

Figure 6 - Giant Burrowing Frog and Red-crowned Toadlet – Important habitat and observations (Prof Michael Mahony)

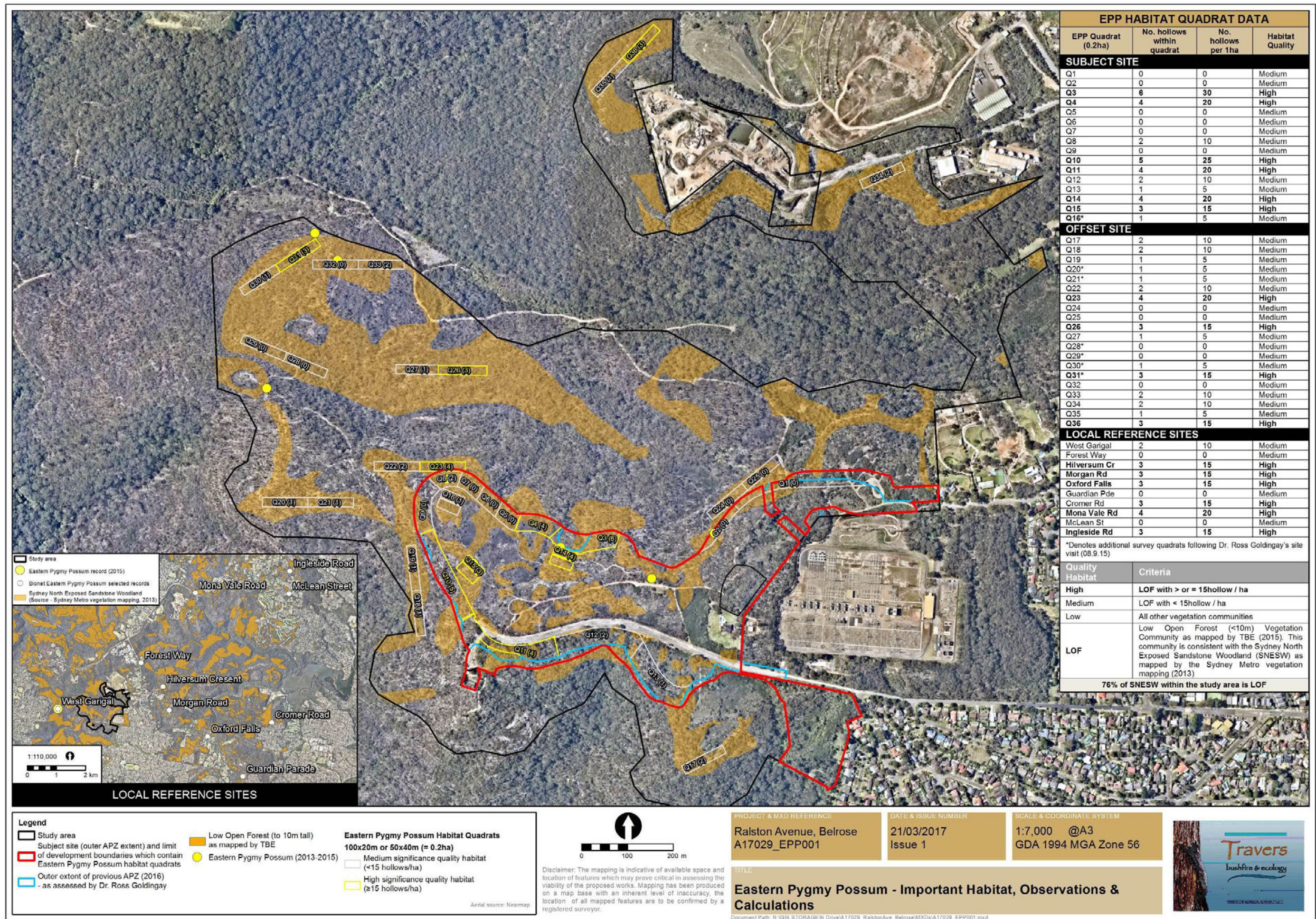


Figure 7 - Eastern Pygmy Possum – Important habitat and observations (Dr Ross Goldingay Expert Report)

4.4 Vegetation connectivity

The subject site is located on a plateau area extending west from the existing Belrose residential area and electrical substation. The slopes surrounding the proposed subdivision and off the escarpment edges will be retained as natural vegetation. These slopes are steeper to the south with a large escarpment edge in the central-south.

To the north, west and south this extensive bushland adjoins Garigal National Park and Middle Harbour Creek catchment (see Figure 8). The total connective landscape covers no less than 1,200ha and is fragmented further north only by Mona Vale Road before heading into Ku-ring-gai National Park towards Berowra and north of Terrey Hills. There is additional connectivity to the north-east towards Narrabeen Lakes and the Warriewood-Ingleside escarpment, however, this is fragmented by Forest Way.

Both Mona Vale Road and Forest Way are very busy roads that would provide a potential barrier for movement for many terrestrial fauna species. However, it is noted that these roads are not fenced in all locations and some wildlife is likely to attempt to cross, at risk of being hit by traffic, at night, or at sunrise when traffic is low.

The majority of the adjoining landscape to the site provides open forest, open woodland and heath habitat associated with steeper gully Hawkesbury soils and exposed slopes.

For all threatened fauna species recorded or with potential to occur, connectivity will remain through the local surrounding bushland and isolation and fragmentation of habitat is not expected. The development extends off the Belrose urban landscape and movement pathways will remain around the naturally vegetated perimeter. Whilst this connectivity will remain some division may occur between plateau populations of small home range species including Eastern Pygmy Possum, Red-crowned Toadlet and other small terrestrial species.

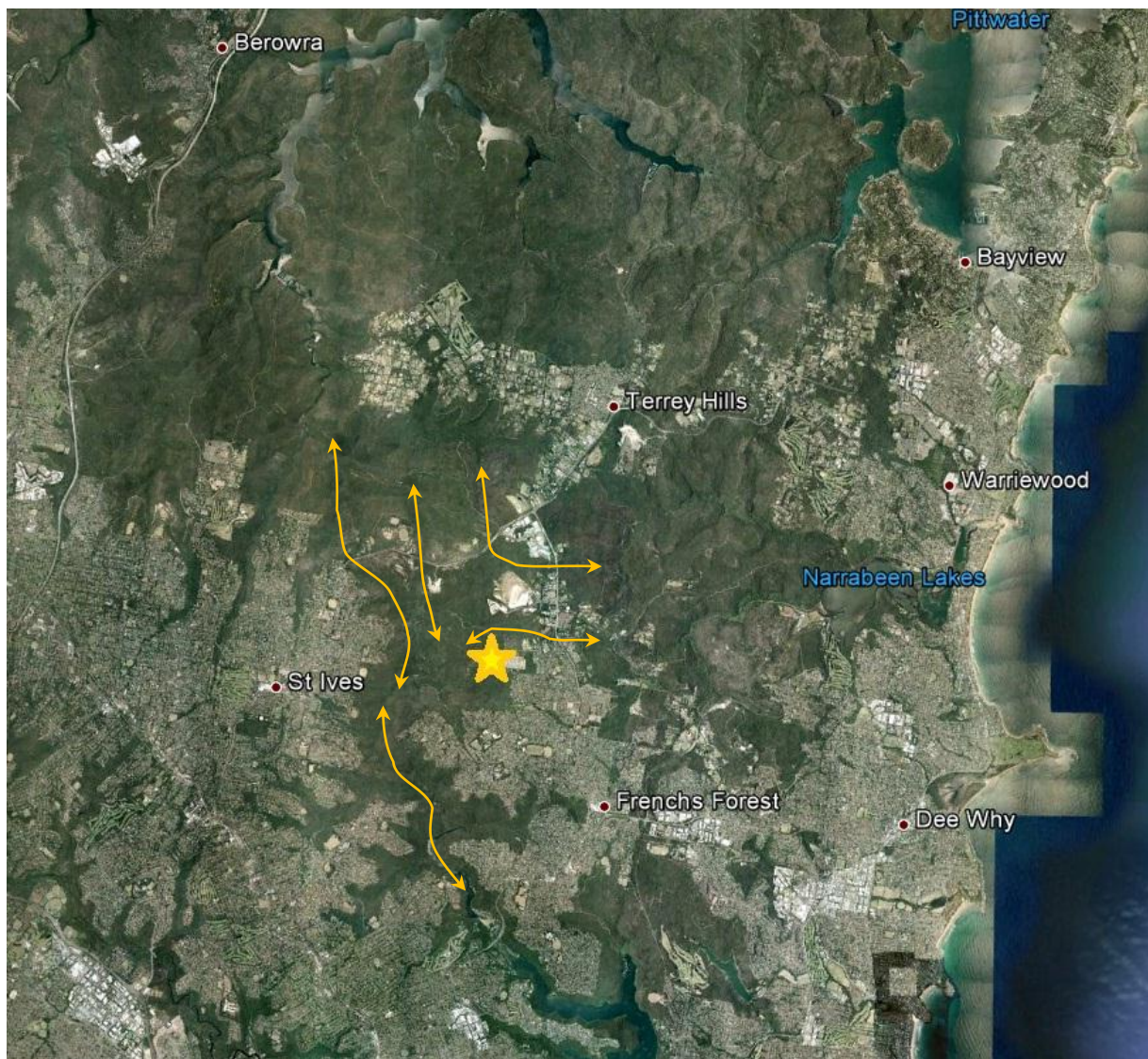


Figure 8 – Vegetation connectivity



Ecological Impacts & Constraints

5

5.1 Recorded threatened species and endangered ecological community

In respect of matters required to be considered under the *EP&A Act* and relating to the species / provisions of the *TSC Act*;

- Ten (10) threatened fauna species occur, being Giant Burrowing Frog (*Helioporus australiacus*), Red-crowned Toadlet (*Pseudophryne australis*), Rosenberg's Goanna (*Varanus rosenbergii*), Powerful Owl (*Ninox strenua*), Little Lorikeet (*Glossopsitta pusilla*), Glossy Black-Cockatoo (*Calyptorhynchus lathamii*), Eastern Pygmy Possum (*Cercartetus nanus*), Grey-headed Flying-fox (*Pteropus poliocephalus*), Little Bentwing-bat (*Miniopterus australis*) and Eastern Bentwing-bat (*Miniopterus orianae oceansis*) were recorded during surveys;
- Two (2) threatened flora species were recorded, *Tetratheca glandulosa* and *Grevillea caleyi*; and
- Two (2) EECs, Coastal Upland Swamp of the Sydney Basin Bioregion and Duffys Forest in the Sydney Basin Bioregion were recorded within the study area.

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

- Two (2) threatened fauna species occur, being Giant Burrowing Frog (*Helioporus australiacus*) and Grey-headed Flying-fox (*Pteropus poliocephalus*);
- No protected migratory bird species were recorded;
- Two (2) threatened flora species occur, being *Tetratheca glandulosa* (listed as vulnerable) and *Grevillea caleyi* (listed as endangered); and
- No EECs listed under this act were recorded within the study area.

In respect of matters relative to the *FM Act* no suitable habitat for threatened marine or aquatic species was observed within the proposed development area and there are no matters requiring further consideration under this Act.

5.2 Ecological impacts of the proposed planning scheme

Direct ecological impacts of the proposed planning scheme include:

- Loss of *Grevillea caleyi* habitat but no loss of recorded plants,
- Loss of *Tetratheca glandulosa* habitat including 138 observed specimens likely to be impacted through development or by APZ management (91% loss), 0.01% of regional population).

- Approximately 29% and 24% loss respectively of rare flora specimens of *Eucalyptus leuhmanniana* and *Angophora crassifolia* as per estimate based upon area of potential habitat within the offset areas.
- 0.59 ha or 16% loss of Coastal Upland Swamp with an additional 0.30 ha proposed for an APZ which is currently an electrical easement that may already be subjected to various levels of vegetation maintenance.
- 0.61 ha or 49% loss of Duffys Forest EECs.
- Loss of four (4) breeding habitat locations for Red-crowned Toadlet and potential indirect impact on other breeding and core habitat areas along ephemeral drainages that drain off the plateau from the development.
- Removal of approximately 9.47 ha of moderate to high quality habitat for Eastern Pygmy Possum containing recorded nesting locations. Indirect impacts such as noise and light spill over and edge effects into other high and moderate quality habitat.
- Removal of hollow dependent threatened species habitat.
- Removal of recorded foraging habitat Rosenberg's Goanna.
- Removal of a foraging opportunities for nectarivore birds, bats and arboreal mammals' species including predominantly banksias and eucalypts.

Indirect ecological impacts of the proposed planning scheme include:

- Increased risk of weed invasion and possibly fungal mobilisation or infections.
- Edge effects and weed impacts of conserved areas.
- Indirect impacts on the dispersal, foraging and breeding habitat of Giant Burrowing Frog
- Potential alteration to the natural overland flow regimes and potential indirect effects along the upper ephemeral and lower perennial drainage catchments that radiate off the development plateau and subsequent potential changes in water quantity and quality effects.
- Increased potential for predation on native species by feral pests.
- Potential removal of bushrock.

Significant areas of potential *Tetratheca glandulosa* habitat exist within the offset lands and more extensive populations are likely to be present. Surveys undertaken to date within the offset areas have not positively located any further *Tetratheca glandulosa* due to the dense vegetation cover which severely restricts access for survey purposes. Whilst the number of specimens' lost is of note, it is currently proposed to offset the loss of *Tetratheca glandulosa* in accordance with the biodiversity certification process.

A combined estimated 72.3% of both populations of *Eucalyptus leuhmanniana* and *Angophora crassifolia* will be conserved. There are an estimated 2,696 *Eucalyptus leuhmanniana* specimens and 922 *Angophora crassifolia* specimens being protected within the proposed offset lands.

With respect to the recoded EEC's, 51% of Duffys Forest and 75% of Coastal Upland Swamp are to be conserved within E3 proposed lands.

The recorded Rosenberg's Goanna (*Varanus rosenbergi*), Red-crowned Toadlet (*Pseudophryne australis*), Giant Burrowing Frog (*Heleioporus australiacus*) and Eastern Pygmy Possum (*Cercartetus nanus*) have been independently assessed by noted experts. Appendix 5, 6 & 7 provides specialist reports for these species in consideration to the anticipated importance of habitat removed. All updated recordings and habitat observations for these species are provided in Figures 5, 6 & 7.

APZ's have been increased since the specialist reviews undertaken between 2012-2015. Given that habitat calculations and their analysis were highly detailed for the previous layout, an update of calculations relevant to specialist review has not been undertaken. Both old and new APZ extents are however shown in the prepared specialist figures (refer Figures 5, 6 & 7) for comparison. Given these additional impacts were on approximately 0.82 ha (2%) of identified important habitat areas for Rosenberg's Goanna (as identified by specialist Gerry Swan), Mr Swan was subsequently notified of the changes. Following a recent site inspection of the new APZ extents on the 16/3/17, Mr Swan has provided a revised letter in Appendix 5 indicating that his conclusion of a not significant impact on the species remains unchanged.

The other recorded threatened species are not considered to be site dependent and will not be adversely affected by the proposed planning scheme. A detailed assessment on all state listed threatened fauna species recorded or with considered potential to occur is provided in Appendix 3.

5.2.1 Rosenberg's Goanna

Based on the advice of Mr Gerry Swan, the Rosenberg's Goanna population is expected not to be significantly impacted and a viable population can be maintained in the presence of the proposed development. The nearest most likely breeding areas for Rosenberg's Goanna are in the north and north-east portion of the study area as confirmed by Mr Gerry Swan, inclusive of lands north of the substation site. Other areas also exist to the southern, south western, eastern, and north eastern aspects of the proposed residential areas.

5.2.2 Giant Burrowing Frog

Based on the target survey for Giant Burrowing Frog, the nearest breeding habitat is 240m to the north of the proposed development. Prof Mahony indicates that it is most unlikely that habitats on the plateau are used routinely for shelter or foraging and indirect impacts on hydrology are unlikely to impact on breeding habitat. Prof Mahony has concluded that based on separation distance from the recorded breeding location and availability of suitable habitat within the proposed offset lands that this species will not likely be significantly impacted. This is provided that the hydrological integrity of breeding habitat is maintained such that the quantity and quality of runoff is not affected by the proposed development.

5.2.3 Red-crowned Toadlet

Red-crowned Toadlet on the other hand has been recorded at several locations surrounding the subject site in the majority where suitable ephemeral breeding areas exist. Four (4) recorded locations were within the proposed development area and will be directly impacted along with surrounding shelter and foraging locations. Prof Mahony concluded that the majority of the recorded breeding sites will not be directly impacted by the proposal and movement will mostly be within the escarpment and mid-slope areas. The greatest risk on the population of the Red-crowned Toadlet is mostly caused by indirect changes in the quality and quantity of runoff into breeding habitat (flow rate, volume, and water quality). As with the Giant Burrowing Frog, Prof Mahony states that mitigation measures are required to ensure that the hydrology of these sites is not altered by the proposal.

5.2.4 Eastern Pygmy Possum

As outlined by specialist Dr Ross Goldingay approximately 8.4 ha (now 9.47 ha including new APZ extensions) of high and moderate quality habitat for the Eastern Pygmy Possum will be removed within the proposed development landscape. High quality habitat is based on recordings of the species, high density of *Banksia ericifolia*, proximate occurrence of a

high diversity of other banksia and eucalypts species and in-particular hollows occurring in densities greater than 15 per hectare. The subject site has been confirmed as containing denning and breeding habitat for Eastern Pygmy Possum. The proposal will therefore impact on denning, breeding and foraging habitat.

Dr Goldingay predicted that the subject site provides habitat containing approximately 21% of the number of EPP estimated within the total study area (development and conservation area). However Dr Goldingay concluded that “*It would appear there would be adequate habitat within Garigal NP and the offset site to support a viable local population based on the definitions given by DECC (2007)*”. Dr Goldingay went on to indicate that the number of affected EPP “*is not insubstantial and requires some mitigation for the development to proceed*”.

5.2.5 Concluding comments

Significant areas of potential breeding and important habitat are available within the proposed offset lands for Rosenberg’s Goanna, Giant Burrowing Frog, Red-crowned Toadlet and Eastern Pygmy Possum. All of the frog species recorded during surveys are indirectly impacted by stormwater drainage and hence the integrated management of stormwater will be important, particularly in maintaining viable threatened species populations.

The proposed conservation lands provide habitat for *Tetratheca glandulosa*, marginal habitat for *Grevillea caleyi* and *Pimelea curviflora* var. *curviflora*.

