with meat or road kill to target Spotted-tailed Quoll. Where Potoroos or Bandicoots are targeted, truffle oil may be used to lace the standard bait mix or used on its own.

Where difficult to access, sensitive or extended trapping periods are undertaken surveillance cameras can be used in terrestrial mammal surveys. The surveillance camera is mounted on a tree and directed towards a closed baited cage trap. Surveillance cameras may also be used to detect use or monitor activity at burrows, hollows, nests, etc.

During diurnal site searches assessment is made of 'found' scats, markings, diggings, runways and scratches located. Any scats or pellets not readily identifiable (particularly predator scats) may be collected and sent to identification expert, Barbara Triggs for identification of contents, hair or bone fragments.

1.5 Bats

Micro-chiropteran bats are surveyed by echolocation using *Anabat* detectors or trapped using harp *(Constantine)* traps, mist nets or trip lines. Micro-chiropteran bats are also surveyed by searches of subterranean habitats such as caves, tunnels or shafts where present, or by searching structures such as under bridges and abandoned buildings or wall/ceiling cavities where entry is possible.

Anabat Mk 2 and SD-1 detectors are used in fixed passive monitoring positions and / or during active nocturnal monitoring. Active monitoring is used in conjunction with spotlighting or during stag-watching for greater accuracy of recorded call identification.

Bat call recordings are interpreted through *Anabat* V and *Anabat* CF Storage and Interface Module ZCAIM devices and analysed using *Anabat* 6 and *Analook* 3.3q computer software packages.

Harp traps and mist nets are placed along suitable flyways such as along open narrow road / river corridors to maximise the likelihood of captures. Traps may be purpose set to capture bats emerging from roosts by being placed at the entry of tunnels / caves or draped over the edge of bridges. Trip lines are placed over water to trip low flying drinking bats into the water. These bats are collected as they swim to the water's edge.

Harp traps are checked during early nocturnal survey as well as each morning. Mist nets and trip lines require constant monitoring. Captured bats are identified using field identification guides. Bats are released at the point of capture after dusk or placed under trunk bark / splits of nearby trees.

Mega-chiropteran bat species, such as Grey-headed Flying-fox, are surveyed by targeting flowering / fruiting trees during spotlighting activities and by listening to distinctive vocalisations. Suitable roosting habitat is searched for presence of small or large established camps during diurnal survey periods.

1.6 Amphibians

Amphibians are surveyed by vocal call identification, call-playback, spotlighting along the edge of water-bodies, pitfall trapping, funnel trapping, by driving along sealed roads near waterways, habitat searches and collection of tadpoles.

Calls are identified in the field by the fauna surveyor. For similar calling species or if an unknown male call is heard it is cross-matched to frog call reference libraries taken into the field. A call library of frogs occupying the NSW coastal areas is also stored into a mobile phone for a quick reference. This phone is carried into the field at all times and may be used for call-playback methods and recording calls for later analysis.

All threatened frog species may be targeted by use of call-playback techniques where suitable habitat exists, with some species more reliable than others in providing a response. Red-crowned Toadlet may also be targeted by clapping and loud retort along suitable habitat drainages in order to evoke a call response.

Any amphibians found are visually identified and when required to be examined are handled with latex gloves and kept moist until release. Any tadpoles requiring capture are collected with a scoop net and placed within a snap-lock clear plastic bag for analysis of colour and morphological features.

Amphibian survey yields best results during or following wet periods with seasonal breeding and subsequent male calling varying according each species. Targeted survey is thus undertaken in appropriate seasons.

1.7 Reptiles

Reptiles are surveyed opportunistically during diurnal site visit(s), but also by habitat searches, pitfall trapping, funnel trapping, by driving along roads on humid nights and by camera surveillance at burrows.

Habitat searches for reptiles are undertaken in likely localities such as under logs, rocky slabs on rock surfaces, under sheet debris, under bark exfoliations and leaf litter at the base of trees and along the edge of wetlands. Aspect and land surface thermal properties are considered to determine best search locations particularly along rocky escarpments.

During warmer months spotlighting may assist survey effort particularly during humid conditions.

1.8 Invertebrates

Target survey is undertaken for the Cumberland Plain Land Snail (*Meridolum corneovirens*) when in proximity to previous *Atlas of NSW Wildlife* database records and particularly where its typical host vegetation community is present. The most appropriate areas of observed habitat are searched. Dense areas of leaf litter with likely moisture retaining properties are scraped using a three pronged rake. Logs, stumps, artificial refuse and rocks are also turned over. In large survey areas searches quadrats are undertaken evenly across highest quality habitat areas to estimate population size.

The top (spiral side), side (showing aperture) and underside (showing umbilicus) of snail specimens found are photographed and sent to Michael Shea of the Australian Museum Malacology Unit for confirmation of identification.

2 Habitat Trees

Hollow bearing tree surveys use a *Trimble* handheld GPS unit to log both field reference location as well as tree data. Data such as hollow types, hollow size, tree species, diameter at breast height, canopy spread and overall height are documented. A metal tag with the tree number is placed on the trunk for field relocation purposes. Other habitat features such as nests and significant sized mistletoe for foraging are also noted.

3 Survey Effort Table Descriptors:

Target - Where effort is specifically concentrated towards an individual species. Selected target species will be identified within the survey effort table and where necessary described within the report.

Opportunistic - Where birds are identified by observation, call or indirect methods as the opportunity arises.

Habitat search - Where suitable areas of habitat for selected fauna groups such as frogs, reptiles and invertebrates are specifically searched.