In summary the impacts on EEC’s threatened and rare flora species include:

Duffys Forest - 0.61 ha or 49.2% will be impacted by the proposed rezoning

Coastal Upland Swamp - 0.59 ha or 16.4% will be impacted by the proposed rezoning with an addition 0.3 ha or 8.3% being impacted by the electrical easement

Grevillea caleyi – 4 specimens recorded (1 additional by not seen since 2013), no direct impacts expected (100% conservation of observed specimens)

Tetratheca glandulosa – 151 specimens recorded, 138 likely to be impacted through development or by APZ management (91.4% loss within subject site to be offset, 0.01% of the regional population)

Eucalyptus luehmanniana – Estimated population is 3796, 1100 will be impacted by the development and APZ (approximately 29.0% loss)

Angophora crassifolia – Estimated population is 1208, 286 will be impacted by the development and APZ (approximately 23.7% loss)

5.3 Ecological constraints

The ecological constraints are a combination of the insitu EECs, Coastal Upland Swamp and Duffys Forest, and threatened species constraints.

5.3.1 Flora constraints

Vegetation community survey has been undertaken throughout the total land parcel owned by MLALC (including the offset lands), whilst target threatened flora searches have been undertaken within the proposed residential areas and the immediate surrounding landscape.

Target flora survey has not been undertaken in the entire offset lands, except for the purposes of identifying the presence or absence of threatened flora species. Therefore individual records as mapped are not considered to be the full extent of the threatened or rare plant populations within the offset lands.

The *MLALC* land parcel and associated road corridors provide known habitat for the following threatened flora species and an EEC:

- *Tetratheca glandulosa* (one hundred and fifty one (151) plants mostly within proposed residential zone)
- *Grevillea caleyi* (four (4) plants along Wyatt Road corridor, however none expected to be directly impacted)
- EEC, Coastal Upland Swamp (3.60 ha)
- EEC, Duffys Forest (1.24 ha)

The land parcel (study area) also contains two (2) populations of the following rare ROTAP listed threatened species:

- *Eucalyptus luehmanniana* - 3,796 plants within study area including offset lands
- *Angophora crassifolia* - estimated 1,208 plants within study area including offset lands

The EEC, Coastal Upland Swamp occurs in several patches covering a total of 1.8ha. All of the Coastal Upland Swamp will be retained as part of the proposed planning scheme. Based on the floristic survey results, the EEC, Coastal Upland Swamp of the Sydney Basin Bioregion provides a vegetation constraint to development of the land. Coastal Upland Swamp occurs on the southern aspect of Ralston Avenue and in the northern portion of the land parcel. The Coastal Upland Swamp is also a protected groundwater dependent ecosystem under the NSW Groundwater Dependent Ecosystem Policy.

Ralston Avenue, which currently extends through to the south western boundary, provides a physical barrier for the existing Coastal Upland Swamp. The planning proposal provides a natural vegetation buffer of 30m to the north west of the largest patch of Coastal Upland Swamp. An APZ provides additional separation.

Following surveys in May 2008 and December 2011, target survey for potential threatened flora species was undertaken in October (spring) 2012, in particular for *Pimelea curviflora* var. *curviflora* which has not been detected within the proposed residential zone to date. *Tetratheca glandulosa* and *Grevillea caleyi* were also resurveyed in October 2012 to ascertain their full coverage across the development area. Further target surveys were undertaken in July 2015 for *Grevillea caleyi* and in September 2015 for *Tetratheca glandulosa*.

Based upon the floristic survey, the current potential botanical constraints are;

- *Tetratheca glandulosa* and *Grevillea caleyi*, threatened plant species under both the *TSC Act* and *EPBC Act*
- EEC, Coastal Upland Swamp and Duffys Forest
- *Angophora crassifolia*, a rare (ROTAP) species found within the taller vegetation stratas and occasionally in Tall Heath / Damp Tall Heath
- *Eucalyptus luehmanniana*, a rare (ROTAP) species has been observed, usually within Tall Heath or Low Open Forest in close proximity to Ralston Avenue, mostly on the southern side of the road on south west to south east facing slopes

Based on the vegetation community mapping, the Low Open Forest and Open Forest communities appear to provide the best potential threatened flora habitat. However, the recorded number and densities of threatened species are low.

The offset lands provide extensive areas of habitat for these species, as demonstrated by target survey for *Eucalyptus luehmanniana* and *Angophora crassifolia*. The offset lands are also expected to provide habitat for *Tetratheca glandulosa* and *Pimelea curviflora* var. *curviflora* and *Grevillea caleyi*.

Given the estimated large numbers of *Eucalyptus luehmanniana* and *Angophora crassifolia* in the offset lands, approximately 70% of the estimated *Eucalyptus luehmanniana* population and 79% *Angophora crassifolia* of the population (nine hundred and seventy eight (978) records) will be retained.

A very small population of *Grevillea caleyi* (four (4) plants) are potentially indirectly impacted by road works and the development area, however the design of the road within the road corridor provides a few metres separation to the specimens.

There have been no significant observations of *Tetratheca glandulosa* within the offset lands thus far despite widespread potential habitat. The habitat is likely to be better on the periphery of the offset area closest to the plateau though. In 2013, the proposal provided a conservation area to assist in the protection of this species in situ on the plateau, however with the redetermination of some vegetation as Duffys Forest EEC, the conservation area was shifted to protect this. The impacts *Tetratheca glandulosa* have increased as a result.

5.3.2 Fauna constraints

Ten (10) threatened fauna species have been recorded within, or in close proximity to, the development area during surveys to date. The recorded species include:

- Powerful Owl (*Ninox strenua*),
- Eastern Pygmy Possum (*Cercartetus nanus*),
- Grey-headed Flying-fox (*Pteropus poliocephalus*),
- Eastern Bentwing-bat (*Miniopterus orianae oceanensis*),
- Little Bentwing-bat (*Miniopterus australis*),
- Glossy Black-Cockatoo (*Calyptorhynchus lathami*),
- Little Lorikeet (*Glossopsitta pusilla*),
- Rosenberg's Goanna (*Varanus rosenbergi*),
- Red-crowned Toadlet (*Pseudophryne australis*), and
- Giant Burrowing Frog (*Heleioporus australiacus*).

Of these species, the Eastern Pygmy Possum, Rosenberg's Goanna, Red-crowned Toadlet and Giant Burrowing Frog are considered to offer constraints to the development proposal such that mitigation measures are specifically required to offset their impacts.

Rosenberg's Goanna

Fauna surveys to date have revealed that the proposed residential area is utilised by Rosenberg's Goanna for foraging purposes, with some evidence also of burrow activity during searches within the proposed APZ. One (1) terrestrial termite mounds suitable for nesting has been observed within the confines of the subject site however this will be retained within the proposed Duffy's Forest area. None have been located within the proposed development area, but due to the density of vegetation the presence of such important breeding opportunities cannot be entirely ruled out. We do expect to find potential termite mounds in the more wooded areas below the escarpment edge. Further investigation

on this species by specialist Gerry Swan determined that the planning scheme is not considered a likely significant impact based on the habitat utilisation and surrounding known habitat of this species.

Mr Swan, a recognised reptile specialist, located a termite mound with a juvenile exit point and several more burrows. The termite nest and observed burrows are located outside of the proposed development area. Mr Swan has concluded that the proposed development site is not critical to the survival of the population, that there is adequate habitat surrounding the proposed residential development site to maintain a viable population, and the proposed residential development is not likely to result in a significant movement of connectivity restriction to the local population. Mr Swan also states that the proposed development is not likely to have a significant impact on the Rosenberg's Goanna population. This opinion remains unchanged following Mr Swans recent site review of APZ extensions. Mr Swan has identified an approximate 39.5 ha critical habitat area for this species which the proposed development layout does encroach on approximately 5.4 (13%) to the northern aspect of the site.

As a result, the current constraints from Rosenberg's Goanna are the identified burrows (or old burrows) within the APZ area and the identified termite mound retained within the Duffys Forest protection area. The burrows are to be retained with associated rock areas and nearby shelter vegetation to the highest extent within APZ requirements. The identified termite mound within the subject site area, whilst retained will be likely inaccessible by the goanna.

Red-crowned Toadlet and Giant Burrowing Frog

Recognised frog specialist, Prof Michael Mahony, with field assistance by *TBE*, undertook targeted surveys for Red-crowned Toadlet and Giant Burrowing Frog (GBF). A GBF breeding location was recorded within the far northern fringe of the offset area, over 300m from the north western tip of the proposed development. Prof Mahony concluded that:

- The density of GBF at the site is low, and that it is most unlikely that habitats on the plateau are used routinely for shelter and foraging. Furthermore, it is not likely that development will break a corridor that connects breeding habitat with foraging and shelter sites since there are no identified breeding sites close to the plateau.
- The considerable distance of the identified breeding habitat from the plateau and the relatively large area of surrounding habitat indicate that indirect impacts on hydrology are unlikely to impact on the GBF breeding habitat.
- It is not likely that the proposal will impact on the local viable population of the GBF.
- There is no need for the placement of buffer zones around habitat on the escarpment since there is no identified breeding, sheltering or foraging habitat.

More recent surveys opportunistically recorded a second breeding location of Giant Burrowing Frog closer to the development but still 240m north of the development boundary. Prof Mahony was notified of this new breeding location but does not think this observation alters the conclusion of his assessment and consideration of the impact of the proposal on the local population of the Giant Burrowing Frog. Prof Mahony indicated that the matters that need to be considered in construction and long-term occupancy of the plateau are to maintain the hydrological integrity of the water that feeds off the plateau. In this case, water volume (and discharge rate) and the potential occurrence of additional nutrients to the natural waterways are the matters that need to be effectively mitigated.

Following additional site surveys for Red-crowned Toadlet in 2013, Prof Mahony concluded that:

- Additional breeding habitats of the Red-crowned Toadlet were detected and twelve (12) breeding locations were identified within the study area outside the subject site. It is concluded that the local population occurs along most of the semi-permanent drainages and soaks that occur near the escarpment and down slope from the plateau. None of these breeding locations will be directly impacted by the proposed development. There are four (4) identified breeding locations within the subject site; one (1) on the western end of the plateau (human made pit), two (2) on the rock face seepage in the north east, and one (1) at the head of the drainage line to the south.
- Movement of the Red-crowned Toadlet will mostly be in the escarpment and mid-slope areas and development of the plateau will not have a significant effect on the local population due to the removal of habitat or the breaking of corridors.
- The potential for impact on the population of the Red-crowned Toadlet is assessed to be related mostly to indirect impacts on the hydrology of the breeding habitat (rate, volume, and water quality of discharge). Specific mitigation measures are required to ensure that the hydrology of these sites is not altered by the proposal.
- Protection of the considerable area of Red-crowned Toadlet habitat below the escarpment and at mid-slope should protect the local viable population.

Eastern Pygmy Possum

Thus far, five (5) confirmed observations including three likely nesting locations for Eastern Pygmy Possum as well as approximately 9.47 ha of moderate to high quality habitat exists within the proposed development landscape (see Figure 4b and Figure 7). The subject site subsequently provides recorded denning, breeding and foraging habitat for the Eastern Pygmy Possum which will provide constraints to development or require appropriate mitigation and offsetting measures. The subject site was also found to record a higher percentage of high quality habitat (37% = 3.5 ha) as compared to the offset area (20% = 7.5 ha). These calculations were 3.1 ha and 7.7 ha respectively as calculated and assessed by Dr Goldingay when the subject site was 6.52 ha smaller. The total high quality habitat removed calculated equates to approximately 32% (28% assessed by Dr Goldingay) within the study area and 6% of the combined connective areas including Garigal N.P.

Key constraints identified by Dr Goldingay included:

- The tall heathland with higher densities of various banksia species will be most influential and is likely to drive breeding in the local population.
- Many scribbly gums (*E. haemastoma*) within the low open forest of the proposed development area contained small hollows; however relatively few of the trees that were inspected within the offset areas contained hollows.
- Important areas of foraging habitat and breeding habitat will be affected by the proposed development.
- Impacts on the Eastern Pygmy Possum from the proposed residential development could be direct and indirect. The loss of habitat from clearing for the residential development would have a direct impact. The most serious indirect impact from the development would be if residents in the area keep house cats. This indirect impact of the development could be removed by prohibiting the keeping of cats in the residential development.
- Foraging habitat for the Eastern Pygmy Possum appears to encompass almost all vegetation communities in the study area (proposed residential area, APZ and offset lands) with the exception of the modified community (Community E) and possibly the riparian woodland-forest (not examined). The most important community would be the Tall Heath (Community B) due to the high density of *B. ericifolia*.
- Brief examination of the area bounded by the proposed residential area and APZ suggest that scribbly gums within the low open forest may be the primary source of tree hollows to be used for breeding.

Mitigation measures identified by Dr Goldingay to reduce the impacts included the placement of suitable nesting boxes, prohibition of cats from the R2 and E3 zones (stipulated through an restriction on the use of land – 88B covenant under the Local Governmnet Act) and provision of road crossings across Mona Vale Road and Forest way to assure populations on both sides.

Therefore, of the recorded fauna species to date, the Red-crowned Toadlet (*Pseudophryne australis*) and Eastern Pygmy Possum (*Cercatetus nanus*) have been found to offer the most considerable constraints to development due to the recorded presence of breeding locations within and the nearby surrounds to the proposed residential area.



Biodiversity Offsets

6

6.1 Background

As the planning proposal has been put forward for biodiversity certification, *EcoLogical Australia* have prepared a Biodiversity Assessment Report and Biodiversity Certification Strategy (2015) using the BCAM methodology. This will need to be updated with the recent changes to consider additional impacts to each vegetation type for APZ purposes, and their surrogate threatened species habitat.

The public exhibition of the Biodiversity Assessment Report and Biodiversity Certification Strategy (2015) for the application for biodiversity certification has been deferred pending further consideration by Northern Beaches Council. This matter will be resolved following public exhibition of the planning proposal.

Biometric vegetation survey within the proposed offset area has been undertaken to confirm the vegetation communities present (Figure 3), to match the vegetation with biometric vegetation types and used to provide a preliminary analysis as to whether the offset lands are likely to meet typically acceptable offset targets.

Notwithstanding the principles of use for biodiversity offsets in NSW (OEH 2010) the key objectives of a biodiversity offset strategy for a proposed development include:

- to achieve a maintain or improve outcome of total native vegetation cover including protection and restoration offsets,
- to secure sites with suitable habitats to compensate for the loss of onsite habitats and which contain suitable habitat for the threatened flora and fauna species previously observed within the development area, and
- to enable long-term management of conserved bushland areas in accordance with an approved vegetation management plan or equivalent.

A basic component of any offset analysis is the calculation of losses and gains (typically in hectares or credits) of each vegetation community, threatened species populations or habitat which identifies the offset ratios for each vegetation community or threatened species.

The adequacy of the offsets is in part determined through the use of the maintain or improve test using the BCAM or BBAM methodologies and in the case of EPBC listed matters in accordance with the *EPBC Act* biodiversity offset policy and biodiversity offset associated calculator as provided by Department of Environment.

The maintain or improve test using the BCAM or BBAM methods, predicts the conservation values based on a comprehensive data set of species records and habitat requirements which are too complex to consider simply as a loss and gain of vegetation communities.

6.2 Offset security

A key principle of the offsetting guidelines is to provide security in perpetuity for the offset outcomes. As such, the offset areas can be protected in a number of ways including:

- Rezoned as E2 Conservation or E3 Environmental Management usually in combination with a voluntary conservation agreement (VCA),
- Protection under a biodiversity certification agreement
- Protection and management as public reserve under the *Local Government Act*
- Protected under a conservation covenant or equivalent
- Transferred into national park estate
- Established as a biobanking site

The method of protection is to be resolved in consultation with OEH and in accordance with the protection options as permissible under the BCAM or BBAM. The proponent's current preferred method of protection is under a biodiversity certification agreement and establishing the offset lands as a biobank site.

Section 6.3 identifies the principles that must be met in order to provide a viable offset site.

6.3 Principles for use of biodiversity offsets in NSW

The following principles have been defined by OEH for the use of biodiversity offsets in NSW. The proposed offset sites are considered in the context of these principles.

1. *Impacts must be avoided first by using prevention and mitigation measures*

The proposal must demonstrate avoidance of impact using prevention and mitigation measures. Subject to the assessment process, the development concept should be able to demonstrate avoidance of significant impacts.

2. *All regulatory requirements must be met*

All other existing legislative requirements must be met. This principle will be addressed as part of the gateway determination of the planning proposal and subsequent development applications.

3. *Offsets must never reward ongoing poor performance*

The proponents must demonstrate satisfactory performance in managing, protecting and maintaining the conservation values of the landscape subject to the approved development application. Current and ongoing land management practices demonstrate that the land is currently being managed in an appropriate manner but will require resources in the future to maintain the lands for biodiversity conservation purposes.

4. *Offsets will complement other government programs*

In this case, the offset lands have significant strategic conservation value, being located adjoining Garigal National Park.

5. *Offsets must be underpinned by sound ecological principles*

The ecological survey, biodiversity offset analysis and subsequent assessment process is intended to flesh out the ecological implications of the proposed development and the offset

arrangements. Consultation with OEH, Northern Beaches Council and DOEE are critical to this process to ensure that the offsets are ecologically sound.

6. *Offsets should aim to result in a net improvement in biodiversity over time*

The provision of the offset site is a major part of the process of seeking a net improvement in biodiversity but its protection and future management must be based on best practice conservation management practices. Future monitoring of the offset site must demonstrate a net improvement in biodiversity values as a result of land management practices including target weed control, revegetation or regeneration works and / or changes in land practices such as ecological or hazard reduction burns.

7. *Offsets must be enduring – they must offset the impact of the development for the period that the impact occurs*

The offset site must clearly demonstrate that it adequately offsets the impact of the development throughout the entire development process.

8. *Offsets should be agreed to prior to the impact occurring*

The offsets are required to be approved by the Director General prior to commencement of any actions related to current development applications.

9. *Offsets must be quantifiable – the impacts and benefits must be reliably estimated*

The offset analysis needs to determine the following parameters:

- The area of Impact,
- The types of ecological communities affected,
- The condition of habitat,
- The conservation status and / or scarcity / rarity of ecological communities,
- The Level of security afforded to the site.

These are key issues to resolve as part of the assessment process in consultation with OEH.

10. *Offsets must be targeted*

The offsets must demonstrate that they target the biodiversity values impacted by the proposed development. Where it does not offset specific ecological impacts, either alternative offsets may need to be provided such as through restoration on other lands.

11. *Offsets must be located appropriately*

The offset sites must be large enough to be of conservation value and must also be located to support other conservation areas or ecological corridors. Access must also be available for management purposes.

12. *Offsets must be supplementary*

The proposed offset areas are not to be under any other conservation agreement and must not be offered as biodiversity offset under any other scheme.

13. Offsets and their actions must be enforceable through development consent conditions, licence conditions, conserving agreements or a contract

The proposed offset must be enforceable through the development consent. Considerations to the transfer of ownership of the land to a public authority, provision of long term funding for the management of the offset site and / or entering into a conservation or certification agreement are important matters to be resolved.

6.4 Offset Ratios

A simple analysis of offset ratios is provided below based on the loss and conservation of vegetation communities as a result of the planning proposal.

Table 6.1 – Biometric vegetation types conserved and impacted

BVTID	Biometric Vegetation Type	Impacted Vegetation (ha)	Total Conserved and retainer (ha)	Grand Total (ha)	% loss of BVT within study area	Offset ratio including conserved and retained lands
ME012	Sydney Peppermint - Smooth-barked Apple - Red Bloodwood shrubby open forest on slopes of moist sandstone gullies, eastern Sydney Basin Bioregion	0.35	17.44	17.79	2.0%	51:1
ME014	Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion	12.33	62.42	74.75	16.5%	6.1:1
ME008	Hairpin Banksia - Kunzea ambigua - Allocasuarina distyla heath on coastal sandstone plateaux, Sydney Basin Bioregion	1.12	7.57	8.69	12.9%	7.8:1
ME015	Needlebush - banksia wet heath on sandstone plateaux of the Sydney Basin Bioregion	0.89	2.71	3.60	24.7%	4.0:1
ME013	Hairpin Banksia - Slender Tea-tree heath on coastal sandstone plateaux, Sydney Basin Bioregion	10.04	13.95	23.99	41.9%	2.4:1
ME039	Red Bloodwood - Smooth-barked Apple shrubby forest on shale or ironstone of coastal plateaux, Sydney Basin Bioregion	0.61	0.63	1.24	49.2%	2.0:1
Cleared	Cleared	N/A	N/A	8.19	N/A	N/A
Grand Total		28.91	109.35	138.26	20.9	4.8:1

It can be seen from the offset ratios that the planning proposal results in generally acceptable offset ratios for all communities within the site that is greater than 2:1.

The site has previously been assessed using BBAM 2014 for biocertification by *EcoLogical Australia* in 2015. The outcomes of the Biodiversity Assessment Report and Biodiversity Certification Strategy is addressed by Ecological Australia (2015) but will need updating to reflect recent amendments to the proposal's design and APZ impacts.

Threatened species offsets are also addressed under the biodiversity certification assessment is addressed by *EcoLogical Australia* (2015). We note that of all the affected threatened species the loss of *Tetratheca glandulosa* and Rosenbergs Goanna habitat is expected to require offsets to be provided through an external offset.

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Conclusions & Recommendations

7

7.1 Conclusions

This document forms the basis of assessment required under Section 5A of the *EPA Act* and matters of national significance under the *EPBC Act*. These assessments determine if the proposed residential development of the site is likely to have a significant effect on threatened species, populations and / or EECs.

With regards to EECs, both appear to be adequately protected by the current proposal. There will be losses to both in terms of area however the impacts on not likely to be large enough to cause a significant impact such that they are placed at risk of local extinction.

In respect to threatened flora species, *Grevillea caleyi* is conserved and not significantly affected by the proposed development. There has been limited observations of *Tetratheca glandulosa* within the proposed conservation lands because the survey effort has been partly limited by access in dense vegetation areas. The ideal habitat for this species is on the plateau and as such, a high proportion of the *known* population will be impacted by the proposal. A reduction of impact and / or detection of further specimens in the offset areas would reduce the impact on the local population.

In respect to threatened fauna species known breeding habitat will be impacted for the Eastern Pygmy Possum and Red-crowned Toadlet and utilised habitat of otherwise importance will be impacted for the Rosenberg's Goanna and Giant Burrowing Frog. The key considerations for these species is to ensure that adequate breeding habitat as well as other important habitat features are sufficiently represented in offset areas to effectively sustain local populations.

The assessment of whether sufficient habitat has been provided as a result of the planning proposal is considered in the attached expert reports for the key impacted threatened fauna species. The evidence submitted within the expert's reports leads *Travers bushfire & ecology* to conclude that there is unlikely to be a significant impact on threatened fauna species.

The proposed offset areas provide a major contribution to the adjoining national park estate and appear to provide typically acceptable offsets based on the loss and gain of vegetation communities. The adequacy of the offsets are assessed in accordance with the Biodiversity Certification Assessment Methodology (BCAM) as provided by Ecological Australia (2015). Development redesign and additional offsets, including restoration of habitat, may be required to adequately offset the loss of threatened flora and fauna habitat.

EPA Act and TSC Act

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

- Ten (10) threatened fauna species have been recorded within and immediately surrounding the proposed development area. Giant Burrowing Frog (*Helioporus*

australiacus), Red-crowned Toadlet (*Pseudophryne australis*), Rosenberg's Goanna (*Varanus rosenbergii*), Glossy Black-Cockatoo (*Calyptrorhynchus lathami*), Powerful Owl (*Ninox strenua*), Little Lorikeet (*Glossopsitta pusilla*), Eastern Pygmy Possum (*Cercartetus nanus*), Grey-headed Flying-fox (*Pteropus poliocephalus*), Little Bentwing-bat (*Miniopterus australis*) and Eastern Bentwing-bat (*Miniopterus orianae oceansis*).

- Two (2) threatened flora species, *Tetratheca glandulosa* and *Grevillea caleyi*, were recorded.
- Two (2) EECs, Coastal Upland Swamp of the Sydney Basin Bioregion and Duffys Forest Ecological Community in the Sydney Basin Bioregion were recorded.
- No endangered populations listed under this act were recorded within the total land parcel.

The rezoning will have a detrimental impact upon *Tetratheca glandulosa* but not one that will lead to a long-term decline such that it may cause a local extinction of the species.

Given the assessment herein and the submitted experts reports *Travers bushfire & ecology* concludes that there is unlikely to be a significant impact on threatened fauna species. The proposal will not likely have a significant impact on any remaining state listed threatened species, populations or EECs. Therefore a species impact statement is not likely to be required.

In respect to threatened fauna species, known breeding habitat will be impacted for the Eastern Pygmy Possum and Red-crowned Toadlet and utilised habitat of otherwise importance will be impacted for the Rosenberg's Goanna and Giant Burrowing Frog. The key considerations for these species is to ensure that adequate breeding habitat as well as other important habitat features are sufficiently represented in offset areas to effectively sustain local populations.

EPBC Act

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

- Two (2) threatened fauna species, Giant Burrowing Frog (*Heliophorus australiacus*) and Grey-headed Flying-fox (*Pteropus poliocephalus*), were recorded
- No protected migratory bird species were recorded
- One (1) threatened flora species *Grevillea caleyi* (listed as endangered) was recorded
- No EECs or endangered populations listed under this act were recorded within the total land parcel.

The proposed subdivision development is not expected to have a significant impact on any matters of NES, particularly based on the advice of Prof. Michael Mahony in respect to the Giant Burrowing Frog and absence of Southern Brown Bandicoot during recent targeted surveys. Further target surveys for New Holloand Mouse are recommended at development application stage however no significant impact is anticipated for this species given the extent of suitable habitat in the offset areas. Therefore a referral to DOEE should not be required at present in respect to matters of NES.

FM Act

In respect of matters relative to the *FM Act*, no suitable habitat for threatened aquatic species was observed within the subject site, and there are no matters requiring further consideration under this Act.

7.2 Recommendations

The following recommendations are provided to minimise adverse impacts on the surrounding terrestrial and aquatic ecosystems:

Fuel and habitat management

- The Fuel Management Plan & Vegetation Management Plan is to be integrated to ensure the protection of all key habitat features for protection within the APZ. These habitat features are to be protected with associated buffer vegetation where possible. Hollows suitable for Eastern Pygmy Possum, all burrows potentially Rosenberg's Monitor and potential Red-crowned Toadlet breeding drainages are to be protected in particular. Pathways, fire trails and stormwater drainage and treatment measures are to be located to maintain a visual and ecological buffer with selective retention of important habitat features.

Detailed habitat searches have been undertaken within the previous APZ extent for the May 2016 assessment. Further habitat searches are required within the extended areas of APZ as part of the current layout; as such features have not been identified within these areas thus far. The Fuel Management Plan & Vegetation Management Plan will need to be amended in accordance with the updated changes.

Vegetation management plan

- A vegetation management plan is to be prepared with the following aims:
 - a. Ensure protection of important habitat areas within the offset lands and minimise losses of habitat for threatened flora and fauna inclusive of the Duffys Forest Conservation Area and the surrounding APZ and conservation lands.
 - b. Maximise long term retention of habitat within APZs.
 - c. Provide adequate buffers to all sensitive watercourse and upland swamp areas such as the north eastern drainage line to conserve Red-crowned Toadlet habitat.
 - d. Ensure best practice landscape and bushland management is in place to minimise the establishment and spread of weed species and the control of waste disposal.
 - e. Maximise the retention of understorey and overstorey habitat within asset protection zones to provide on ground refugia and habitat linkages without compromising the effectiveness of the APZs.
 - f. All landscaping within the road corridors and open space areas are to be revegetated using locally occurring native plant species.
 - g. Target weed control is to be undertaken within 20m of any works to control the invasion or spread of noxious or invasive environmental weed species.
 - h. Standard *Phytophthora cinnamomi* protocol applies to the cleaning of all plant, equipment, hand tools and work boots prior to delivery onsite to ensure that there is no loose soil or vegetation material caught under or on the equipment and within the tread of vehicle tyres. Any equipment onsite found to contain soil or vegetation material is to be cleaned in a quarantined work area or wash station and treated with anti-fungal herbicides.

- i. Erosion control measures are to be in place to reduce temporary erosion and sedimentation risks to adjacent EEC vegetation and any nearby drainage channel.

Stormwater management, groundwater and surface discharges

- Ensure all stormwater inputs are treated to a receiving waters standard as determined by MUSIC modelling for water quality and quantity targets in pre development conditions. Baseline water quality sampling is to be undertaken to all aspects as a target to achieve and to determine baseline environmental quality.
- Existing surface and groundwater discharges are to be maintained in terms of quality and quantity to Coastal Upland Swamps areas through the careful management of surface runoff, permeable surfaces, overland flow and to maintain the current quantity and peak discharges from site.
- The potential occurrence of additional nutrients into the natural surrounding waterways is to be effectively mitigated to pre development conditions. Stormwater management is to protect the surrounding conservation areas and associated threatened species habitat in the long term, particularly Red-crowned Toadlet and Giant Burrowing Frog breeding locations. Consequently, the target quality should be equivalent to the receiving water quality as determined by baseline water quality sampling over a 12 month period (minimum 6 sample runs spread throughout the year with at least two peak discharge sample runs immediately after storm events).

Protection and enhancement of Eastern Pygmy-possum habitat

- A detailed hollow-bearing tree assessment is to be undertaken throughout the development landscape to mitigate impacts on hollow dependent fauna species. This is to effectively recover all residing EPP as well as suitable hollows within the development landscape. Vegetation clearance within the development site is to be undertaken selectively under the direction of a project ecologist to allow the affective searching and recovering of any wildlife within all suitable habitat areas.
- Nesting boxes suitable for EPP are to be installed in the surrounding conservation lands prior to vegetation clearance in suitable habitat areas. Eastern Pygmy Possum nest boxes are to be installed throughout the offset area at a density of 1 per ha throughout all suitable habitat areas within the proposed conservation areas. The most appropriate design for breeding females is given in Rueegger et al. (2012). These boxes would require monitoring approximately once per year for a period of 3 years to determine uptake and to estimate the population size.
- Vegetation clearance is to be undertaken in a manner that removes dense areas of heath and understorey scrub, prior to any clearance of trees including hollow or shelter sites. All trees suitable or potentially suitable for Eastern Pygmy Possum within areas to be cleared or managed is to be inspected for use with a torch or videoscope (for deeper cavities). Any hollows showing signs of use are to be retained where possible or practical. Any hollows to be removed are to be sectionally dismantled as one or more complete hollows, relocated into EPP habitat and refixed to a tree at a suitable height and aspect for EPP. They are to be reaffixed to a similar tree to permit similar ongoing use. Any hollows found to contain EPP are to be relocated at this time with the residing individuals. Where this cannot be achieved any EPP recovered from the development landscape is to be relocated into the installed nesting boxes by a Fauna Ecologist. All relocated or supplementary habitat (EPP nest boxes) are to be located within quality habitat areas with consideration to diverse foraging opportunities with an emphasis on the presence of nearby *Banksia ericifolia* in greater than 30% presence of understorey vegetation.

- The keeping of cats is to be prohibited within the residential development area and all dogs are to be kept within fully enclosed or fenced yards to be stipulated through an restriction on the use of land – 88B covenant under the Local Government Act. An exercise area for dogs is to be provided.

Biodiversity offsets & habitat connectivity

- Biodiversity offsets are to be provided in accordance with the outcomes of the Biodiversity Assessment Report and Biodiversity Certification Strategy (Ecological Australia 2015).
- Where possible provide on site and off site restoration areas that can offset the loss of threatened species habitat and provide an overall net benefit to local threatened species populations or existing nearby existing reserves or conservation areas. Subject to a feasibility study this may include the biotic translocation and restoration of habitat removed from within the site.
- Subject to land owner, OEH, Council & RMS approval, a fauna overpass/land bridge is to be considered for installation across Mona Vale Road and Forest Way where habitat exists on both sides close to national park boundaries. As this recommendation by Dr Goldingay impacts on lands owned by others the installation of a fauna overpass can only be considered as land management strategy by agencies alike to ensure future viability of fauna populations within Garigal National Park. A future land bridge or similar should be considered but should not be a condition of consent for this development which does not affect local connectivity but instead securely conserves a significant portion of native landscape for conservation purposes.

Figure 9 below shows options for fauna overpass locations. As outlined by EPP expert Dr Ross Goldingay, the local population of EPP and other arboreal mammal species in Garigal NP would benefit from having more secure connectivity with the other portion of Garigal NP to the north-east and with Ku-ring-gai Chase NP to the north. This would allow the movement of individuals which might boost the local EPP population should there be a wildfire in Garigal NP.

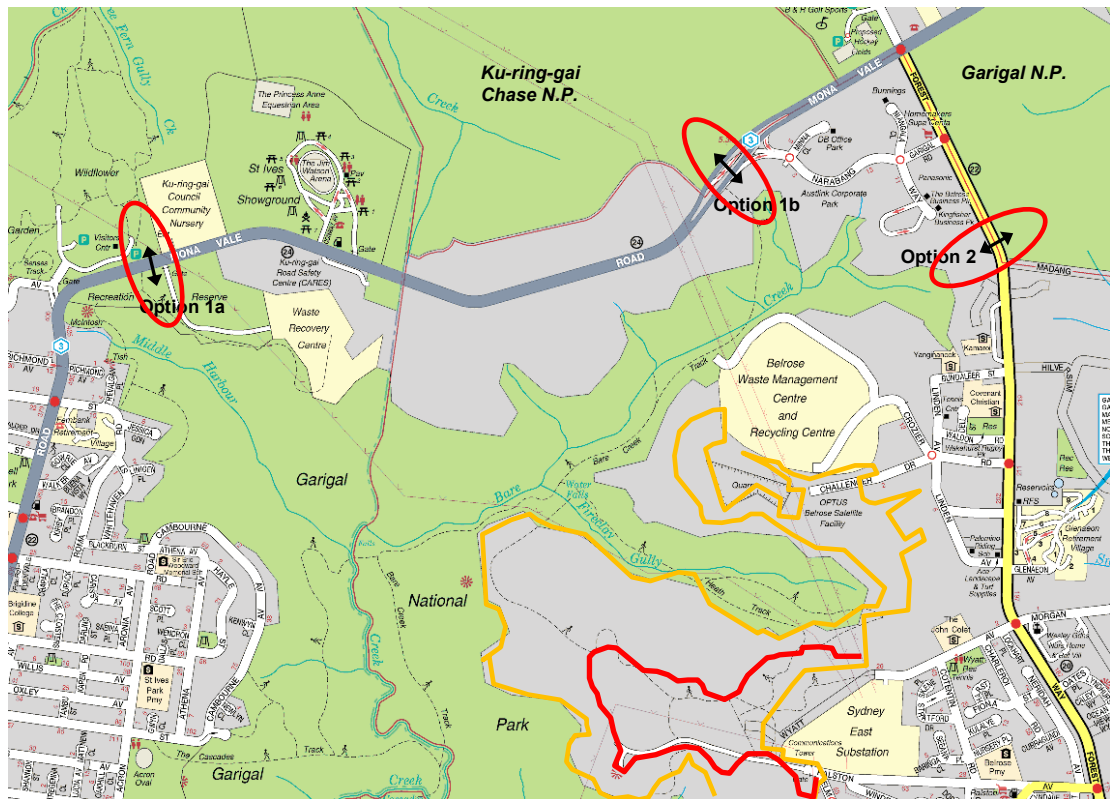


Figure 9 – Options for fauna overpass locations adjacent to national parks.

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Fauna Survey Methodologies

A1

The fauna survey methods outlined within this appendix are techniques employed by *Travers bushfire & ecology*, based on industry standards as well as additional methods found to be effective for select fauna groups. 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 methods outlined 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 if 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 with 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 five minute periods with five 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 five 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 potential Koala habitat (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) 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 has 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. Microchiropteran 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* 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, search 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 (33x10x10cm) and Type B (45x15x15cm), 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 (40mm diameter x 120mm long) and / or large (90mm diameter x 200mm long) PVC pipe sections for collecting 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 identification expert, 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 15cm diameter and 60cm long 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 18cm x 18cm x 75cm long 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 microchiropteran bats. Harp traps have an aluminium frame with a two-bank 4.2m² area and calico capture bag set along the base area.

Mist netting - Is used to capture microchiropteran 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 microchiropteran bat species and are sourced from the only known supplier in Poland.