Diurnal Bird Census Point(s) - Are bird surveys undertaken within a specified area surrounding a point (or in a quadrat) for a specified amount of time. Size and time will be specified in the survey effort table. These are more typically undertaken across larger sites where the total area cannot be effectively covered during the survey period. Subsequently census points are selected to adequately represent each of the habitat areas present and particularly areas designated for proposed development. Often census points are commenced at locations where bird activity is noticeably high.

Spotting-scope Outlook - A *Nikon* spotting scope with 16~47 zoom at x60 magnification on a mounted tripod is used for distant inspections of diurnal birds. This is undertaken at wetlands for viewing waterfowl and waders but also other difficult to access areas. It may also be used for inspecting activity at nests, hollows and combined with spotlight for a panoramic search in open areas.

Call-playback - This involves broadcasting recorded calls through a 15 watt *Toa 'Faunatech'* amplifier to evoke a response from species known to reply. Species selected for call-playback will be indicated in the survey effort table.

Spotlighting - is carried out using a hand held 55 watt spotlight powered by a 12 volt rechargeable battery. This technique involves walking amongst the woodland areas, forest fringes, along roads, trails and fence lines so that a maximum number of trees can be observed. Spotlighting around water-bodies and particularly along the shallow fringes is used for finding frogs. Spotlighting is used in combination with binoculars or spotting scope for closer night inspections.

Stag-watching - involves watching hollows in the dusk period approximately 15 minutes prior to dark until 30 minutes following dark. Placement of the observer on the ground allows for a silhouette of any emerging fauna to be seen against the lighter sky background such that a spotlight is not required, which would likely to disrupt emergence behaviour. Where any movement is observed a spotlight may then be used for identification purposes.

Search Quadrats - are undertaken within a specified area surrounding a point (or in a quadrat) for a specified amount of time. These are more typically undertaken across larger sites where the total area cannot be effectively covered during the survey period. Subsequently quadrats are selected to adequately represent each of the suitable habitat areas present and particularly areas designated for proposed development. The use of this technique simply as an initial time-effective suitable indicator of presence / absence of Koalas has been discussed with Koala expert Stephen Phillips.

Koala Spot Assessment Technique (SAT) - Method outlined by *Phillips & Callaghan* (2008) and accepted by the *Australian Koala Foundation* to determine Koala activity levels. Activity levels are calculated from the proportion of trees showing signs of Koala use as indicated by the presence of scats as well as site location within the state.

Elliott trapping - using *Elliott* type A (33x10x10 cm) and Type B (45x15x15 cm), B and / or Type C traps for trapping small sized mammals. Trapping nights' effort will be indicated in the survey effort table. Trapping layout, trap sizes, baiting and trapping period will be outlined within the site specific methodology section.

Medium Cage trapping - using medium sized cage traps (17x17x45cm foldout cages with tread-plate mechanism or 22x25x58cm rigid cage with tread-plate mechanism) for trapping up to cat/bandicoot sized mammals. Trapping layout, target species, baiting and trapping period will be outlined within the site specific methodology section.

Large Cage trapping - using large sized cage traps (25x25x50cm foldout cages with pull lever (meat) mechanism, 28x28x60cm foldout cages with tread-plate mechanism or 30x30x70cm rigid cage with tread-plate mechanism) for trapping up to quoll sized mammals. Trapping layout, target species, baiting and trapping period will be outlined within the site specific methodology section.

Hair tubing - using small (40mmx120mm) and / or large (90mmx200mm) PVC pipe sections for collection of mammal hair samples. At one end of each tube is an enclosed chamber where the bait is placed and capped. Small drill holes in the inside face of the chamber allow the smell of the bait to permeate out through the tube without allowing access to the bait. At the other open entry end, double-sided tape is attached around the inner rim so hair samples of animals entering the tube are collected. Hair samples collected are sent to Barbara Triggs for identification. Trapping layout, tube sizes, baiting and trapping period will be outlined within the site specific methodology section.

Pitfall trapping - is used to survey for small terrestrial mammals, frogs, reptiles and invertebrates. Pitfall trapping involves the use of 15cmx60cm PVC stormwater pipe sections placed vertically into pre dug holes. The pipe is placed and set firm with surrounding soil so that the top rim is level with the ground surface. Drift fences made of damp proof course 270mm wide are held tight and upright by wooden and steel pegs and run along the length of each trap-line. Drift fences are run over the middle of each pit in the trap line ensuring at least 5m of fencing is run along each side of each pit. Ground fauna passing beyond the pitfall transect are diverted towards the pits along the fence line.

Funnel trapping - is used to survey mainly for frogs and reptiles. Funnel traps are 18cmx18cmx75cm and constructed of shade cloth with an internal spring and wire frame in a similar design to yabby traps. At each end an inward facing funnel directs fauna through a 4cm hole and into the trap. Herpetofauna search the walls and corners for an exit and discover it difficult to re-find the internal exit hole. As with pitfall traps, funnel traps are used with drift fences that divert fauna towards the trap entry. At least 5m of fencing is run between each funnel trap which may be placed on either side of the fence. Trapping layout, target species, fence lengths and trapping period will be outlined within the site specific methodology section.

Passive Anabat monitoring - involves leaving the bat recorder in a fixed mounted position to record call-sequences of passing bats. Recording locations are determined in order to represent different available foraging structures for various micro-chiropteran bat species. Dams, cleared flyways, high insect activity areas, forest edges and ecotones are particularly targeted.