Trip lining - Is used to capture microchiropteran 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 (e.g. none, light drizzle, heavy drizzle, heavy rain)
- Recent rain events (where relevant)
- Wind strength e.g. calm, light (leaves rustle), moderate (moves branches), strong (moves tree crowns)
- Wind direction
- Moon (where relevant) (e.g. 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 subject site for state and nationally listed threatened flora species recorded within 10km on the *Atlas of NSW Wildlife* (OEH) or indicated to have potential habitat present within 10km on the *EPBC Protected Matters Tool*.

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 recording on site				Considered in 7 part test of significance (✓)
					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	
<i>Acacia bynoeana</i> OEH 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	✓ mostly near existing tracks	✓	x	Low	✓
<i>Acacia gordonii</i> OEH	E1	E	Erect or spreading shrub 0.5-1.5m high growing in heath and dry sclerophyll forest on sandstone outcrops. Distribution limits N-Bilpin S-Faulconbridge.	x	x	-	-	x	x

Scientific name DATABASE SOURCE	TSC Act	EPBC Act	Growth form and habitat requirements	Recorded on site (✓)	If not recording on site				Considered in 7 part test of significance (✓)
					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	
<i>Acacia pubescens</i> OEH EPBC	V	V	Spreading shrub 1-4m high growing in open sclerophyll forest and woodlands on clay soils. Distribution limits N-Bilpin S-Georges River.	x	x	-	-	x	x
<i>Acacia terminalis</i> ssp <i>terminalis</i> OEH EPBC	E1	E	Erect shrub to 2m tall, flowers from March to July. Occurs in eucalypt woodland or forest, usually in sandy soil on creek banks, hill slopes or in shallow soil in rock crevices and sandstone platforms on cliffs. Typically restricted to the Port Jackson and eastern suburbs of Sydney.	x	x	-	-	x	x
<i>Allocasuarina glareicola</i> 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
<i>Ancistrachne maidenii</i> OEH	V	-	Decumbent grass. Grows in sandstone-derived soils. Distribution limits Berowra Waters, Brooklyn and Wisemans Ferry.	x	x	>10km NW	-	x	x
<i>Asterolasia elegans</i> 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
<i>Boronia umbellata</i> OEH	V	V	Orara Boronia is an open shrub, 1 – 2m tall. Geographically restricted to Glenreagh and Lower Bucca, north of Coffs Harbour where it grows around gullies in wet open forest.	x	x	-	-	x	x

Scientific name DATABASE SOURCE	TSC Act	EPBC Act	Growth form and habitat requirements	Recorded on site (✓)	If not recording on site				Considered in 7 part test of significance (✓)
					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	
<i>Caladenia tessellata</i> OEH EPBC	E1	V	Terrestrial orchid. Clay-loam or sandy soils. Distribution limits N-Swansea S-south of Eden.	x	x	-	-	x	x
<i>Callistemon linearifolius</i> OEH	V	-	Shrub to 4m high. Dry sclerophyll forest on coast and adjacent ranges. Distribution limits N-Nelson Bay S-Georges River.	x	✓ very limited to drainage line areas	✓	✓	Low	✓
<i>Chamaesyce psammogeton</i> OEH	E1	-	Prostrate herb. Coastal dunes. Distribution limits N-Tweed Heads S-Jervis Bay	x	x	-	-	x	x
<i>Cryptostylis hunteriana</i> OEH 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
<i>Darwinia biflora</i> OEH EPBC	V	V	Erect or spreading shrub to 0.8m high. Grows in heath or understorey of woodland on or near shale-capped ridges underlain by Hawkesbury sandstone. Distribution limits N-Gosford S-Cheltenham.	x	x	-	-	x	x
<i>Darwinia peduncularis</i> OEH	V	-	Divaricate shrub to 1.5m high. Grows in dry sclerophyll forest on sandstone hillsides and ridges. Distribution limits N-Glen Davis S-Hornsby.	x	x	-	-	x	x
<i>Deyeuxia appressa</i> OEH EPBC	E1	E	Erect grass to 0.9m high. Grows on wet ground. Distribution limits N-Hornsby S-Bankstown.	x	x	-	-	x	x

Scientific name DATABASE SOURCE	TSC Act	EPBC Act	Growth form and habitat requirements	Recorded on site (✓)	If not recording on site				Considered in 7 part test of significance (✓)
					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	
<i>Dillwynia tenuifolia</i> OEH	V	-	Erect shrub 0.6-1m high. Grows in Woodlands and Open Forest on sandstone shale or laterite. Distribution limits N-Howes Valley S-Cumberland Plain.	x	x	>10km SW (1 record)	-	x	x
<i>Diuris bracteata</i> OEH	E1	Extinct	An orchid that grows in dry sclerophyll woodland. Was thought to be extinct until approximately 10yrs ago. Found in the Sydney Basin Bioregion. Flowers in September.	x	x	-	-	x	x
<i>Epacris purpurascens</i> var. <i>purpurascens</i> OEH	V	-	Erect shrub to 1.5m high growing in sclerophyll forest and scrub and near creeks and swamps on Sandstone. Distribution limits N-Gosford S-Blue Mountains.	x	✓ limited to the edge of drainage lines	✓	✓	Low - Moderate	✓
<i>Eucalyptus camfieldii</i> OEH EPBC	V	V	Stringybark to 10m high. Grows on coastal shrub heath and woodlands on sandy soils derived from alluviums and Hawkesbury sandstone. Distribution limits N-Norah Head S-Royal NP.	x	✓ most of the central plateau area	✓	✓	Moderate	✓
<i>Eucalyptus nicholii</i> OEH	V	-	This species is widely planted as an urban street tree and in gardens but is quite rare in the wild. It is confined to the New England Tablelands of NSW, where it occurs from Nundle to north of Tenterfield, largely on private property.	x	x	-	-	x	x
<i>Eucalyptus scoparia</i> OEH	E1	V	Smooth-barked tree only known from vicinity of Bald Rock.	x	x	-	-	x	x

Scientific name DATABASE SOURCE	TSC Act	EPBC Act	Growth form and habitat requirements	Recorded on site (✓)	If not recording on site				Considered in 7 part test of significance (✓)
					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	
<i>Genoplesium baueri</i> OEH EPBC	E1	-	A terrestrial orchid that grows in sparse sclerophyll forest and moss gardens over sandstone. Distribution limits N – Hunter Valley S – Nowra	x	x	-	-	x	x
<i>Genoplesium plumosum</i> OEH	E4A	-	Terrestrial Orchid that grows in mallee scrubland and Callitris Woodland. Distribution south from Griffith	x	x	-	-	x	x
<i>Grammitis stenophylla</i> OEH	E1	-	A small lithophytic fern with fronds generally <5cm. Occurs in rainforest and wet sclerophyll forest in the coastal divisions of NSW.	x	x	-	-	x	x
<i>Grevillea caleyi</i> OEH EPBC	E1	E	Shrub mostly 1-3m high. Grows in laterite. Distribution limits Terrey Hills-Belrose area.	x	✓ ideal habitat to the north and north-east of the existing residence	✓	✓	Recorded	✓
<i>Grevillea parviflora</i> subsp. <i>parviflora</i> OEH	V	V	Open to erect shrub to 1m. Grows in woodland on light clayey soils Distribution limits N-Cessnock S-Appin.	x	x	-	-	x	x
<i>Grevillea parviflora</i> subsp. <i>supplicans</i> OEH	E1	-	Low spreading shrub. Grows in skeletal sandy soil over sandstone. Distribution limits Maroota – Marramarra Creek area.	x	x	-	-	x	x

Scientific name DATABASE SOURCE	TSC Act	EPBC Act	Growth form and habitat requirements	Recorded on site (✓)	If not recording on site				Considered in 7 part test of significance (✓)
					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	
<i>Grevillea shiressii</i> OEH EPBC	V	V	Shrub 2-5m high. Flowers mainly spring. Grows along creek banks in wet sclerophyll forest. Sandy soil on Hawkesbury sandstone. Restricted to the Gosford area. CC.	x	x	-	-	x	x
<i>Haloragis exalata</i> subsp. <i>exalata</i> EPBC	V	V	Shrub to 1.5m high. Grows in damp places near watercourses. Distribution limits N-Tweed Heads S-south of Eden.	x	x	-	-	x	x
<i>Haloragodendron lucasii</i> OEH EPBC	E1	E	Straggling shrub to 1.5m high. Grows in open forest on sheltered slopes near creeks. Distribution limits Ku-ring-gai Plateau and Mt Wilson.	x	✓ marginal habitat near drainage lines around the fringes of the proposed development area	✓	x	Very low	✓
<i>Hibbertia puberula</i> OEH	E1	-	Shrublets with branches up to 30cm long. Not been seen for 40 years however early records are from Hawkesbury River area in Sydney and the Blue Mountains.	x	x	-	-	x	x
<i>Hibbertia spanantha</i> OEH	CE	CE	Grows in forest with canopy species including Eucalyptus pilularis, E. resinifera, Corymbia gummifera and Angophora costata. The understorey is open with species of Poaceae, Orchidaceae, Fabaceae and Liliaceae. Flowers Oct-Nov with odd flowers throughout the year. Substrate is identified as a light clay occurring on a shale sandstone soil transition.	x	x	9km SW (1 record within 10km)	-	x	x

Scientific name DATABASE SOURCE	TSC Act	EPBC Act	Growth form and habitat requirements	Recorded on site (✓)	If not recording on site				Considered in 7 part test of significance (✓)
					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	
<i>Hibbertia superans</i> OEH	E1	-	Small spreading shrub to 0.3m high. Grows on sandstone, usually in or near SSTF. Distribution limits N-Glenorie S-Kellyville disjunct Mt Boss.	x	x	-	-	x	x
<i>Hypsela sessiliflora</i> OEH	E1	Ext.	Prostrate herb, rooting at nodes, growing in damp places on the Cumberland Plain.	x	x	-	-	x	x
<i>Kunzea rupestris</i> OEH EPBC	V	V	Shrub to 1.5m high. Grows in cracks and fissures on Hawkesbury sandstone rock platforms. Distribution limits N-Maroota S-Glenorie.	x	x	-	-	x	x
<i>Lasiopetalum joyceae</i> OEH EPBC	V	V	Erect shrub to 2m high. Grows in heath and open forest on Hawkesbury sandstone. Distribution limits Hornsby Plateau.	x	✓ Limited by geographic range. Nearest record 5km away	x	✓	Low	✓
<i>Leptospermum deanei</i> OEH EPBC	V	V	Shrub to 5m high. Grows on forested slopes. Distribution limits Near watershed of Lane Cove River.	x	x	-	-	x	x
<i>Melaleuca biconvexa</i> EPBC	V	V	Tall shrub. Grows in wetlands adjoining perennial streams and on the banks of those streams, generally within the geological series known as the Terrigal Formation. Distribution limits N-Port Macquarie S-Jervis Bay.	x	x	-	-	x	x

Scientific name DATABASE SOURCE	TSC Act	EPBC Act	Growth form and habitat requirements	Recorded on site (✓)	If not recording on site				Considered in 7 part test of significance (✓)
					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	
<i>Melaleuca deanei</i> OEH EPBC	V	V	Shrub to 3m high. Grows in heath on sandstone. Distribution limits N-Gosford S-Nowra.	x	✓ limited to the low open woodland and open woodland vegetation communities	✓	✓	Low-moderate	✓
<i>Microtis angusii</i> OEH EPBC	E1	E	Terrestrial orchid which is known from one population at Ingleside. Associated with the Duffy's Forest vegetation community. Flowers May-Oct.	x	Small areas of Sub-optimal	4 km NE (83 records within 10km)	1992	Very Low	✓
<i>Pelargonium</i> sp. <i>Striatellum</i> 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
<i>Persoonia hirsuta</i> OEH EPBC	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	✓ limited to the open woodland vegetation community	x	✓	Low	✓
<i>Persoonia laxa</i> OEH	E4	Ext.	Decumbent or prostrate shrub. Not been seen since 1908. Once recorded in Newport and Manly.	x	x	-	-	x	x

Scientific name DATABASE SOURCE	TSC Act	EPBC Act	Growth form and habitat requirements	Recorded on site (✓)	If not recording on site				Considered in 7 part test of significance (✓)
					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	
<i>Persoonia mollis</i> <i>ssp. maxima</i> OEH EPBC	E1	E	Erect to prostrate shrub. Grows in moist to wet sclerophyll forests on Hawkesbury sandstone. Distribution limits N-Cowan S-Hornsby.	x	x	-	-	x	x
<i>Pimelea curviflora</i> <i>var. curviflora</i> OEH EPBC	V	V	Woody herb or sub-shrub to 0.2-1.2m high. Grows on Hawkesbury sandstone near shale outcrops. Distribution Sydney.	x	✓ limited to the low open woodland and open woodland vegetation communities and some tall heath	✓	✓	Moderate	✓
<i>Pimelea spicata</i> 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
<i>Prostanthera junonis</i> OEH	E1	E	Small shrub. Grows in sclerophyll forest and heath in shallow soil on sandstone. Distribution limits Somersby region.	x	x	-	-	x	x
<i>Prostanthera marifolia</i> OEH EPBC	E4a	Critic . E	Erect shrub to 0.3m high. Woodland dominated by Eucalyptus sieberi and Corymbia gummifera. In deeply weathered clay soil with ironstone nodules. Has been recorded previously in the Sydney Harbour region.	x	x	-	-	x	x

Scientific name DATABASE SOURCE	TSC Act	EPBC Act	Growth form and habitat requirements	Recorded on site (✓)	If not recording on site				Considered in 7 part test of significance (✓)
					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	
<i>Pterostylis saxicola</i> OEH	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
<i>Sarcochilus hartmannii</i> OEH	V	V	An orchid which grows on volcanic rocks, often in shallow soil in sclerophyll forest or exposed sites usually at an elevation above 500m. Distribution – north from the Richmond River in the far north of NSW.	x	x	-	-	x	x
<i>Senecio spathulatus</i> OEH	E	-	A low growing daisy that prefers primary dunes. Known to occur at Cape Howe and between Kurnell north to Myall Lakes National Park. Also occurs in coastal locations in eastern Victoria.	x	x	-	-	x	x
<i>Syzygium paniculatum</i> OEH EPBC	V	V	Small tree. Subtropical and littoral rainforest on sandy soil. Distribution limits N-Forster S-Jervis Bay.	x	x	-	-	x	x
<i>Tetratheca glandulosa</i> OEH	V	V	Spreading shrub to 0.2m high. Sandy or rocky heath or scrub. Distribution limits N-Mangrove Mountain S-Port Jackson.	✓	✓ most vegetation communities have some potential habitat but away from the damper areas	✓	✓	Recorded	✓

Scientific name DATABASE SOURCE	TSC Act	EPBC Act	Growth form and habitat requirements	Recorded on site (✓)	If not recording on site				Considered in 7 part test of significance (✓)
					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	
<i>Thesium australe</i> EPBC	V	V	Erect herb to 0.4m high. Root parasite. Themeda grassland or woodland often damp. Distribution limits N-Tweed Heads S-south of Eden.	x	x	-	-	x	x
<i>Triplarina imbricata</i> EPBC	E1	E	A shrub to 2.8m tall, flowers from Nov-Dec. Occurs in heath, often in damp places along creek lines; coast and adjacent ranges. Known from the Tabulum and Nymboida districts in NE NSW.	x	x	-	-	x	x
<i>Wilsonia backhousei</i> OEH	V	-	Perennial subshrub with procumbent branches. Grows in coastal saltmarshes. <i>Wilsonia backhousei</i> is salt tolerant and is found in intertidal saltmarshes and, more rarely, on seacliffs. In New South Wales <i>Wilsonia backhousei</i> is scattered along the coast, reaching a northern limit at Wamberal Lagoon. In the Sydney region there has been a considerable decline in the abundance of the species over the last 100yrs, largely as a result of loss of habitat. Distribution limits N-Sydney S-South of Eden.	x	x	-	-	x	x
OEH	- Denotes species listed within 10km of the subject site on the <i>Atlas of NSW Wildlife</i> database								
EPBC	- Denotes species listed within 10km of the subject site in the <i>EPBC Act</i> habitat search								
V	- Denotes vulnerable listed species under the relevant Act								
E or E1	- Denotes endangered listed species under the relevant Act								

Scientific name DATABASE SOURCE	TSC Act	EPBC Act	Growth form and habitat requirements	Recorded on site (✓)	If not recording on site				Considered in 7 part test of significance (✓)
					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	
NOTE:	<div>1. This field is not considered if no suitable habitat is present within the subject site</div> <div>2. 'Records' refer to those provided by the <i>Atlas of NSW Wildlife</i> database. Updated 1:100,000 database map sheet requests to OEH are undertaken every 3 months as recommended.</div> <div>3. 'Nearby' or 'recent' records are species specific accounting for home range, dispersal ability and life cycle.</div>								

A detailed assessment in accordance with Section 5A of the *EPA Act* will be completed for these species in Appendix 3 of this report.

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

Table A2.2 – Threatened fauna habitat assessment

Common name <i>Scientific name</i> DATABASE SOURCE	TSC Act	EPBC Act	Preferred habitat <i>Distribution limit</i>	Recorded on site (✓)	If not recorded on-site				Considered in 7 part test of significance (✓)
					Suitable habitat present (✓)	Nearby and/or high number of record(s) (✓) <i>Notes 1,2 & 3</i>	Record (s) from recent years (✓) <i>Notes 1,2 & 3</i>	Potential to occur	
Giant Burrowing Frog <i>Heleioporus australiacus</i> OEH EPBC	V	V	Inhabits open forests and riparian forests along non-perennial streams, digging burrows into sandy creek banks. <i>Distribution Limit: N-Near Singleton S-South of Eden.</i>	✓	-	-	-	-	✓
Stuttering Frog <i>Mixophyes balbus</i> EPBC	E	V	Terrestrial inhabitant of rainforest and wet sclerophyll forests. <i>Distribution Limit: N-near Tenterfield S-South of Bombala.</i>	x	x	-	-	x	x
Giant Barred Frog <i>Mixophyes iteratus</i> EPBC	E	E	Terrestrial inhabitant of rainforest and open forests. <i>Distribution Limit: N-Border Ranges National Park. S-Narooma.</i>	x	x	-	-	x	x
Red-crowned Toadlet <i>Pseudophryne australis</i> 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. <i>Distribution Limit: N-Pokolbin. S-near Wollongong.</i>	✓	-	-	-	-	✓

Common name <i>Scientific name</i> DATABASE SOURCE	TSC Act	EPBC Act	Preferred habitat <i>Distribution limit</i>	Recorded on site (✓)	If not recorded on-site				Considered in 7 part test of significance (✓)
					Suitable habitat present (✓)	Nearby and/or high number of record(s) (✓) <i>Notes 1,2 & 3</i>	Record (s) from recent years (✓) <i>Notes 1,2 & 3</i>	Potential to occur	
Green and Golden Bell Frog <i>Litoria aurea</i> OEH EPBC	E	V	Prefers the edges of permanent water, streams, swamps, creeks, lagoons, farm dams and ornamental ponds. Often found under debris. <i>Distribution Limit: N-Byron Bay S-South of Eden.</i>	x	x	-	-	x	x
Littlejohn's Tree Frog <i>Litoria littlejohnii</i> EPBC	V	V	Found in wet and dry sclerophyll forest associated with sandstone outcrops at altitudes 280-1,000m on eastern slopes of Great Dividing Range. Prefers flowing rocky streams. <i>Distribution Limit: N-Hunter River S-Eden.</i>	x	✓	x	x	x	x
Rosenberg's Goanna <i>Varanus rosenbergi</i> OEH	V	-	Hawkesbury sandstone outcrop specialist. Inhabits woodlands, dry open forests and heathland sheltering in burrows, hollow logs, rock crevices and outcrops. <i>Distribution Limit: N-Nr Broke. S-Nowra Located in scattered patches near Sydney, Nowra and Goulburn.</i>	✓	-	-	-	-	✓
Broad-headed Snake <i>Hoplocephalus bungaroides</i> EPBC	E	V	Sandstone outcrops, exfoliated rock slabs and tree hollows in coastal and near coastal areas. <i>Distribution Limit: N-Mudgee Park. S-Nowra.</i>	x	✓	x	x	x	x

Common name <i>Scientific name</i> DATABASE SOURCE	TSC Act	EPBC Act	Preferred habitat <i>Distribution limit</i>	Recorded on site (✓)	If not recorded on-site				Considered in 7 part test of significance (✓)
					Suitable habitat present (✓)	Nearby and/or high number of record(s) (✓) <i>Notes 1,2 & 3</i>	Record (s) from recent years (✓) <i>Notes 1,2 & 3</i>	Potential to occur	
Magpie Goose <i>Anseranas semipalmata</i> OEH	V	-	A strongly nomadic species found in tropical through to sub-tropical wetlands, flood plains, large swamps, dams and wet grasslands with dense growths of rushes and sedges. <i>Distribution Limit: N-Tweed Heads. S-Mulwala.</i>	x	x	-	-	x	x
Cotton Pygmy-goose <i>Nettapus coromandelianus</i> OEH	E	-	An aquatic species found in tropical to subtropical coastal lagoons, swamps and large bodies of calm fresh water with abundant vegetation. <i>Distribution Limit: N-Tweed Heads. S-Pambula.</i>	x	x	-	-	x	x
Freckled Duck <i>Stictonetta naevosa</i> OEH	V	-	Occurs mainly within the Murray-Darling basin and the channel country within large cool temperate to sub-tropical swamps, lakes and floodwaters with cumbungi, lignum or melaleucas. <i>Distribution Limit: N-Tenterfield. S-Albury.</i>	x	x	-	-	x	x
Wompoo Fruit-dove <i>Ptilinopus magnificus</i> OEH	V	-	Inhabits large undisturbed patches of lowland and adjacent highland rainforest and moist eucalypt forests where it feeds on fruit. <i>Distribution Limit: N-Tweed Heads. S-Sydney.</i>	x	x	-	-	x	x

Common name <i>Scientific name</i> DATABASE SOURCE	TSC Act	EPBC Act	Preferred habitat <i>Distribution limit</i>	Recorded on site (✓)	If not recorded on-site				Considered in 7 part test of significance (✓)
					Suitable habitat present (✓)	Nearby and/or high number of record(s) (✓) <i>Notes 1,2 & 3</i>	Record (s) from recent years (✓) <i>Notes 1,2 & 3</i>	Potential to occur	
Superb Fruit-dove <i>Ptilinopus superbus</i> OEH	V	-	Rainforests, adjacent mangroves, eucalypt forests, scrubland with native fruits. <i>Distribution Limit: N-Border Ranges National Park. S-Bateman's Bay.</i>	x	x	-	-	x	x
Black-necked Stork <i>Ephippiorhynchus asiaticus</i> OEH	E	-	Occurs in tropical to warm temperate terrestrial wetlands, estuarine and littoral habitats such as mangroves, tidal mudflats, floodplains, open woodlands, irrigated lands, bore drains, sub-artesian pools, farm dams and sewerage ponds. <i>Distribution Limit: N-Tweed Heads. S-Nowra.</i>	x	x	-	-	x	x
Australasian Bittern <i>Botaurus poiciloptilus</i> 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. <i>Distribution Limit: N-North of Lismore. S-Eden.</i>	x	x	-	-	x	x
Black Bittern <i>Ixobrychus flavicollis</i> OEH	V	-	Found in shadowy, leafy waterside trees such as callistemons, casuarinas, paperbarks, eucalypts, mangroves and willows along tidal creeks, freshwater and brackish streams & ponds, sheltered mudflats and oyster slats. <i>Distribution Limit: N-Tweed Heads. S-South of Eden.</i>	x	x	-	-	x	x

Common name <i>Scientific name</i> DATABASE SOURCE	TSC Act	EPBC Act	Preferred habitat <i>Distribution limit</i>	Recorded on site (✓)	If not recorded on-site				Considered in 7 part test of significance (✓)
					Suitable habitat present (✓)	Nearby and/or high number of record(s) (✓) <i>Notes 1,2 & 3</i>	Record (s) from recent years (✓) <i>Notes 1,2 & 3</i>	Potential to occur	
White-bellied Sea Eagle <i>(Haliaeetus leucogaster)</i> OEH	V	-	Occupies coasts, islands, estuaries, inlets, large rivers, inland lakes and reservoirs. <i>Sedentary; dispersive. N-Tweed Heads. S-South of Eden.</i>	x	x	-	-	x	x
Little Eagle <i>Hieraaetus morphnoides</i> OEH	V	-	Utilises plains, foothills, open forests, woodlands and scrublands; river red gums on watercourses and lakes. <i>Distribution Limit - N-Tweed Heads. S-South of Eden.</i>	x	✓	x	✓	low	✓
Osprey <i>Pandion haliaetus</i> OEH	V	-	Utilises water bodies including coastal waters, inlets, lakes, estuaries and offshore islands with a dead tree for perching and feeding. <i>Distribution Limit: N-Tweed Heads. S-South of Eden.</i>	x	x	-	-	x	x
Spotted Harrier <i>Circus assimilis</i> OEH	V	-	Utilises grassy plains, crops and stubblefields; saltbush, spinifex associations; scrublands, mallee, heathlands; open grassy woodlands. <i>Distribution Limit: N-Tweed Heads. S-South of Eden.</i>	x	x	-	-	x	x

Common name <i>Scientific name</i> DATABASE SOURCE	TSC Act	EPBC Act	Preferred habitat <i>Distribution limit</i>	Recorded on site (✓)	If not recorded on-site				Considered in 7 part test of significance (✓)
					Suitable habitat present (✓)	Nearby and/or high number of record(s) (✓) <i>Notes 1,2 & 3</i>	Record (s) from recent years (✓) <i>Notes 1,2 & 3</i>	Potential to occur	
Square-tailed Kite <i>Lophoictinia isura</i> 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. <i>Distribution Limit: N-Goondiwindi. S-South of Eden.</i>	x	marginal	x	✓	low	✓
Grey Falcon <i>Falco hypoleucos</i> OEH	V	-	Occurs over mainly inland drainage systems of open plains and lightly timbered country including the acacia scrub, spinifex and tussock grasslands. <i>Distribution Limit: N-Mullumbimby. S-Bega.</i>	x	x	-	-	x	x
Black Falcon <i>Falco subniger</i> OEH	V	-	Inhabits plains, grasslands, foothills, timbered watercourses, wetland environs, crops; occasionally over towns and cities. <i>N-Tweed Heads. S-South of Eden</i>	x	x	-	-	x	x
Bush Stone-curlew <i>Burhinus grallarius</i> OEH	E	-	Utilises open forests and savannah woodlands, sometimes dune scrub, savannah and mangrove fringes. <i>Distribution Limit: N-Border Ranges National Park. S-Near Nowra.</i>	x	x	-	-	x	x
Australian Painted Snipe <i>Rostratula australis</i> EPBC	V	V	Most numerous within the Murray-Darling basin and inland Australia within marshes and freshwater wetlands with swampy vegetation. <i>Distribution Limit: N-Tweed Heads. S-South of Eden.</i>	x	x	-	-	x	x

Common name <i>Scientific name</i> DATABASE SOURCE	TSC Act	EPBC Act	Preferred habitat <i>Distribution limit</i>	Recorded on site (✓)	If not recorded on-site				Considered in 7 part test of significance (✓)
					Suitable habitat present (✓)	Nearby and/or high number of record(s) (✓) <i>Notes 1,2 & 3</i>	Record (s) from recent years (✓) <i>Notes 1,2 & 3</i>	Potential to occur	
Gang-gang Cockatoo <i>Callocephalon fimbriatum</i> OEH	V	-	Prefers wetter forests and woodlands from sea level to > 2,000m on Great Dividing Range, timbered foothills and valleys, timbered watercourses, coastal scrubs, farmlands and suburban gardens. <i>Distribution Limit: mid north coast of NSW to western Victoria.</i>	x	Sub-optimal	x	x	unlikely	✓
Glossy Black-Cockatoo <i>Calyptorhynchus lathami</i> OEH	V	-	Open forests with <i>Allocasuarina</i> species and hollows for nesting. <i>Distribution Limit: N-Tweed Heads. S-South of Eden.</i>	✓	-	-	-	-	✓
Little Lorikeet <i>Glossopsitta pusilla</i> OEH	V	-	Inhabits forests, woodlands; large trees in open country; timbered watercourses, shelter beds, and street trees. <i>Distribution Limit: N-Tweed Heads. S-South of Eden.</i>	✓	-	-	-	-	✓
Swift Parrot <i>Lathamus discolor</i> OEH EPBC	E	E	Inhabits eucalypt forests and woodlands with winter flowering eucalypts. <i>Distribution Limit: N-Border Ranges National Park. S-South of Eden.</i>	x	marginal	✓	✓	✓	✓
Turquoise Parrot <i>Neophema pulchella</i> OEH	V	-	Inhabits coastal scrubland, open forest and timbered grassland, especially ecotones between dry hardwood forests and grasslands. <i>Distribution Limit: N-Near Tenterfield. S-South of Eden.</i>	x	✓	x	x	Not likely	x

Common name <i>Scientific name</i> DATABASE SOURCE	TSC Act	EPBC Act	Preferred habitat <i>Distribution limit</i>	Recorded on site (✓)	If not recorded on-site				Considered in 7 part test of significance (✓)
					Suitable habitat present (✓)	Nearby and/or high number of record(s) (✓) <i>Notes 1,2 & 3</i>	Record (s) from recent years (✓) <i>Notes 1,2 & 3</i>	Potential to occur	
Superb Parrot <i>Polytelis swainsonii</i> OEH	V	V	Inhabits open woodland and riverine forests of inland NSW. <i>Distribution Limit: N-Near Walgett. S-South of Deniliquin.</i>	x	x	-	-	x	x
Barking Owl <i>Ninox connivens</i> OEH	V	-	Inhabits principally woodlands but also open forests and partially cleared land and utilises hollows for nesting. <i>Distribution Limits: N-Border Ranges National Park. S-Eden.</i>	x	✓	✓	Not within 5km	✓	✓
Powerful Owl <i>Ninox strenua</i> OEH	V	-	Forests containing mature trees for shelter or breeding and densely vegetated gullies for roosting. <i>Distribution Limits: N-Border Ranges National Park. S-Eden.</i>	✓	-	-	-	-	✓
Grass Owl <i>Tyto capensis</i> OEH	V	-	Inhabits grassland, coastal heath and lignum swamps, sheltering in dense grass tussocks by day. <i>Distribution Limit: N-Tweed Heads. S-Lithgow.</i>	x	x	-	-	x	x
Masked Owl <i>Tyto novaehollandiae</i> OEH	V	-	Open forest and woodlands with cleared areas for hunting and hollow trees or dense vegetation for roosting. <i>Distribution Limit: N-Border Ranges National Park. S-Eden.</i>	x	✓	x	x	unlikely	✓
Sooty Owl <i>Tyto tenebricosa</i> OEH	V	-	Tall, dense, wet forests containing trees with very large hollows. <i>Distribution Limit: N-Border Ranges National Park. S-South of Eden.</i>	x	x	-	-	x	x

Common name <i>Scientific name</i> DATABASE SOURCE	TSC Act	EPBC Act	Preferred habitat <i>Distribution limit</i>	Recorded on site (✓)	If not recorded on-site				Considered in 7 part test of significance (✓)
					Suitable habitat present (✓)	Nearby and/or high number of record(s) (✓) <i>Notes 1,2 & 3</i>	Record (s) from recent years (✓) <i>Notes 1,2 & 3</i>	Potential to occur	
Eastern Bristlebird <i>Dasyornis brachypterus</i> EPBC	E	E	Coastal woodlands, dense scrubs and heathlands, especially where low heathland borders taller woodland or dense tall tea-tree. <i>Distribution Limit: N-Tweed Heads. S-South of Eden.</i>	x	✓	x	x	low	N/A
Painted Honeyeater <i>Grantiella picta</i> EPBC	V	V	A nomadic bird occurring in low densities within open forest, woodland and scrubland feeding on mistletoe fruits. Inhabits primarily Boree, Brigalow and Box-Gum Woodlands and Box-Ironbark Forests. <i>Distribution Limit: N-Boggabilla. S-Albury with greatest occurrences on the inland slopes of the Great Dividing Range.</i>	x	x	-	-	x	x
Black-chinned Honeyeater <i>Melithreptus gularis</i> 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. <i>Distribution Limit: N-Cape York pen. Qld. S-Victor H. Mt Lofty Ra & Flinders Ra. SA.</i>	x	marginal	x	x	x	x
Regent Honeyeater <i>Xanthomyza Phrygia</i> OEH EPBC	E4A	E	Found in temperate eucalypt woodland and open forest including forest edges, wooded farmland and urban areas with mature eucalypts. <i>Distribution Limit: N-Urbanville. S-Eden.</i>	x	x	✓	x	Not likely	x

Common name <i>Scientific name</i> DATABASE SOURCE	TSC Act	EPBC Act	Preferred habitat <i>Distribution limit</i>	Recorded on site (✓)	If not recorded on-site				Considered in 7 part test of significance (✓)
					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-crowned Babbler <i>Pomatostomus temporalis temporalis</i> OEH	V	-	Found in dry open forests, woodland scrubland, farmland with isolated trees. Distribution Limit mostly west of Great Dividing Range except Hunter Valley. <i>Distribution Limit: N-Qld widespread. S-Mornington Pen. E-se SA.</i>	x	x	-	-	x	x
Varied Sittella <i>Daphoenositta chrysoptera</i> OEH	V	-	Open eucalypt woodlands/forests (except heavier rainforests); mallee, inland acacia, coastal tea-tree scrubs; golf courses, shelterbelts, orchards, parks, scrubby gardens. <i>Distribution Limit: N-Border Ranges National Park. S-South of Eden.</i>	x	✓	x	x	low	✓
Dusky Woodswallow <i>Artamus cyanopterus cyanopterus</i> OEH	V	-	Found in woodlands and dry open sclerophyll forests, usually dominated by eucalypts, including mallee associations. It has also been recorded in shrublands and heathlands and various modified habitats, including regenerating forests; very occasionally in moist forests or rainforests. Prefers habitat with an open understorey. Often observed in farmland tree patches or roadside remnants. <i>Widespread in eastern, southern and southwestern Australia.</i>	x	✓	x	x	low	✓

Common name <i>Scientific name</i> DATABASE SOURCE	TSC Act	EPBC Act	Preferred habitat <i>Distribution limit</i>	Recorded on site (✓)	If not recorded on-site				Considered in 7 part test of significance (✓)
					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	
White-fronted Chat <i>Epithianura albifrons</i> OEH	V	-	Found in open damp ground, grass clumps, fencelines, heath, samphire saltmarshes, mangroves, dunes, saltbush plains. <i>Distribution Limit: N-Tweed Heads. S-South of Eden.</i>	x	x	-	-	x	x
Diamond Firetail <i>Stagonopleura guttata</i> OEH	V	-	Found in Eucalypt woodlands, forests and mallee where there is grassy understorey west of the Great Div. also drier coastal woodlands of the Cumberland Plain and Hunter Richmond and Clarence River Valleys. <i>Distribution Limit: N-Rockhampton Q. S-Eyre Pen Kangaroo Is. SA.</i>	x	x	-	-	x	x
Scarlet Robin <i>Petroica boodang</i> OEH	V	-	Found in foothill forests, woodlands, watercourses; in autumn-winter, more open habitats: river red gum woodlands, golf courses, parks, orchards, gardens. <i>Distribution Limit: N-Tweed Heads. S-South of Eden.</i>	x	✓	x	x	low	✓
Spotted-tailed Quoll <i>Dasyurus maculatus</i> OEH EPBC	V	E	Dry and moist open forests containing rock caves, hollow logs or trees. <i>Distribution Limit: N-Mt Warning National Park. S-South of Eden.</i>	x	✓	✓	x	✓	✓

Common name <i>Scientific name</i> DATABASE SOURCE	TSC Act	EPBC Act	Preferred habtiat <i>Distribution limit</i>	Recorded on site (✓)	If not recorded on-site				Considered in 7 part test of significance (✓)
					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	
Southern Brown Bandicoot <i>Isoodon obesulus</i> OEH EPBC	E	E	Utilises a range of habitats containing thick ground cover - open forest, woodland, heath, cleared land, urbanised areas and regenerating bushland. <i>Distribution Limit: N-Kempsey. S-South of Eden.</i>	x	✓	✓	✓	✓	✓
Koala <i>Phascolarctos cinereus</i> OEH	V	-	Inhabits both wet and dry eucalypt forest on high nutrient soils containing preferred feed trees. <i>Distribution Limit: N-Tweed Heads. S-South of Eden.</i>	x	✓	✓	x	unlikely	✓
Eastern Pygmy Possum <i>Cercatetus nanus</i> OEH	V	-	Found in a variety of habitats from rainforest through open forest to heath. Feeds on insects but also gathers pollen from banksias, eucalypts and bottlebrushes. Nests in banksias and myrtaceous shrubs. <i>Distribution Limit: N-Tweed Heads. S-Eden.</i>	✓	-	-	-	-	✓
Yellow-bellied Glider <i>Petaurus australis</i> OEH	V	-	Tall mature eucalypt forests with high nectar producing species and hollow bearing trees. <i>Distribution Limit- N-Border Ranges National Park. S-South of Eden.</i>	x	✓	x	x	x	x
Squirrel Glider <i>Petaurus norfolcensis</i> OEH	V	-	Mixed aged stands of eucalypt forest & woodlands including gum barked & high nectar producing species & hollow bearing trees. <i>Distribution Limit: N-Tweed Heads. S-Albury.</i>	x	x	-	-	x	x