Active Anabat monitoring - is a method of active microbat recording during stag-watching or during complete nocturnal survey. Active monitoring involves an SD-1 recorder allied with a PDA for viewing call-sequences in real-time. When calls are heard the transducer microphone is actively directed towards the calling animal with the aid of a spotlight, so longer and clearer call sequences may be recorded. When calls of a potential threatened species are observed on the PDA screen a view by spotlight of the bat size and wing morphology is attempted for greater identification accuracy.

Active vehicle Anabat monitoring - is a method of active microbat recording deployed when large distances need to be covered in a nocturnal survey period. A Hi-mic extension cable allows the transducer microphone to be placed on a bracket on the roof of a travelling vehicle so calls may be viewed whilst driving. The vehicle travels at no more than 40km/h to

prevent wind interference. When calls of a potential threatened species are observed on the dash mounted PDA screen active spotlighting is undertaken.

Harp trapping - is used to capture micro-chiropteran bats. Harp traps have an aluminium frame with a two-bank 4.2m^2 area and calico capture bag set along the base area.

Mist netting - is used to capture micro-chiropteran bats. The mist net capture area is 2.4m high and 9m wide and supported by two 3.5m poles which are braced with ropes and pegs. Design is a 0.08mm ultrafine nylon monofilament thread arranged in a 14x14mm mesh, with four horizontal capture pockets. These features are specific for the use to capture micro-chiropteran bat species and are provided from the only known supplier in Poland.

Trip lining - is used to capture micro-chiropteran bats. Fishing line is strung tight on pegs in a zig-zag pattern across open water-bodies just above the water surface to trip drinking bats into the water.

Camera surveillance - is used to monitor activity at burrows, hollows, etc. or to survey for species presence at baited stations. A *Reconyx Hyperfire* digital weatherproof camera is used with a passive infrared motion detector and a night-time infrared illuminator. The camera is mounted on a tree or tripod and takes three consecutive photo frames on the detection of movement up to 30m away or the detection of a heat/cold source different to the ambient temperature.

Weather conditions - Survey effort for each fauna group accounting for methods undertaken, duration, and weather conditions are provided in the survey effort table. Weather details are documented for all survey techniques and include:

- Air temperature;
- Cloud cover
- Rain (eg none, light drizzle, heavy drizzle, heavy rain);
- Recent rain events (where relevant);
- Wind strength eg calm, light (leaves rustle), moderate (moves branches), strong (moves tree crowns).
- Wind direction
- Moon (where relevant) (eg none, 1/4 moon, 1/2 moon, 3/4 moon, full moon);

Threatened & Migratory Species Habitat Assessment

A2

Table A2.1 below provides an assessment of potential habitat within the study area for state and nationally listed threatened flora species recorded within 10km on the *Atlas of NSW Wildlife* database (OEH) or indicated to have potential habitat present within 10km on the *EPBC Protected Matters Report.*

Table A2.1 – Threatened flora habitat assessment

Scientific Name DATABASE SOURCE	**TSC Act**	**EPBC Act**	**GROWTH FORM AND HABITAT REQUIREMENTS**	**RECORDED ON SITE (✓)**	**IF NOT RECORDED ON-SITE**				**TO BE CONSIDERD IN ANY FUTURE 7 PART TEST ASSESSMENT (✓)**
					Suitable Habitat Present (✓)	**Nearby and/or high number of record(s) (✓)** *Notes 1,2 & 3*	**Record(s) from recent years (✓)** *Notes 1,2 & 3*	**Potential to occur**	
Acacia bynoeana EPBC	E1	V	Erect or spreading shrub to 0.3m high growing in heath and dry sclerophyll open forest on sandy soils. Often associated with disturbed areas such as roadsides. Distribution limits N-Newcastle S-Berrima.	x	✓	x	x	Very Low	✓
Acacia clunes-rossiae OEH	V	-	Shrub to 2m tall, flowering in September. Grows in dry sclerophyll forest in valleys and on rocky slopes from the Kowmung River and adjacent Coxs River district.	x	x	-	-	x	x
Acacia flocktoniae EPBC	V	V	Shrub to 4m tall, flowering between June and August. Grows in dry sclerophyll forest on sandstone geology. Known from the southern Blue Mountains area such as Mt Victoria, Megalong Valley and Yerranderie.	x	x	-	-	x	x

Scientific Name DATABASE SOURCE	TSC Act	EPBC Act	GROWTH FORM AND HABITAT REQUIREMENTS	RECORDED ON SITE (✓)	IF NOT RECORDED ON-SITE				TO BE CONSIDERD IN ANY FUTURE 7 PART TEST ASSESSMENT (✓)
					Suitable Habitat Present (✓)	Nearby and/or high number of record(s) (✓) *Notes 1,2 & 3*	Record(s) from recent years (✓) *Notes 1,2 & 3*	Potential to occur	
Acacia pubescens OEH	V	V	Spreading shrub 1-4m high open sclerophyll growing in open forest and woodlands on clay soils. Distribution limits N-Bilpin S-Georges River.	x	✓	✓	✓	✓	✓
Allocasuarina glareicola OEH EPBC	E1	E	Small shrub 1-2m high growing in open sclerophyll forest on lateritic soils derived from tertiary alluviums. Distribution limits Castlereagh NR region.	x	x	-	-	x	x
Asterolasia elegans EPBC	E1	E	Erect shrub 1-3m high growing in moist sclerophyll forests on Hawkesbury sandstone slopes hillsides. Distribution limits Maroota region.	x	x	-	-	x	x
Bossiaea oligosperma EPBC	V	V	A small shrub to 2m tall which looks similar to *Bossiaea obcordata* however lacks the spiny branches. Known from 2 disjunct areas, 1 near Warragamba and 1 near Windellama.	x	x	-	-	x	x
Caladenia tessellata EPBC	E1	V	Terrestrial orchid. Clay-loam or sandy soils. Distribution limits N-Swansea S-south of Eden.	x	x	-	-	x	x
Cryptostylis hunteriana EPBC	V	V	Saprophytic orchid. Grows in swamp heath on sandy soils. Distribution limits N-Gibraltar Range S-south of Eden.	x	x	-	-	x	x
Cynanchum elegans EPBC	E1	E	Climber or twiner to 1m. Grows in rainforest gullies, scrub and scree slopes. Distribution limits N-Gloucester S-Wollongong.	x	x	-	-	x	x