Common name <i>Scientific name</i> DATABASE SOURCE	TSC Act	EPBC Act	Preferred habitat <i>Distribution limit</i>	Recorded on site (✓)	If not recorded on-site				Considered in 7 part test of significance (✓)
					Suitable habitat present (✓)	Nearby and/or high number of record(s) (✓) <i>Notes 1,2 & 3</i>	Record (s) from recent years (✓) <i>Notes 1,2 & 3</i>	Potential to occur	
Greater Glider <i>Petauroides volans</i> EPBC	-	V	Favours forests with a diversity of eucalypt species, due to seasonal variation in its preferred tree species. Population density is optimal at elevation levels at 845 m above sea level. Prefer overstorey basal areas in old-growth tree stands. Highest abundance typically in taller, montane, moist eucalypt forests, with relatively old trees and abundant hollows <i>Distribution Limit: N-Border Ranges National Park. S- South of Eden.</i>	x	x	-	-	x	x
Long-nosed Potoroo <i>Potorous tridactylus</i> EPBC	V	V	Coastal heath and dry and wet sclerophyll forests with a dense understorey. <i>Distribution Limit: N-Mt Warning National Park. S-South of Eden.</i>	x	✓	x	x	x	x
Brush-tailed Rock-wallaby <i>Petrogale penicillata</i> EPBC	E	V	Found in rocky gorges with a vegetation of rainforest or open forests to isolated rocky outcrops in semi-arid woodland country. <i>Distribution Limit: N-North of Tenterfield. S-Bombala.</i>	x	✓	x	x	x	x

Common name <i>Scientific name</i> DATABASE SOURCE	TSC Act	EPBC Act	Preferred habitat <i>Distribution limit</i>	Recorded on site (✓)	If not recorded on-site				Considered in 7 part test of significance (✓)
					Suitable habitat present (✓)	Nearby and/or high number of record(s) (✓) <i>Notes 1,2 & 3</i>	Record (s) from recent years (✓) <i>Notes 1,2 & 3</i>	Potential to occur	
Grey-headed Flying-fox <i>Pteropus poliocephalus</i> 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. <i>Distribution Limit: N-Tweed Heads. S-Eden.</i>	✓	-	-	-	-	✓
Yellow-bellied Sheath-tail bat <i>Saccolaimus flaviventris</i> OEH	V	-	Rainforests, sclerophyll forests and woodlands. <i>Distribution Limit: N-North of Walgett. S-Sydney.</i>	x	✓	x	x	unlikely	✓
East-coast Freetail Bat <i>Micronomus norfolkensis</i> 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. <i>Distribution Limit: N-Woodenbong. S-Pambula.</i>	x	✓	✓	✓	low	✓
Large-eared Pied Bat <i>Chalinolobus dwyeri</i> OEH EPBC	V	V	Warm-temperate to subtropical dry sclerophyll forest and woodland. Roosts in caves, tunnels and tree hollows in colonies of up to 30 animals. <i>Distribution Limit: N-Border Ranges National Park. S-Wollongong.</i>	x	✓	x	✓	low	x

Common name <i>Scientific name</i> DATABASE SOURCE	TSC Act	EPBC Act	Preferred habitat <i>Distribution limit</i>	Recorded on site (✓)	If not recorded on-site				Considered in 7 part test of significance (✓)
					Suitable habitat present (✓)	Nearby and/or high number of record(s) (✓) <i>Notes 1,2 & 3</i>	Record (s) from recent years (✓) <i>Notes 1,2 & 3</i>	Potential to occur	
Little Bentwing-bat <i>Miniopterus australis</i> OEH	V	-	Roosts in caves, old buildings and structures in the higher rainfall forests along the south coast of Australia. <i>Distribution Limit: N-Border Ranges National Park. S-Sydney.</i>	✓	-	-	-	-	✓
Eastern Bentwing-bat <i>Miniopterus orianae oceanis</i> OEH	V	-	Prefers areas where there are caves, old mines, old buildings, stormwater drains and well timbered areas. <i>Distribution Limit: N-Border Ranges National Park. S-South of Eden.</i>	✓	-	-	-	-	✓
Eastern Falsistrelle <i>Falsistrellus tasmaniensis</i> OEH	V	-	Recorded roosting in caves, old buildings and tree hollows. <i>Distribution Limit: N-Border Ranges National Park. S-Pambula.</i>	x	Sub-optimal	x	x	unlikely	✓
Large-footed Myotis <i>Myotis macropus</i> OEH	V	-	Roosts in caves, mines, tunnels, buildings, tree hollows and under bridges. Forages over open water. <i>Distribution limits: N-Border Ranges National Park. S-South of Eden.</i>	x	x	-	-	x	x
Greater Broad-nosed Bat <i>Scoteanax rueppellii</i> OEH	V	-	Inhabits areas containing moist river and creek systems, especially tree lined creeks. <i>Distribution Limit: N-Border Ranges National Park. S-Pambula.</i>	x	✓	x	✓	low	✓

Common name <i>Scientific name</i> DATABASE SOURCE	TSC Act	EPBC Act	Preferred habitat <i>Distribution limit</i>	Recorded on site (✓)	If not recorded on-site				Considered in 7 part test of significance (✓)
					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	
New Holland Mouse <i>Pseudomys novaehollandiae</i> 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. <i>Distribution Limit: N-Border Ranges National Park. S-South of Eden.</i>	x	✓	✓	x	✓	N/A
Dural Woodland Snail <i>Pommerhelix duralensis</i> EPBC	-	E	Occurs on shale-sandstone transitional landscapes The species is found within the Local Government Areas of Blue Mountains City, Penrith City, The Hills Shire, Wollondilly Shire, Hornsby Shire and Parramatta City. The species has a strong affinity for communities in the interface region between shale-derived and sandstone-derived soils, with forested habitats that have good native cover and woody debris. It favours sheltering under rocks or inside curled-up bark. It does not burrow nor climb. The species has also been observed resting in exposed areas, such as on exposed rock or leaf litter, however it will also shelter beneath leaves, rocks and light woody debris.	x	x	-	-	x	x

Common name <i>Scientific name</i> DATABASE SOURCE	TSC Act	EPBC Act	Preferred habitat <i>Distribution limit</i>	Recorded on site (✓)	If not recorded on-site				Considered in 7 part test of significance (✓)
					Suitable habitat present (✓)	Nearby and/or high number of record(s) (✓) <i>Notes 1,2 & 3</i>	Record (s) from recent years (✓) <i>Notes 1,2 & 3</i>	Potential to occur	
Macquarie Perch <i>Macquaria australasica</i> 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.	x	x	-	-	x	x
Australian Greyling <i>Prototroctes maraena</i> 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 (e.g. weirs, waterfalls).	x	x	-	-	x	x
OEH	Denotes species listed within 10km of the subject site on the <i>Atlas of NSW Wildlife</i>								
EPBC	Denotes species listed within 10km of the subject site in the <i>EPBC Act</i> habitat search								
V	Denotes vulnerable listed species under the relevant Act								
E	Denotes endangered listed species under the relevant Act								
NOTE:	<p>This field is not considered if no suitable habitat is present within the subject site</p> <p>‘Records’ refer to those provided by the <i>Atlas of NSW Wildlife</i>. Updated 1:100,000 database map sheet requests to OEH are undertaken every 3 months as recommended.</p> <p>‘Nearby’ or ‘recent’ records are species specific accounting for home range, dispersal ability and life cycle.</p>								

A detailed assessment in accordance with Section 5A of the *EPA Act* will be completed for these species in Appendix 3 of this report.

Table A2.3 provides an assessment of potential habitat within the subject site for nationally *protected* migratory fauna species recorded within 10km on the *EPBC Protected Matters Tool*. 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
Oriental or Horsfield's Cuckoo (<i>Cuculus optatus</i>)	It mainly inhabits forests, occurring in coniferous, deciduous and mixed forest. It feeds mainly on insects and their larvae, foraging for them in trees and bushes as well as on the ground.	✓	x	-
White-throated Needletail (<i>Hirundapus caudacutus</i>)	Airspace over forests, woodlands, farmlands, plains, lakes, coasts, towns; companies forage often along favoured hilltops and timbered ranges. <i>Breeds Siberia, Himalayas, east to Japan. Summer migrant to eastern Australia.</i>	✓	x	-
Rainbow Bee-eater (<i>Merops ornatus</i>)	Open woodlands with sandy, loamy soil; sandridges, sandspits, riverbanks, road cuttings, beaches, dunes, cliffs, mangroves, rainforest, woodlands, golf courses. <i>Breeding resident in northern Australia. Summer breeding migrant to south east and south west Australia.</i>	Sub-optimal	x	-
Spectacled Monarch (<i>Monarcha trivirgatus</i>)	Understorey of mountain / lowland rainforest, thickly wooded gullies, waterside vegetation, mostly well below canopy. <i>Summer breeding migrant to south-east Qld and north-east NSW down to Port Stephens from Sept/Oct to May. Uncommon in southern part of range.</i>	x	-	-
Black-faced Monarch (<i>Monarcha melanopsis</i>)	Rainforests, eucalypt woodlands; coastal scrubs; damp gullies in rainforest, eucalypt forest; more open woodland when migrating. <i>Summer breeding migrant to coastal south east Australia, otherwise uncommon.</i>	Sub-optimal	x	-
Yellow Wagtail (<i>Motacilla flava</i>)	The yellow wagtail typically forages in damp grassland and on relatively bare open ground at edges of rivers, lakes and wetlands, but also feeds in dry grassland and in fields of cereal crops.	x	-	-
Satin Flycatcher (<i>Myiagra cyanoleuca</i>)	Heavily vegetated gullies in forests, taller woodlands, usually above shrub-layer; during migration, coastal forests, woodlands, mangroves, trees in open country, gardens. <i>Breeds mostly south east Australia and Tasmania over warmer months, winters in north east Qld.</i>	x	-	-

Common name Scientific name	Preferred habitat Migratory breeding	Suitable habitat present (✓)	Recorded on site (✓)	Comments
Rufous Fantail (<i>Rhipidura rufifrons</i>)	Undergrowth of rainforests / wetter eucalypt forests / gullies; monsoon forests, paperbarks, sub-inland and coastal scrubs; mangroves, watercourses; parks, gardens. On migration, farms, streets buildings. <i>Breeding migrant to south east Australia over warmer months. Altitudinal migrant in north east NSW in mountain forests during warmer months.</i>	✓	×	-
Great Egret (<i>Ardea alba</i>)	Shallows of rivers, estuaries; tidal mudflats, freshwater wetlands; sewerage ponds, irrigation areas, larger dams, etc. <i>Dispersive; cosmopolitan.</i>	×	-	-
Cattle Egret (<i>Ardea ibis</i>)	Stock paddocks, pastures, croplands, garbage tips, wetlands, tidal mudflats, drains. <i>Breeds in summer in warmer parts of range including NSW.</i>	×	-	-
Latham's Snipe (<i>Gallinago hardwickii</i>)	Soft wet ground or shallow water with tussocks and other green or dead growth; wet parts of paddocks; seepage below dams; irrigated areas; scrub or open woodland from sea-level to alpine bogs over 2,000m; samphire on saltmarshes; mangrove fringes. <i>Breeds Japan. Regular summer migrant to Australia. Some overwinter.</i>	×	-	-
Bar-tailed Godwit (<i>Limosa lapponica</i>)	The Bar-tailed Godwit is found mainly in coastal habitats such as large intertidal sandflats, banks, mudflats, estuaries, inlets, harbours, coastal lagoons and bays. It is found often around beds of seagrass and, sometimes, in nearby saltmarsh.	×	-	-
Common Greenshank (<i>Tringa nebularia</i>)	Found in a wide variety of inland wetlands and sheltered coastal habitats (with large mudflats and saltmarsh, mangroves or seagrass) of varying salinity. Habitats include embayments, harbours, river estuaries, deltas and lagoons. It uses both permanent and ephemeral terrestrial wetlands, including swamps, lakes, dams, rivers, creeks, billabongs, waterholes and inundated floodplains, claypans and saltflats. Also artificial wetlands, including sewage farms and saltworks dams, inundated rice crops and bores. In NSW the Hunter River estuary has been identified as a site of international importance. <i>Breeds in Eurasia, the northern British Isles, Scandanavia, east Estonia and north-east Belarus, through Russia and east.</i>	×	-	-

Common name Scientific name	Preferred habitat Migratory breeding	Suitable habitat present (✓)	Recorded on site (✓)	Comments
Little Tern (<i>Sternula albifrons</i>)	In Australia, Little Terns inhabit sheltered coastal environments, including lagoons, estuaries, river mouths and deltas, lakes, bays, harbours and inlets, especially those with exposed sandbanks or sand-spits, and also on exposed ocean beaches. Little Terns nest on sand-spits, banks, ridges or islets and also on wide and flat or gently sloping sandy ocean beaches, and occasionally in sand-dunes. Forage in shallow waters of estuaries, coastal lagoons and lakes, frequently over channels next to spits and banks or entrances, and often close to breeding colonies. They also forage along open coasts, especially around bars off the entrances to rivers and lagoons, less often at sea, and usually within 50 m of shore.	x	-	-
Fork-tailed Swift (<i>Apus pacificus</i>)	Aerial: over open country, from semi-arid deserts to coasts, islands; sometimes over forests, cities. <i>Breeds Siberia, Himalayas, east to Japan south east Asia. Summer migrant to east Australia. Mass movements associated with late summer low pressure systems into east Australia. Otherwise uncommon.</i>	✓	x	-



7 Part Test of Significance

A3

Council, or the authorising authority, is required to consider the impact upon threatened species, populations and / or EECs from any development or activity via the process of a 7 part test of significance. The significance of the assessment is then used to determine the need for a more detailed SIS.

This 7 part test has been updated since the May 2016 proposal to account for the updated APZ extensions and thus a further 6.5 ha of natural habitat impacts.

In light of the current planning proposal there is no requirement to undertake an assessment of threatened species in accordance with Section 5A of the EPA Act. Such an assessment will be undertaken at the appropriate time which is during the preparation of a Part 4 development application. Alternatively should the proponent and the Council determine that the best route is for a biocertification approach, then the matter of threatened species, endangered ecological communities and populations will be given appropriate assessment under the biocertification legislation.

The impacts of the rezoning proposal relates to a proposed development area of **28.91 ha** including APZs and proposed road extensions of the total 138.26 ha land within the study area. This includes electrical easement lands that are already set aside for irregular vegetation clearing activities.

Flora and fauna investigations and habitat assessments of the study area have resulted in the identification of suitable habitat for the following threatened species and populations with varying potential to occur. Species recorded or with a considered potential to occur have been noted. The potential for any direct or indirect impacts on these species has also been considered and noted.

Threatened flora

- *Acacia bynoeana*
- *Callistemon linearifolius*
- *Epacris purpurascens* var. *purpurascens*
- *Eucalyptus camfieldii*
- *Grevillea caleyi* *
- *Haloragodendron lucasii*
- *Microtis angusii*
- *Lasiopetalum joyceae*
- *Melaleuca deanei*
- *Microtis angusii*
- *Persoonia hirsuta*
- *Pimelea curviflora* var. *curviflora*
- *Tetratheca glandulosa* *

Threatened fauna

Common name	TSC Act	Potential to occur	Habitat impacts
Giant Burrowing Frog	V	recorded	Direct - on recorded dispersal/burrowing/foraging
Red-crowned Toadlet	V	recorded	Direct - on 4 recorded breeding & core activity areas, Indirect - on potential other breeding & core activity areas.
Rosenberg's Goanna	V	recorded	Direct - on recorded foraging and potential nesting/breeding Indirect - on potential burrowing and other core habitat

Common name	TSC Act	Potential to occur	Habitat impacts
Little Lorikeet	V	recorded	Direct - on potential foraging
Glossy Black-Cockatoo	V	recorded	Direct and indirect - on potential foraging
Powerful Owl	V	recorded	Direct and indirect - on potential foraging
Grey-headed Flying-fox	V	recorded	Direct - on recorded foraging
Little Bentwing-bat	V	recorded	Direct - on recorded foraging
Eastern Bentwing-bat	V	recorded	Direct - on recorded foraging
Eastern Pygmy Possum	V	recorded	Direct - on recorded breeding/nesting & foraging
Swift Parrot	E	possible	Direct - on potential foraging
Barking Owl	V	possible	Direct - on potential foraging
Spotted-tailed Quoll	V	possible	Direct - on potential foraging, Indirect - on potential denning
Southern Brown Bandicoot	E	possible	Direct - on potential foraging/denning/breeding
Little Eagle	V	low	Direct - on low potential foraging
Square-tailed Kite	V	low	Direct - on low potential foraging
Varied Sittella	V	low	Direct - on potential foraging/breeding
Dusky Woodswallow	V	low	Direct - on low potential foraging and unlikely breeding
Scarlet Robin	V	low	Direct - on low potential foraging and unlikely breeding
East-coast Freetail Bat	V	low	Direct - on potential foraging and unlikely roosting/breeding
Greater Broad-nosed Bat	V	low	Direct - on potential foraging and unlikely roosting/breeding
Large-eared Pied Bat	V	low	Direct - on potential foraging and indirect on unlikely roosting
Gang-gang Cockatoo	V	unlikely	Direct - on unlikely foraging
Masked Owl	V	unlikely	Direct - on unlikely foraging
Koala	V	unlikely	Direct - on unlikely habitat use
Yellow-bellied Sheath-tail-bat	V	unlikely	Direct - on unlikely foraging
Eastern Falsistrelle	V	unlikely	Direct - on unlikely foraging/roosting/breeding

Endangered populations

- No endangered populations are known to occur within the former Warringah portion of the Northern Beaches LGA.