Scientific Name DATABASE SOURCE	TSC Act	EPBC Act	GROWTH FORM AND HABITAT REQUIREMENTS	RECORDED ON SITE (✓)	IF NOT RECORDED ON-SITE				TO BE CONSIDERD IN ANY FUTURE 7 PART TEST ASSESSMENT (✓)
					Suitable Habitat Present (✓)	Nearby and/or high number of record(s) (✓) *Notes 1,2 & 3*	Record(s) from recent years (✓) *Notes 1,2 & 3*	Potential to occur	
Eucalyptus benthamii OEH	V	V	Blue gum to 40m high. Wet forest on sandy alluvial soils. Distribution limits N-Yarramundi S-Bents Basin.	x	x	-	-	x	x
Grevillea parviflora subsp *parviflora* OEH EPBC	V	V	Open to erect shrub to 1m. Grows in woodland on light clayey soils Distribution limits N-Cessnock S-Appin.	x	Marginal	x	✓	unlikely	x
Melaleuca deanei EPBC	V	V	Shrub to 3m high. Grows in heath on sandstone. Distribution limits N-Gosford S-Nowra.	x	x	-	-	x	x
Pelargonium sp. *Striatellum* EPBC	E1	E	Herb to 90cm tall which grows in damp places especially beside streams and lakes. Occasionally in swamp forest or associated with disturbance. Varied distribution from SE NSW to QLD.	x	x	-	-	x	x
Persoonia acerosa EPBC	V	V	Erect to spreading shrub. Grows in heath or dry sclerophyll forest on sandstone. Distribution limits N-Bilpin S-Hill Top.	x	Marginal	x	x	unlikely	x
Persoonia hirsuta OEH	E1	E	Erect to decumbent shrub. Grows in dry sclerophyll forest and woodland on Hawkesbury sandstone with infrequent fire histories. Distribution limits N-Glen Davis S-Hill Top.	x	✓	✓	✓	low	✓
Pimelea curviflora var. *curviflora* EPBC	V	V	Woody herb or sub-shrub to 0.2-1.2m high. Grows on Hawkesbury sandstone near shale outcrops. Distribution Sydney.	x	✓	x	x	Very low	✓

Scientific Name DATABASE SOURCE	TSC Act	EPBC Act	GROWTH FORM AND HABITAT REQUIREMENTS	RECORDED ON SITE (✓)	IF NOT RECORDED ON-SITE				TO BE CONSIDERD IN ANY FUTURE 7 PART TEST ASSESSMENT (✓)
					Suitable Habitat Present (✓)	Nearby and/or high number of record(s) (✓) *Notes 1,2 & 3*	Record(s) from recent years (✓) *Notes 1,2 & 3*	Potential to occur	
Pimelea spicata EPBC	E1	E	Decumbent or erect shrub to 0.5m high. Occurs principally in woodland on soils derived from Wianamatta Shales. Distribution limits N-Lansdowne S-Shellharbour.	x	x	-	-	x	x
Pomaderris brunnea EPBC	V	V	Shrub to 3m high. Confined to Upper Nepean and Colo Rivers where it grows in open forest.	x	x	-	-	x	x
Pterostylis saxicola EPBC	E1	E	Terrestrial orchid. Grows in shallow sandy soil above rock shelves, usually near Wianamatta / Hawkesbury transition. Distribution limits N-Hawkesbury River S-Campbelltown.	x	x	-	-	x	x
Pultenaea glabra OEH	V	V	Erect shrub. Grows in moist, sheltered section of dry sclerophyll forest on sandstone in Higher Blue Mountains and Glen Davis areas.	x	x	-	-	x	x
Streblus pendulinus EPBC	-	E	Tree or large shrub to 6m tall. Coastal species along watercourses in warmer rainforest area.	x	x	-	-	x	x
Thelymitra sp. 'Kangaloon' EPBC	-	Critic. E	A terrestrial orchid with dark blue flowers, presented in mid-late spring. Only known from the Robertson area in the Southern Highlands. Often in association with the endangered ecological community *Temperate Highland Peat Swamps on Sandstone.*	x	x	-	-	x	x

OEH	- Denotes species listed within 10km of the study area on the *Atlas of NSW Wildlife* database
EPBC	- Denotes species listed within 10km of the study area in the *EPBC Act* habitat search

Scientific Name DATABASE SOURCE	**TSC Act**	**EPBC Act**	**GROWTH FORM AND HABITAT REQUIREMENTS**	**RECORDED ON SITE (✓)**	**IF NOT RECORDED ON-SITE**				**TO BE CONSIDERD IN ANY FUTURE 7 PART TEST ASSESSMENT (✓)**
					Suitable Habitat Present (✓)	**Nearby and/or high number of record(s) (✓)** *Notes 1,2 & 3*	**Record(s) from recent years (✓)** *Notes 1,2 & 3*	**Potential to occur**	
V	- Denotes vulnerable listed species under the relevant Act								
E or E1	- Denotes endangered listed species under the relevant Act								
NOTE:	1. This field is not considered if no suitable habitat is present within the study area 2. 'records' refer to those provided by the *Atlas of NSW Wildlife* database. Updated 1:100,000 database map sheet requests to OEH are undertaken every 3 months as recommended. 3. 'nearby' or 'recent' records are species specific accounting for home range, dispersal ability and life cycle.								

Table A2.2 below provides an assessment of potential habitat within the study area for state and nationally listed threatened fauna species recorded within 10km on the *Atlas of NSW Wildlife* database (OEH) or indicated to have potential habitat present within 10km on the *EPBC Protected Matters Report.*

Table A2.2 – Threatened fauna habitat assessment

COMMON NAME ***Scientific Name*** DATABASE SOURCE	**TSC Act**	**EPBC Act**	**PREFERRED HABITAT** ***Distribution Limit***	**RECORDED ON SITE (✓)**	**IF NOT RECORDED ON-SITE**				**TO BE CONSIDERD IN ANY FUTURE 7 PART TEST ASSESSMENT (✓)**
					Suitable Habitat Present (✓)	**Nearby and/or high number of record(s) (✓)** *Notes 1,2 & 3*	**Record(s) from recent years (✓)** *Notes 1,2 & 3*	**Potential to occur**	
Giant Burrowing Frog *Heleioporus australiacus* EPBC	V	V	Inhabits open forests and riparian forests along non-perennial streams, digging burrows into sandy creek banks. *Distribution Limit: N-Near Singleton S-South of Eden.*	×	✓	×	-	✓	✓
Stuttering Frog *Mixophyes balbus* EPBC	E	V	Terrestrial inhabitant of rainforest and wet sclerophyll forests. *Distribution Limit: N-near Tenterfield S-South of Bombala*.	×	×	×	-	Not likely	×
Red-crowned Toadlet *Pseudophryne australis* OEH	V	-	Prefers sandstone areas, breeds in grass and debris beside non-perennial creeks or gutters. Individuals can also be found under logs and rocks in non-breeding periods. *Distribution Limit: N-Pokolbin. S-near Wollongong.*	×	✓	×	-	low	✓

COMMON NAME ***Scientific Name*** DATABASE SOURCE	TSC Act	EPBC Act	PREFERRED HABITAT ***Distribution Limit***	RECORDED ON SITE (✓)	IF NOT RECORDED ON-SITE				TO BE CONSIDERD IN ANY FUTURE 7 PART TEST ASSESSMENT (✓)
					Suitable Habitat Present (✓)	Nearby and/or high number of record(s) (✓) *Notes 1,2 & 3*	Record(s) from recent years (✓) *Notes 1,2 & 3*	Potential to occur	
Littlejohn's Tree Frog *Litoria littlejohnii* EPBC	V	V	Found in wet and dry sclerophyll forest associated with sandstone outcrops at altitudes 280-1000m on eastern slopes of Great Dividing Range. Prefers flowing rocky streams. *Distribution Limit: N-Hunter River S-Eden.*	×	✓	×	-	low	✓
Broad-headed Snake *Hoplocephalus bungaroides* EPBC	E	V	Sandstone outcrops, exfoliated rock slabs and tree hollows in coastal and near coastal areas. *Distribution Limit: N-Mudgee Park. S-Nowra.*	×	✓	×	-	low	✓
Australasian Bittern *Botaurus poiciloptilus* OEH EPBC	V	E	Found in or over water of shallow freshwater or brackish wetlands with tall reed beds, sedges, rushes, cumbungi, lignum and also in rice fields, drains in tussocky paddocks, occasionally saltmarsh, brackish wetlands. *Distribution Limit: N-North of Lismore. S- Eden.*	×	×	-	-	×	×
Red Goshawk *Erythrotriorchis radiatus* EPBC	E	V	Inhabits tall open forests and woodlands. Breeds in tall trees adjacent to watercourses of wetlands. *Distribution Limit: N-Border Ranges National Park. S-Foster.*	×	×	-	-	×	×

COMMON NAME ***Scientific Name*** DATABASE SOURCE	TSC Act	EPBC Act	PREFERRED HABITAT ***Distribution Limit***	RECORDED ON SITE (✓)	IF NOT RECORDED ON-SITE				TO BE CONSIDERD IN ANY FUTURE 7 PART TEST ASSESSMENT (✓)
					Suitable Habitat Present (✓)	Nearby and/or high number of record(s) (✓) *Notes 1,2 & 3*	Record(s) from recent years (✓) *Notes 1,2 & 3*	Potential to occur	
Little Eagle *Hieraaetus morphnoides* TBE	V	-	Utilises plains, foothills, open forests, woodlands and scrublands; river red gums on watercourses and lakes. *Distribution Limit - N-Tweed Heads. S-South of Eden.*	×	✓	×	×	✓	✓
Square-tailed Kite *Lophoictinia isura* OEH	V	-	Utilises mostly coastal and sub-coastal open forest, woodland or lightly timbered habitats and inland habitats along watercourses and mallee that are rich in passerine birds. *Distribution Limit: N-Goondiwindi. S-South of Eden.*	✓	-	-	-	-	✓
Australian Painted Snipe *Rostratula australis* EPBC	V	V	Most numerous within the Murray-Darling basin and inland Australia within marshes and freshwater wetlands with swampy vegetation. *Distribution Limit: N-Tweed Heads. S-South of Eden.*	×	×	-	-	×	×
Gang-gang Cockatoo *Callocephalon fimbriatum* OEH	V	-	Prefers wetter forests and woodlands from sea level to > 2000m on Great Divide, timbered foothills and valleys, timbered watercourses, coastal scrubs, farmlands and suburban gardens. *Distribution Limit: mid north coast of NSW to western Victoria.*	×	✓	✓	✓	✓	✓