Endangered ecological communities

- Coastal Upland Swamp in the Sydney Basin Bioregion
- Duffys Forest

The direct impacts of the proposal within the subject site are considered as:

- Removal or modification of 0.61 ha of Duffys Forest EEC (49%). There are opportunities for restoration works within a proposed Duffys Forest protection area that will increase the area.
- Removal or modification of 0.59 ha of Coastal Upland Swamp, with an additional 0.30 ha under an existing electrical easement which is already subject to ongoing vegetation management.
- Removal or modification of 28.91 ha of habitat of combined short, tall and damp heath, low open forest and open forest providing diverse threatened species habitat opportunities on a local plateau. Such plateau habitat opportunities on Lambert soils are a limited habitat in the local connective landscape.
- Removal of recorded Eastern Pygmy Possum foraging, denning and breeding habitat. This includes removal of suitable hollows in relative high density proximate to extensive *Banksia ericifolia* and other diverse floristics for foraging.
- Removal of recorded Giant Burrowing Frog dispersal and burrowing / shelter / foraging habitat.

- Removal of four (4) recorded Red-crowned Toadlet breeding areas containing adjacent shelter, foraging and dispersal opportunity across the plateau to adjacent breeding locations.
- Removal of recorded Rosenberg's Goanna foraging, burrowing and possible nesting habitat.
- Removal of other recorded (and potential to occur) threatened fauna species foraging habitat.
- Removal of one mostly small hollows and some medium hollows providing recorded habitat for Eastern Pygmy Possum, Powerful Owl prey species.

The potential indirect impacts of the proposal from the subject site are considered as:

- Increased human presence and spill-over into adjacent natural habitats.
- Removal of connectivity across the plateau and reduction in stepping stones for flying species. Subsequent reduced cross-site movements by small bird species such as passerines.
- Increased presence of dogs and cats and subsequent potential impacts on native wildlife.
- Edge effects such as increased human use, weed incursions caused from soil disturbance, further clearing, dumping and landscaping species becoming a nuisance and in the adjacent remnant bushland.
- Potential spill-over effects from noise, activity, scent and lighting into the adjacent quality natural habitat areas.
- Increased soil nutrients from runoff off the development landscape and into lower drainages causing weed plumes, altered habitat and water quality changes within threatened frog species habitat.
- Altered hydrology causing impacts on natural water quantity to threatened frog species habitat in lower drainages.

The potential cumulative impacts (combined results of past, current and future activities) of the proposal are considered as:

- Increased risk of weed invasion and fungal mobilisation or infections.
- Loss of plateau heath and forest communities on Lambert soils providing unique habitat attributes for fauna within the locality.
- Cumulative loss of EEC within the locality.
- Further fragmentation of the connective remnant.
- Increased varied human presence and activity within the remaining natural habitat areas of the adjacent bushland remnant.

With consideration to the relative direct and indirect impacts on all threatened species with varying potential to occur, it is considered that the proposal is unlikely to disrupt the life cycle for any of these listed species such that a viable local population would be placed at risk of extinction. Species recorded present during survey, previously recorded nearby or with high potential to occur and requiring further discussion given potential impacts are further discussed in detail below.

The 7 part test of significance is as follows:

- a) ***In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction***

THREATENED SPECIES RECORDED PRESENT

Grevillea caleyi

The potential habitat for *Grevillea caleyi* is restricted within the subject site to those areas which have taller vegetation and a regular composition of *Eucalyptus sieberi* and *Corymbia gummifera* on laterite soil on ridge tops. It is more regularly associated with the EEC Duffys Forest. This vegetation is present surrounding the electrical substation and incorporates vegetation in the far north east of the subject site. A total of eight (8) specimens were located in this area before the 2012 hazard reduction burn, including seven (7) specimens on the fence line between the Wyatt Avenue road corridor and the electrical substation and one (1) outlier specimen within the development area (conserved in the Duffys Forest reserve).

Post the 2012 burn, there are currently four (4) specimens on the fence line in the Wyatt Road corridor, and no further specimens within the development lands.

Suitable design of a future road (Wyatt Avenue) has avoided impacting the specimens as the road corridor is 20m wide and the likely road pavement and sides for cut and fill would not likely exceed 10m in width. It is assumed that these specimens will be retained based upon the current layout although indirect impacts need to be managed.

The hazard reduction burn in 2012 continued on to the electrical substation lands. Consequently, mature specimens have been burnt out and new seedlings underneath them were observed in August 2013. A total of thirty eight (38) juvenile specimens were counted during the survey. In July 2015, the same area was resurveyed but there were less individuals present and it was noted that they had been grazed upon as they were shorter than those observed two (2) years previous.

The current estimated local population for *Grevillea caleyi* is seventeen (17) inclusive of individuals within the substation lands.

No individuals of *Grevillea caleyi* are to be directly impacted by the proposal. The proposed road along the Wyatt Road corridor has been shifted to avoid impacts, and the previous location of the individual burnt by fire is within the proposed Duffys Forest protection area.

The proposed rezoning is not expected to have a significant impact on this species through the loss of habitat, altered fire regimes or altered surface runoff conditions subject to defining an appropriate fire management regime for the conserved lands and implementation of a barrier to retained specimens on the road corridor edge to avoid access and trampling.

Given the retention of *Grevillea caleyi* on the fence line in the Wyatt Avenue corridor, protection of habitat with the Duffys Forest reserve and given the extent of habitat on adjoining lands and known specimens comprising a local population, the proposal is unlikely to disrupt the life cycle for any of these listed species such that a viable local population would be placed at risk of extinction.

Tetratheca glandulosa

Tetratheca glandulosa

The potential habitat areas within the subject site and broader offset area for *Tetratheca glandulosa* are extensive. The one hundred and fifty one (151) specimens observed thus far within the study area are largely within the low open forest and open forest vegetation communities, and seldom within the tall heath as these areas are typically very dense and do not allow enough penetration of light to the ground layer for *Tetratheca glandulosa* to thrive.

Throughout the study area, large numbers of other *Tetratheca* species were sighted, notably *Tetratheca ericifolia* and *Tetratheca thymifolia*, however there were not large numbers of *Tetratheca glandulosa* recorded, despite the good habitat potential. In areas where *Tetratheca glandulosa* was observed, they were typically found in clumps of 10-50 individuals.

Intensive target searches for *Tetratheca glandulosa* have not been undertaken within all offset areas due to highly dense and inaccessible vegetation. However the targeted surveys tended to focus more on the peripheral upper slopes in close proximity to the subject site. There have been searches undertaken within the quadrats, on the meander between quadrats and along existing walking track edges.

The upper slopes in non-sheltered localities are likely to provide the more likely potential habitats. The vegetation types with suitable habitat include ME014, ME039 and ME008 to a lesser extent, of which 71.7 ha will be protected (84.7% conservation). However it is estimated that approximately 25% of the offset area would contain likely habitat based on topography, aspect, exposure suitable this species. This equates to 18.9 ha of likely suitable habitat within the proposed offset areas. Approximately 13.0 ha is being removed within the proposed development area (ME014, ME039 and ME008). It is therefore estimated that 60.2% of *Tetratheca glandulosa* habitat is being retained within the proposed offset areas.

Based upon the current known population, the direct impact is upon 138 of the 151 observed specimens (91.4% loss), although some additional specimens (approximately 10 specimens) may be retained within APZ but are assumed to be impacted. Downslope specimens may be impacted indirectly through changes to hydrological regimes, and changes to fire regimes where located very close to proposed dwellings.

The impact of the proposed development on *Tetratheca glandulosa* is further discussed in the Biodiversity Assessment Report and Biodiversity Certification Strategy is addressed by *EcoLogical Australia* (2015). *Tetratheca glandulosa* also occurs within a number of Council managed bushland reserves located in the region within the former Warringah, Hornsby and Pittwater local government areas. Within its geographic distribution, *Tetratheca glandulosa* is known from 150 populations comprising an estimated total of 11,000 mature plants, although as the species is clonal in nature this may be an over-estimate of genetically distinct individuals. Of the National Parks where *Tetratheca glandulosa* is known to occur, only three, Cattai, Wollemi and Yengo National Parks and parts of Brisbane Waters, Dharug and Marramarra National Park occur outside the region.

Accordingly, although exact numbers of *Tetratheca glandulosa* occurring at each location are unknown it is likely that by far the greater proportion of the estimated 11,000 individual mature plants occur within the region. A red flag impact of 134 *Tetratheca glandulosa* plants represents 0.01% of the estimated plants within its geographic distribution which is considered to be relatively minor impact. This is also considered to be a relatively minor

impact within the region (estimated to be a slightly smaller area than the geographic distribution for this species), even when the total number for this species may be an over-estimate due to its clonal nature (*EcoLogical Australia* 2015).

Whilst we believe that the impact upon the species is detrimental to the plateau population within the subject site, it has been recorded within the greater study area.

The distribution of the species in the broader / regional area is expansive over sandstone communities, extending along the ridgelines of the northern Sydney and the Central Coast towards Kulnura and Bucketty.

The proposed impact is not at the edge of the species' distribution nor will it fragment or isolate the distribution of the species which are all 7 part test considerations.

Whilst the rezoning will have a detrimental impact upon *Tetratheca glandulosa* but not one that will lead to an impact or long-term decline such that it may cause a local extinction of the species.

Giant Burrowing Frog (*Heleioporus australiacus*)

Giant Burrowing Frog was previously recorded in 1996 to the north near Fireclay Gully on outer edge of the offset area (possibly adjacent to the Heath Trail). This species was also recorded to the south west in 2010 along French's Creek, near the intersection of Middle Harbour Creek (again possibly adjacent to the French's Creek Trail).

This species is typically known to breed in drainages that flow from natural sandstone habitats. Whilst this may suggest that adults would utilise mostly the north eastern and south eastern extents of the proposed development area, the species has been found to burrow, forage and generally occupy territories hundreds of metres from riparian areas (Webb 1983; Lemckert et al. 1998). As with other frog species, the young also have wide dispersal ranges as a natural behaviour to colonise new suitable habitats in the locality.

The individual recorded during the 2012 surveys was found desiccated in a funnel trap and identified in the hand to a probable level of certainty. The specimen was later confirmed by DNA analysis by The Australian Museum to be Giant Burrowing Frog. The captured Giant Burrowing Frog was a juvenile and therefore may have been in dispersal at the time of capture. The capture point was in the middle of the proposed development area.

Further targeted surveys were undertaken by specialist Prof Michael Mahony with *Travers bushfire & ecology* during the late autumn peak breeding period of 2013 along all major drainages, perched swamps and roadside gutters surrounding the subject site. A breeding location was identified within a made-made scrape next to the Heath Track which continues into Garigal National Park. This breeding location identified many tadpoles in a small number of perennial pools along the edge of the fire trail. The main larger pool contained a typical sandy substrate with a few surrounding yabby burrows and appeared to be continuously fed by ground water and not a defined drainage line. Numerous Giant Burrowing Frog tadpoles were present with no adults recorded by call or observation. This location is close to the nearest Atlas record of this species from 1996. No tadpoles or activity were recorded close to the subject site in locations previously identified as having potential.

This initial recorded breeding location is located more than 300m from the north western tip of the proposed development landscape. Eastern Pygmy Possum surveys in 2015 opportunistically recorded a second breeding location closer to the development but still

240m north of the development boundary. Prof Mahony was notified of this new breeding location but concluded that his assessment remains valid.

Based on the recorded distances of breeding from the proposed development area, the new and extended APZ's incorporated into the proposal since the May 2016 assessment will not incur any notable closer distances to the recorded breeding locations.

Prof Mahony in his assessment (see Appendix 6) concluded that:

- The density of GBF at the site is low, and that it is most unlikely that habitats on the plateau are used routinely for shelter and foraging. Furthermore, it is not likely that development will break a corridor that connects breeding habitat with foraging and shelter sites since there are no identified breeding sites close to the plateau.
- The considerable distance of the identified breeding habitat from the plateau and the relatively large area of surrounding habitat indicate that indirect impacts on hydrology are unlikely to impact on the GBF breeding habitat.
- It is not likely that the proposal will impact on the local viable population of the GBF.
- There is no need for the placement of buffer zones around habitat on the escarpment since there are no identified breeding, sheltering or foraging habitat.

This species is potentially restricted by Mona Vale Road to the north and urban development in the remaining surrounds. The extent of the local population is not known but existing records suggest that suitable habitat continues within the broader catchment area within the offset lands and the surrounding Garigal National Park.

Prof Mahony indicated that the matters that need to be considered in the future development design is to maintain the hydrological integrity (quality, quantity and discharge rates) of the waterflows that feed off the plateau.

Given the assessment provided by Prof Mahony and provided that the concerns of indirect impacts on surrounding drainages can be effectively mitigated, it is concluded that the proposed subdivision is not likely to significantly impact on the local population of Giant Burrowing Frog.

Red-crowned Toadlet (*Pseudophryne australis*)

Red-crowned Toadlets use small ephemeral drainage lines, which feed water from the top of ridges to perennial creeks below. This species is confined to the Hawkesbury sandstone formation and is not usually found in the vicinity of permanent water (Ehmann, 1997). Breeding habitat is small puddles or depressions where rock or leaf litter holds back water temporarily (Ehmann, 1997; State Forests Threatened Species Protocol, 1997). Breeding congregations can occur deep in grass and debris beside such non-perennial creeks, gutters etc. They have also been noted to be very partial to damp shelves and cracks in sandstone where they have been observed emerging at dusk (NPWS 1997). At other times, individuals disperse and are found under rocks, logs etc. on sandstone ridges (Cogger, H. G. 2000).

The Red-crowned Toadlet was initially recorded to the central north of the proposed development area in both 2008 and 2011. In 2011 it was also recorded north of the western endpoint of Ralston Avenue. Both of these recorded locations were found to be dry during 2012 survey. This 2012 survey session was undertaken following a dry spring period and other potential breeding locations were also dry at this time, particularly the ephemeral drainages along the northern aspects of the escarpment. This restricted identification of further breeding locations.

Prof Michael Mahony was engaged to undertake additional survey, habitat assessment and specialist review of the impacts on Red-crowned Toadlet during the late autumn and early winter of 2013. *Travers bushfire & ecology* provided assistance in target surveys at this time where the majority of drainages that run off the plateau area surrounding the proposal were searched. Search transects undertaken by *Travers bushfire & ecology* are shown in Figure 6 of the Ecological Assessment Report (*Travers bushfire & ecology* 2013) and searches undertaken by Prof Mahony are depicted within his attached report (Appendix 6).

The 2013 target surveys were undertaken during suitable weather conditions predominantly following rain events which included heavy mid autumn falls. Several new breeding locations were also identified across the study area and surrounding the proposed development layout during more recent Eastern Pygmy Possum habitat assessments in offset areas in 2015. The total of all surveys revealed that all ephemeral drainage lines from the plateau and perched swamp areas provide potential breeding habitat for this species.

Recent habitat assessments within the extended APZ areas below powerlines has identified some potential additional breeding opportunity. These however do not appear as natural drainages but rather modified ditches beside trails (in the north-east) and a scoured drainage from substation runoff (through the south-eastern portion). A similar modified drainage flowing from the north-western corner of the substation did not record breeding in the scoured channel but rather in an adjacent soak. Therefore this additional breeding opportunity is not ideal. It should be noted here that these easements can be managed by the electrictral contractors at any time and such management may potentially not reduce the breeding potential.

The Red-crowned Toadlet has also been recorded at various locations in the surrounding connective habitats into Garigal National Park. Given that Red-crowned Toadlet is never found far from breeding areas and it typically displays limited movement, this species is assumed to have a reduced capacity to disperse. Results from the study area would however suggest dispersal is likely possible between the recorded breeding areas. This is particularly where they occur closer together on the upper slopes or where they are linked by escarpment edges that retain moist areas below.

The potential impacts on this species from the proposed development include:

- Removal of four (4) recorded breeding areas
- Indirect impacts of altered water quality and / or quantity onto other recorded breeding areas as well as potentially others located just off the escarpment.

The proposed rezoning is not expected to have a significant impact on a local population of this species through the loss of habitat, altered fire regimes or altered surface runoff conditions. This is subject to defining an appropriate fire management regime for the conserved lands, integrated interface management of the bushland / APZ zone and implementation on performance based stormwater quality and quantity measures.

Following additional site surveys for Red-crowned Toadlet in 2013, Prof Mahony concluded that:

- Additional breeding habitats of the Red-crowned Toadlet were detected and twelve (12) breeding locations were identified within the study area outside the subject site. It is concluded that the local population occurs along most of the semi-permanent drainages and soaks that occur near the escarpment and down slope from the plateau. None of these breeding locations will be directly impacted by the proposed development. There are four (4) identified breeding locations within the subject site; one (1) on the western end of the plateau (human made pit), two (2) on the rock

face seepage in the north east, and one (1) at the head of the drainage line to the south.

- Movement of the Red-crowned Toadlet will mostly be in the escarpment and mid-slope areas and development of the plateau will not have a significant effect on the local population due to the removal of habitat or the breaking of corridors.
- The potential for impact on the population of the Red-crowned Toadlet is assessed to be related mostly to indirect impacts on the hydrology of the breeding habitat (rate, volume, and water quality of discharge). Specific mitigation measures are required to ensure that the hydrology of these sites is not altered by the proposal.
- Protection of the considerable area of Red-crowned Toadlet habitat below the escarpment and at mid-slope should protect the local viable population.

Prof Mahony's detailed report and assessment is provided in Appendix 6. Prof Mahony concluded that development of the plateau will not have a significant impact on the local population of Red-crowned Toadlet due to any removal of habitat or the breaking of corridors. The potential for impact on the population of the Red-crowned Toadlet is related mostly to indirect impacts on the hydrology of the breeding habitat (rate, volume, and water quality of waters into breeding areas). Mitigation measures are required to ensure that the hydrology of breeding sites is not altered by the proposal.

Provided that measures can be put in place to effectively maintain water quality and quantity towards the breeding drainages off the plateau, then there will not be a likely significant impact on a local population of Red-crowned Toadlets.

Rosenberg's Goanna (*Varanus rosenbergi*)

On the east coast of NSW, the Rosenberg's Goanna (also known as Heath Monitor) is a Hawkesbury / Narrabeen sandstone outcrop specialist (State Forests of NSW, 1995). The Rosenberg's Goanna is largely restricted to heath (NPWS 1997); inhabiting humid woodlands, dry hardwood forests and heathland where it shelters in self-dug burrows, hollow logs, rock crevices and sandstone outcrops (Cogger 1992), usually with a sandy substrate (State Forests of NSW, 1997). Eggs are generally laid within a terrestrial termite mound but they are unlikely to use termite mounds exclusively for nesting purposes.