COMMON NAME ***Scientific Name*** DATABASE SOURCE	TSC Act	EPBC Act	PREFERRED HABITAT ***Distribution Limit***	RECORDED ON SITE (✓)	IF NOT RECORDED ON-SITE				TO BE CONSIDERD IN ANY FUTURE 7 PART TEST ASSESSMENT (✓)
					Suitable Habitat Present (✓)	Nearby and/or high number of record(s) (✓) *Notes 1,2 & 3*	Record(s) from recent years (✓) *Notes 1,2 & 3*	Potential to occur	
Glossy Black-Cockatoo *Calyptorhynchus lathami* OEH	V	-	Open forests with *Allocasuarina* species and hollows for nesting. *Distribution Limit: N-Tweed Heads. S-South of Eden.*	✓	-	-	-	-	✓
Swift Parrot *Lathamus discolour* OEH EPBC	E	E	Inhabits eucalypt forests and woodlands with winter flowering eucalypts. *Distribution Limit: N-Border Ranges National Park. S-South of Eden*.	×	✓	×	-	low	✓
Barking Owl *Ninox connivens* OEH	V	-	Inhabits principally woodlands but also open forests and partially cleared land and utilises hollows for nesting. *Distribution Limits: N-Border Ranges National Park. S-Eden.*	×	✓	×	✓	✓	✓
Powerful Owl *Ninox strenua* OEH	V	-	Forests containing mature trees for shelter or breeding and densely vegetated gullies for roosting. *Distribution Limits: N-Border Ranges National Park. S-Eden.*	×	✓	✓	✓	✓	✓
Masked Owl *Tyto novaehollandiae* OEH	V	-	Open forest and woodlands with cleared areas for hunting and hollow trees or dense vegetation for roosting. *Distribution Limit: N-Border Ranges National Park. S-Eden.*	✓	-	-	-	-	✓

COMMON NAME ***Scientific Name*** DATABASE SOURCE	TSC Act	EPBC Act	PREFERRED HABITAT ***Distribution Limit***	RECORDED ON SITE (✓)	IF NOT RECORDED ON-SITE				TO BE CONSIDERD IN ANY FUTURE 7 PART TEST ASSESSMENT (✓)
					Suitable Habitat Present (✓)	Nearby and/or high number of record(s) (✓) *Notes 1,2 & 3*	Record(s) from recent years (✓) *Notes 1,2 & 3*	Potential to occur	
Sooty Owl *Tyto tenebricosa* OEH	V	-	Tall, dense, wet forests containing trees with very large hollows. *Distribution Limit: N-Border Ranges National Park. S-South of Eden.*	×	✓ Sub-optimal	✓	×	low	✓
Brown Treecreeper *Climacteris picumnus victoriae* OEH	V	-	Occupies Eucalypt woodlands, open woodland lacking a dense understorey with fallen dead timber. *Distribution Limit:(Sub species victoriae) Central NSW west of Great Div. Cumberland Plains, Hunter Valley, Richmond, Clarence, and Snowy River Valleys.*	×	marginal	×	-	unlikely	×
Eastern Bristlebird *Dasyornis brachypterus* EPBC	E	E	Coastal woodlands, dense scrubs and heathlands, especially where low heathland borders taller woodland or dense tall tea-tree. *Distribution Limit: N-Tweed Heads. S-South of Eden.*	×	marginal	×	-	unlikely	×
Speckled Warbler *Chthonicola sagittata* OEH	V	-	Found in temperate eucalypt woodland and open forest including forest edges, wooded farmland and urban areas with mature eucalypts. *Distribution Limit: N-Urbanville. S-Eden.*	×	marginal	×	✓	unlikely	✓
Black-chinned Honeyeater *Melithreptus gularis gularis* OEH	V	-	Found in woodlands containing box-ironbark associations and River Red Gums, also drier coastal woodlands of the Cumberland Plain and Hunter Richmond and Clarence. *Distribution Limit: N-Cape York pen. Qld. S-Victor H. Mt Lofty Ra & Flinders Ra. SA.*	×	✓	×	×	low	✓

COMMON NAME *Scientific Name* DATABASE SOURCE	TSC Act	EPBC Act	PREFERRED HABITAT *Distribution Limit*	RECORDED ON SITE (✓)	IF NOT RECORDED ON-SITE				TO BE CONSIDERD IN ANY FUTURE 7 PART TEST ASSESSMENT (✓)
					Suitable Habitat Present (✓)	Nearby and/or high number of record(s) (✓) *Notes 1,2 & 3*	Record(s) from recent years (✓) *Notes 1,2 & 3*	Potential to occur	
Regent Honeyeater *Xanthomyza Phrygia* OEH EPBC	E4A	E	Found in temperate eucalypt woodland and open forest including forest edges, wooded farmland and urban areas with mature eucalypts. *Distribution Limit: N-Urbanville. S-Eden.*	×	✓	×	×	unlikely	✓
Varied Sittella *Daphoenositta chrysoptera* OEH	V	-	Open eucalypt woodlands / forests (except heavier rainforests); mallee, inland acacia, coastal tea-tree scrubs; golf courses, shelterbelts, orchards, parks, scrubby gardens. *Distribution Limit: N-Border Ranges National Park. S-South of Eden*.	×	✓	×	-	✓	✓
Scarlet Robin *Petroica boodang* TBE	V	-	Found in foothill forests, woodlands, watercourses; in autumn-winter, more open habitats: river red gum woodlands, golf courses, parks, orchards, gardens. *Distribution Limit: N-Tweed Heads. S-South of Eden.*	×	✓	×	-	low	✓
Spotted-tailed Quoll *Dasyurus maculatus* OEH EPBC	V	E	Dry and moist open forests containing rock caves, hollow logs or trees. *Distribution Limit: N-Mt Warning National Park. S-South of Eden.*	×	✓	✓	×	✓	✓

COMMON NAME *Scientific Name* DATABASE SOURCE	TSC Act	EPBC Act	PREFERRED HABITAT *Distribution Limit*	RECORDED ON SITE (✓)	IF NOT RECORDED ON-SITE				TO BE CONSIDERD IN ANY FUTURE 7 PART TEST ASSESSMENT (✓)
					Suitable Habitat Present (✓)	Nearby and/or high number of record(s) (✓) *Notes 1,2 & 3*	Record(s) from recent years (✓) *Notes 1,2 & 3*	Potential to occur	
Koala *Phascolarctos cinereus* OEH	V	-	Inhabits both wet and dry eucalypt forest on high nutrient soils containing preferred feed trees. *Distribution Limit: N-Tweed Heads. S-South of Eden.*	×	marginal	×	×	unlikely	✓
Yellow-bellied Glider *Petaurus australis* OEH	V	-	Tall mature eucalypt forests with high nectar producing species and hollow bearing trees. *Distribution Limit- N-Border Ranges National Park. S-South of Eden*.	×	✓	Numerous but not nearby	-	low	✓
Squirrel Glider *Petaurus norfolcensis* OEH	V	-	Mixed aged stands of eucalypt forest & woodlands including gum barked & high nectar producing species & hollow bearing trees. *Distribution Limit: N-Tweed Heads. S-Albury.*	×	marginal	×	×	unlikely	✓
Long-nosed Potoroo *Potorous tridactylus* EPBC	V	V	Coastal heath and dry and wet sclerophyll forests with a dense understorey. *Distribution Limit: N-Mt Warning National Park. S-South of Eden.*	×	✓	×	×	unlikely	✓
Brush-tailed Rock-wallaby *Petrogale penicillata* OEH EPBC	E	V	Found in rocky gorges with a vegetation of rainforest or open forests to isolated rocky outcrops in semi-arid woodland country. *Distribution Limit: N-North of Tenterfield. S-Bombala.*	×	✓	×	×	unlikely	✓

COMMON NAME *Scientific Name* DATABASE SOURCE	TSC Act	EPBC Act	PREFERRED HABITAT *Distribution Limit*	RECORDED ON SITE (✓)	IF NOT RECORDED ON-SITE				TO BE CONSIDERD IN ANY FUTURE 7 PART TEST ASSESSMENT (✓)
					Suitable Habitat Present (✓)	Nearby and/or high number of record(s) (✓) *Notes 1,2 & 3*	Record(s) from recent years (✓) *Notes 1,2 & 3*	Potential to occur	
Grey-headed Flying-fox *Pteropus poliocephalus* OEH EPBC	V	V	Found in a variety of habitats including rainforest, mangroves, paperbark swamp, wet and dry open forest and cultivated areas. Forms camps commonly found in gullies and in vegetation with a dense canopy. *Distribution Limit: N-Tweed Heads. S-Eden.*	×	✓	×	×	low	✓
East-coast Freetail Bat *Micronomus norfolkensis* OEH	V	-	Inhabits open forests and woodlands foraging above the canopy and along the edge of forests. Roosts in tree hollows, under bark and buildings. *Distribution Limit: N-Woodenbong. S-Pambula.*	×	✓	×	×	low	✓
Large-eared Pied Bat *Chalinolobus dwyeri* OEH EPBC	V	V	Warm-temperate to subtropical dry sclerophyll forest and woodland. Roosts in caves, tunnels and possibly tree hollows. Cave roosts in colonies of up to 30 animals. *Distribution Limit: N-Border Ranges Nation Park. S-Wollongong.*	×	✓	✓	✓	✓	✓
Eastern Bentwing-bat *Miniopterus orianae oceansis* OEH	V	-	Prefers areas where there are caves, old mines, old buildings, stormwater drains & well-timbered areas. *Distribution Limit: N-Border Ranges National Park. S-South of Eden.*	✓	-	-	-	-	✓

COMMON NAME *Scientific Name* DATABASE SOURCE	TSC Act	EPBC Act	PREFERRED HABITAT *Distribution Limit*	RECORDED ON SITE (✓)	IF NOT RECORDED ON-SITE				TO BE CONSIDERD IN ANY FUTURE 7 PART TEST ASSESSMENT (✓)
					Suitable Habitat Present (✓)	Nearby and/or high number of record(s) (✓) *Notes 1,2 & 3*	Record(s) from recent years (✓) *Notes 1,2 & 3*	Potential to occur	
Large-footed Myotis *Myotis macropus* OEH	V	-	Roosts in caves, mines, tunnels, buildings, tree hollows and under bridges. Forages over open water. *Distribution limits: N-Border Ranges National Park. S-South of Eden.*	×	limited	×	×	low	✓
Greater Broad-nosed Bat *Scoteanax rueppellii* OEH	V	-	Inhabits areas containing moist river & creek systems especially tree lined creeks. *Distribution Limit: N-Border Ranges National Park. S-Pambula.*	×	✓	×	×	low	✓
New Holland Mouse *Pseudomys novaehollandiae* EPBC	-	V	Occurs in heathlands, woodlands, open forest and paperbark swamps and on sandy, loamy or rocky soils. Coastal populations have a marked preference for sandy substrates, a heathy understorey of leguminous shrubs less than 1m high and sparse ground litter. Recolonise of regenerating burnt areas. *Distribution Limit: N-Border Ranges National Park. S-South of Eden.*	×	marginal	×	×	unlikely	×
Cumberland Plain Land Snail *Meridolum corneovirens* OEH	E	-	Inhabits remnant eucalypt woodland of the Cumberland Plan. Shelters under logs, debris, clumps of grass, around base of trees and burrowing into loose soil. *Distribution Limit: Cumberland Plain of Sydney Basin Region.*	×	marginal	×	×	unlikely	×

COMMON NAME ***Scientific Name*** DATABASE SOURCE	TSC Act	EPBC Act	PREFERRED HABITAT ***Distribution Limit***	RECORDED ON SITE (✓)	IF NOT RECORDED ON-SITE				TO BE CONSIDERD IN ANY FUTURE 7 PART TEST ASSESSMENT (✓)
					Suitable Habitat Present (✓)	Nearby and/or high number of record(s) (✓) *Notes 1,2 & 3*	Record(s) from recent years (✓) *Notes 1,2 & 3*	Potential to occur	
Macquarie Perch *Macquaria australasica* EPBC	V	E	Occurs in south east Australia at moderate to high altitudes in rivers and reservoirs. *Historical records show the species was widespread and abundant in the upper reaches of the Lachlan, Murrumbidgee and Murray Rivers and their tributaries. Allen (1989) states that introduced populations are present in Nepean River and water supply dams in the Sydney area. Occurs in lakes and flowing streams, usually in deep holes.*	×	unlikely	✓ not in same river system	-	unlikely	×
Australian Greyling *Prototroctes maraena* EPBC	Part 2, Section 19 – Protected Fish	V	Clear, moderate to fast flowing water in the upper reaches of rivers (sometimes to altitudes above 1,000m). Typically found in gravel bottom pools. Often forming aggregations below barriers to upstream movement (eg weirs, waterfalls).	×	✓	×	-	unlikely	×

OEH	-	Denotes species listed within 10km of the study area on the *Atlas of NSW Wildlife* database
EPBC	-	Denotes species listed within 10km of the study area in the *EPBC Act* habitat search
V	-	Denotes vulnerable listed species under the relevant Act
E	-	Denotes endangered listed species under the relevant Act
NOTE:	1.	The *Atlas of NSW Wildlife* database has made recent changes which do not provide easy access to the recorded date of records. Thus a "?" has been placed on records where this information has not been further researched.
	2.	This field is not considered if no suitable habitat is present within the study area
	3.	'records' refer to those provided by the *Atlas of NSW Wildlife* database. Updated 1:100,000 database map sheet requests to OEH are undertaken every 3 months as recommended.
	4.	'nearby' or 'recent' records are species specific accounting for home range, dispersal ability and life cycle.

Table A2.3 below provides an assessment of potential habitat within the study area for nationally *protected* migratory fauna species recorded within 10km on the *EPBC Protected Matters Report*. Nationally *threatened* migratory species are considered in Table A2.2 above.

Table A2.3 – Migratory fauna habitat assessment

COMMON NAME *Scientific Name*	PREFERRED HABITAT *Migratory Breeding*	Suitable Habitat Present (✓)	Recorded on Site (✓)	COMMENTS
White-bellied Sea Eagle (*Haliaeetus leucogaster*)	Coasts, islands, estuaries, inlets, large rivers, inland lakes, reservoirs. *Sedentary; dispersive.*	marginal	×	-
White-throated Needletail (*Hirundapus caudacutus*)	Airspace over forests, woodlands, farmlands, plains, lakes, coasts, towns; companies forage often along favoured hilltops and timbered ranges. *Breeds Siberia, Himalayas, east to Japan. Summer migrant to eastern Australia.*	✓	×	-
Rainbow Bee-eater (*Merops ornatus*)	Open woodlands with sandy, loamy soil; sandridges, sandspits, riverbanks, road cuttings, beaches, dunes, cliffs, mangroves, rainforest, woodlands, golf courses. *Breeding resident in northern Australia. Summer breeding migrant to south-east and south-west Australia.*	×	-	-
Black-faced Monarch (*Monarcha melanopsis*)	Rainforests, eucalypt woodlands; coastal scrubs; damp gullies in rainforest, eucalypt forest; more open woodland when migrating. *Summer breeding migrant to coastal south east Australia, otherwise uncommon*.	✓	×	-
Satin Flycatcher (*Myiagra cyanoleuca*)	Heavily vegetated gullies in forests, taller woodlands, usually above shrub-layer; during migration, coastal forests, woodlands, mangroves, trees in open country, gardens. *Breeds mostly south east Australia and Tasmania over warmer months, winters in north-east Qld.*	✓	×	-
Rufous Fantail (*Rhipidura rufifrons*)	Undergrowth of rainforests / wetter eucalypt forests / gullies; monsoon forests, paperbarks, sub-inland and coastal scrubs; mangroves, watercourses; parks, gardens. On migration, farms, streets buildings. *Breeding migrant to south east Australia over warmer months. Altitudinal migrant in north east NSW in mountain forests during warmer months.*	✓	×	-
Great Egret (*Ardea alba*)	Shallows of rivers, estuaries; tidal mudflats, freshwater wetlands; sewerage ponds, irrigation areas, larger dams, etc. *Dispersive; cosmopolitan.*	✓	×	-