Rosenberg's Goanna is a mobile species and is a lot more versatile than currently reported (Gerry Swan pers. com. 2012). For example, the species has been observed in the Rylstone area utilising grassland areas for foraging purposes (entering burrows and preying on a young rabbit) and has been observed entering backyards with little native vegetation.

Rosenberg's Goanna was initially recorded only from cage trapping of a juvenile in 2011. Following this, 2012 surveys in more suitable, warmer weather conditions observed the species at a number of locations throughout the proposed development area as well as trapping of an individual in a cage trap in the north eastern proposed development area. The trapped monitor had a cotton spool taped to the tail with biodegradable sticky tape (a method suggested by reptile specialist Gerry Swan). The cotton line was later followed with GPS to two (2) burrow locations, one (1) located just within the APZ area and the other located just outside of the north eastern portion of the proposed development area extent (see Figure 5).

Based on the age of the trapped goannas we estimate that there is a minimum of three (3) Rosenberg's Goannas utilising the site's habitats. Rosenberg's Goanna was observed using the edge of tracks for basking and presumably can move around more easily using walking trails.

The rocky escarpment edge surrounding the proposed development area extents, particularly where heath associations occur, are important for this species. Such habitat provides basking and burrowing opportunities and core nesting habitat is generally where termite mounds are found in proximity to these areas (see Figure 5). Rosenberg's Goanna has also been observed using a wide range of vegetation types in the Shoalhaven area using Shale Sandstone Transition Forest, Turpentine Forest, Sandstone Forest, Heath Woodland and Mallee Heath (Gerry Swan pers.com. 2012). Therefore, this species may be more of a generalist than currently believed and may utilise most habitat areas surrounding core habitat but still within its home range for foraging.

One (1) terrestrial termite mound has been recorded present within the Duffys Forest Conservation Area within the subject site and forms part of the biodiversity offset area. (See Figures 4b & 5). This mound should be noted as an important habitat feature within the Conservation Area that should not be indirectly impacted by any nearby adjacent road works. It is however considered that this mound will be unlikely utilised on the post development landscape given its isolation within a pocket park from contiguous areas of habitat.

Recognised reptile specialist, Mr Gerry Swan, was engaged to undertake a site study on Rosenberg's Goanna which resulted in the observation of three other termite mounds including one (1) with a juvenile exit point and several more burrows (see Appendix 5 for *Cygnets Surveys and Consultancy* Report, November 2012). Two of these termite mounds are located just within the northern APZ, the other termite mound (noted as a nest site) and the other recorded burrows are located outside of the proposed development area. The burrows identified by Mr Swan have been identified in suitable habitat areas to the north and north-west of the proposed development area.

Recent identification of important habitat features through the proposed APZ area also identified likely burrows along the northern interface (see the fauna results Figure 4b). These have been highlighted for retention within the Bushfire Fuel Management Plan (TBE 2015). Further detailed survey of important habitat features within the recent APZ extension areas and an update to the Bushfire Fuel Management Plan are recommended as part of this report. Such survey will not be limited to Rosenberg's Goanna habitat features but will specifically target locations of burrows for protection.

Mr Swan was notified of the recent APZ extension area to the proposal given that the extension includes further removal of 0.82ha of Important Habitat Area initially mapped by Mr Swan (see Figure 5). Initially the proposal impacted on 4.55ha of the total 39.51ha area of this Important Habitat Area.

Mr Swan has concluded in his report (Appendix 5) that the proposed development site is not critical to the survival of the population, that there is adequate habitat surrounding the proposed residential development site to maintain a viable population, and the proposed residential development is not likely to result in a significant restriction on the movement of the local population. Mr Swan states that the proposed development is not likely to have a significant impact on the Rosenberg's Goanna population. Mr Swan has indicated that this conclusion remains the same with consideration to the recent APZ extensions. Interface management between the development area and mapped critical habitat areas as identified by Mr Swan needs to be investigated.

This species may be restricted by Mona Vale Road to the north and urban development in the remaining surrounds. However as this species is capable of and has been previously observed crossing roads (despite the risk of collisions), the home ranges are likely to be large and capable of extending beyond existing unfenced road corridors (Gerry Swan pers.com. 2012). Home ranges for this species (at least on Kangaroo Island) for thirteen

(13) studied animals ranged from 1.71ha to 43.7ha with a mean of 19.44ha. The proposed residential area is quite small compared to the total available habitat in the locality (Gerry Swan pers.com. 2012).

Little Lorikeet (*Glossopsitta pusilla*)

Little Lorikeets mostly occur in dry, open eucalypt forests and foraging in small flocks on nectar and pollen in the tree canopy, particularly on profusely flowering eucalypts. Long term investigations indicate that breeding birds are resident from April to December and, even during their non-resident period, they may return to the nest area for short periods if there is some tree flowering in the vicinity (Courtney & Debus 2006).

The proposed development area provides sub-optimal foraging habitat for the Little Lorikeet. This species was recorded during initial surveys in 2008, however the location of the recording was not documented as the species was not listed as threatened at this time. No Little Lorikeets were recorded during 2011 or 2012 surveys over two (2) weeks during the breeding period, suggesting that breeding is not taking place within the proposed development area or nearby. The proposed development would remove seasonally available foraging resources (excluding winter), however, would not be considered likely to remove any likely breeding habitat that may significantly impact on a local population.

Glossy Black-Cockatoo (*Calyptrorhynchus 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.

The Glossy Black-Cockatoo has not been observed during all combined bird surveys and other opportunistic surveys undertaken to date. The presence of the species was confirmed during observations of chewed cones in two locations to the north of the subject site whilst undertaking habitat assessments for Eastern Pygmy Possum in 2015. The north-western location revealed only three possible chewed cones of *Allocasuarina dystyla* just beyond the proposed APZ boundary. The north-eastern recorded location showed extensive signs of foraging to suggest regular utilisation of *Allocasuarina littoralis*. This location is shown on Figure 4a.

The subject site area and nearby surrounds contains no suitable large hollows for breeding. *Allocasuarina dystyla* is most prevalent within tall heath portions both within the subject site as well as the offset area however this tree is not generally regarded as a significant feed tree. *Allocasuarina littoralis* on the other hand is well regarded as a regular feed tree and the presence of *A. littoralis* is somewhat limited within the subject site itself.

Therefore the proposal will not impact on any suitable breeding habitat and limited foraging habitat potential for the Glossy Black-Cockatoo, particularly in respect to available foraging resources in the surrounding locality. The subject site is also not considered likely to provide any regular habitat support for the species given the absence of its recording within the subject site during extensive surveys to date. Therefore the proposal is not likely to significantly impact on a local population of this species such that it would threatened local extinction.

Powerful Owl (*Ninox strenua*)

The Powerful Owl inhabits mature rainforest, wet and dry eucalypt forest and woodland. Optimal habitat includes a tall shrub layer and abundant hollows supporting high densities of arboreal mammals. Roosting is generally within dense foliage of mid canopy trees in sheltered gullies. Large trees with hollows at least 45cm in diameter and 100cm deep are required for nesting. Estimates of the home range of this species vary greatly, but territories are thought to range from 800-1,500ha (Kavanagh 1997).

The proposed development area provides no suitable breeding hollows for the Powerful Owl. No suitable hollows were observed within indirectly affected distances surrounding the subject site. The proposed development area also provides unlikely roosting habitat. Powerful Owl may utilise the site for foraging, given the presence of arboreal prey species; however, prey species are present in low density given the low density of available hollow resources to support possums and gliders. The Recorded Grey-headed Flying-fox and Sugar Glider would provide the most utilised prey species.

The Powerful Owl was recorded responding to call playback during 2008 surveys. Call playback may call owls away from core foraging and roosting areas. No signs of owl activity by evidence of whitewash below roosting locations was found evident in the low Open Forest areas during extensive surveys to date. This species is therefore not likely to be significantly impacted by development within the proposed development area.

Grey-headed Flying-fox (*Pteropus poliocephalus*)

Grey-Headed Flying-foxes are canopy feeding frugivores and nectarivores, inhabiting a wide range of habitats including rainforest, mangroves, paperbark forests, wet and dry sclerophyll forests and cultivated areas. This species roosts in camps, which may contain tens of thousands of individuals. Camps are commonly formed in gullies, typically not far from water and usually in vegetation with a dense canopy (Tidemann 1998). Generally, foraging is within 20km of camps but individuals are known to commute up to 50km to a productive food source.

The proposed development area provides no suitable roosting or breeding habitat for the Grey-headed Flying-fox. A nearby large camp is located at Gordon over 3.5km from the proposed development area and individuals observed during surveys were likely foraging out from this camp site. The proposed development area provides seasonal foraging opportunity for the Grey-headed Flying-fox (excluding winter) within the low Open Forest areas. Loss of habitat within the development area will reduce foraging resources within the locality, however, this is not likely to cause a significant impact on this species.

Little Bentwing-bat (*Miniopterus australis*) and Eastern Bentwing-bat (*Miniopterus orianae oceanensis*)

These species are considered here together due to similar habitat requirements.

The Little Bentwing-bat forages below the canopy and the Eastern Bentwing-bat forages above and below the canopy within Open Forests and woodlands, feeding on small insects. The species roosts 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 both species, particularly for breeding where maternity caves must have suitable temperature, humidity and physical dimensions to permit breeding (Dwyer 1995).

Both of these species were recorded during 2012 surveys by only one or two call sequence (passes) on the *Anabat* recorder. Neither species were recorded during previous *Anabat* surveys. This suggests only low use of the proposed development area at this time, which is understandable due to the predominant heath structure within the site.

Whilst suitable caves for roosting and breeding may be present in the surrounding locality, and perhaps the nearby central south of the proposed development area, there are no such opportunities within the proposed development area itself. Therefore, development within the proposed development area will impact only on suitable foraging habitat for both species. Such removal of foraging habitat will not likely result in a significant impact for either of these species.

Eastern Pygmy Possum (*Cercartetus nanus*)

The Eastern Pygmy-possum is found from rainforest through sclerophyll forest to heath throughout their range. Banksia and myrtaceous shrubs and trees are favoured (Turner and Ward, 2008). Eastern Pygmy Possums usually shelter alone in tree cavities, rotten stumps, holes in the ground, disused bird nests and possum dreys and in vegetation thickets such as *Xanthorrhoea* species (Menkhorst, 1996). The home ranges of males, about 0.65 hectares are larger than those of females, about 0.35 hectares and not exclusive with home ranges broadly overlapping.

Apart from females with young in the nest, individuals may utilise a number of nest sites within the home range (Turner and Ward, 2008; Menkhorst, 1996). An important determinant of habitat quality may be the proportion of the year in which pollen is available and the species is usually associated with floristically diverse shrub community, especially those including Banksia species. However populations also occur in box-ironbark associations where the understorey is sparse but relatively diverse (Menkhorst, 1996).

The following is an excerpt on habitat for Eastern Pygmy Possum as summarised by expert Dr Ross Goldingay (2015):

Diet: The diet of the eastern pygmy-possum consists predominantly of nectar and pollen, but insects are also included and may be important when nectar and pollen are absent or less abundant (Turner 1984; Huang et al 1987; van Tets and Whelan 1997). The eastern pygmy-possum occurs in a broad range of habitats from heathland to rainforest (Bowen and Goldingay 2000; Harris and Goldingay 2005a; Tulloch and Dickman 2006; Harris et al. 2007a). Its foraging habitat most commonly contains species of banksia. Two species that are particularly important for nectar feeding are *Banksia ericifolia* and *B. serrata* (Harris 2010; Rueegger 2011; Goldingay, Harris and Rueegger unpublished data).

Breeding habitat - Despite the eastern pygmy-possum using a wide range of different shelter types for nesting (Tulloch 2004; Goldingay 2011) it now appears that females are quite selective of the sites they use for breeding (Rueegger et al. 2012). Tree hollows are likely to be favoured such that a local shortage may limit the local population size of this species.

Banksia ericifolia appears to be particularly important when present and regulates breeding activity in Royal National Park (Goldingay and Rueegger unpublished data). Other species of banksia and myrtaceae will also be important for nectar and pollen when they are in flower. Higher densities of various banksia species will be most influential and is likely to drive breeding in the local population.

Within Royal National Park breeding was recorded within 19 tree hollows used by 8 pygmy-possums (Rueegger 2011). Four of these pygmy-possums were males and some of the

females were not breeding at the time of study so the following records represent trees hollows used for shelter as well as those used for breeding. The majority of hollows (13) were in live trees and the majority (12) were hollows in the trunk. The most commonly used tree species (8 records) were the red bloodwood (*E. gummifera*), followed by the Sydney peppermint (*E. piperita*) and *B. serrata*. The diameter at breast height of these trees averaged 36.9 ± 6.3 (SE) cm (11-90 cm). The entrances to hollows ranged from 0.5 to 9 m above the ground (mean 2.7 ± 0.5 m). Entrances to hollows averaged $3.8 (\pm 0.4)$ cm (range 2-7 cm) in the horizontal dimension and $5.1 (\pm 0.3)$ cm (range 3-8 cm) in the vertical dimension. The depth of these hollows averaged 27.6 ± 7.3 cm (range 6-125 cm) from the entrance.

Radio-tracking of the eastern pygmy-possum has also been conducted by Harris (2010) in Royal National Park and Barren Grounds Nature Reserve. These studies show that Eastern Pygmy-possums use tree hollows within a range of tree species based on what is available, they select hollows with a small entrance and their hollows are commonly close to the ground (~3 m). Hollows with a large chamber relative to the size of one pygmy-possum, which can be difficult to determine, will be required for breeding.

Recent studies by the NSW Scientific Committee have also shown that within its range EPP appears to be patchily distributed despite the fact that the species is broadly distributed throughout its range and connective opportunities exist otherwise in the locality.

Most local records are located on the other side of Forest Way, however one record exists within 700m to the west in 2003 (Figure 7). It would be fair to assume that the recorded individuals within the study area is part of a population that extends into the adjacent connective Garigal National Park and confined by Mona Vale Road and Forest Way.

The proposed development area provides suitable habitat for the Eastern Pygmy Possum based on the floristic diversity within the Heath and Open Forest communities, a diversity of *Banksia* species and nesting opportunities within small hollows.

This species was not recorded during initial surveys by *Travers bushfire & ecology*. Warringah Council recorded the species by observation of an adult and two juveniles in a Scribbly Gum hollow on 5 June 2013 inside the north western portion of the development footprint. Following this recording specialist Dr Ross Goldingay was engaged to undertake a site visit and review impacts on this species. During the site walkover with Dr Goldingay a second low hollow was found in an *Angophora crassifolia* with bedding material consistent with the species. Other recorded locations by evidence of fine bedding material at the base of small hollows have been found also during recent site habitat assessments within the subject site (see Figure 4b and Figure 7 for locations).

At the recorded locations habitat for this species is considered highly suitable. This is given the high density of *Banksia ericifolia* which occurs at highest densities at the outer plateau areas and the surrounding moderate escarpments, particularly towards the north where Lambert soils types continue in lower gradual contours extending well into the proposed offset areas. The recordings and the presence of young confirms the use of the site for denning and breeding. The proposal will therefore impact on denning, breeding and foraging habitat.

Dr Goldingay was engaged to prepare a report on the impacts on this species. Dr Goldingay's initial *Report on Habitat of the Eastern Pygmy Possum on land near Ralston Avenue, Belrose (August 2013)* is provided in Appendix 7. This advice concurred that the site contained breeding habitat of importance for Eastern Pygmy-possum but the degree of direct and indirect impact was not able to be determined without further survey and habitat assessment. However Dr Goldingay advised there was no separation of important habitat

areas created as a result of the proposed residential zone, and the spatial location of the proposed development will not pose a particular restriction on movements by the local population.

To enable a determination to be made as to the significance of impact on this habitat in the context of the local connective landscape, habitat assessment and target survey for Eastern Pygmy-possum was undertaken within the development site and surrounding proposed conservation areas under the guidance of Dr Goldingay.

In order to collect further hollow data, sixteen (16) 20m x 200m habitat assessment quadrats equivalent to sixty-four (64) biometric quadrats were subsequently undertaken across the study area from late May 2015, three of these were located in the subject site and the remaining thirteen were undertaken in the offset lands. The three quadrats located within the subject site were placed proximate to recorded Eastern Pygmy Possum locations to demonstrate quality habitat.

All quadrats were located according to vegetation mapping in order to represent Sandstone Gully Forest (x3), Low Open Forest (x9) and Open Forest (x4) communities. Figure 7 shows the locations of quadrats. Within each quadrat both the number of apparent and possible hollows suitable for Eastern Pygmy Possum were recorded. In addition to this the available foraging habitat was noted as a number or percentage presence of banksia species (specifically *B. ericifolia*) and a number of the different mytaceous tree species.

Custom built denning/nesting tubes for Eastern Pygmy Possum were also placed along ten (10) quadrats located in Low Open Forest (x7) and Open Forest (x3) communities in the offset areas for two months. Hollows were also inspected with a videscope during the collection of tubes.

The habitat assessment, quadrat data and review of vegetation communities enabled the preparation of mapping by *Travers bushfire & ecology* showing areas of high, moderate and low quality habitat within the study area. Dr Goldingay determined that LOF vegetation as mapped by *Travers bushfire & ecology* provided at medium to high quality habitat and all remaining vegetation communities within the study area was determined to contribute to low quality habitat. This community provided the most suitable habitat areas based on presence of foraging plant species (particularly *B ericifolia*, *B serrata*, *E haemastoma* and *C gummifera*) in association to the presence of hollows (particularly within *E haemastoma*). Remaining heath communities within the study area contained ample banksia foraging opportunity but generally no hollows and the open/gully forest communities contained fewer banksias particularly *B ericifolia* which are suspected to drive breeding activity (see Goldingay report Appendix 7).

This analysis was confirmed by undertaking similar quadrat data at ten local reference locations within the Northern Beaches (previously Warringah, Manly and Pittwater) LGA where EPP has been recorded in recent years. Eight of the ten quadrats were within Sydney North Exposed Sandstone Woodland which is consistent with the TBE Low Open Forest community and six of these contained greater than or equal to 15 hollows per hectare (see Figure 7).

Survey and analysis of further quadrat data collected within the proposed offset area was undertaken to determine the extent of medium to high quality habitat based on the presence of hollows within the LOF community. This data amounted to a total of 36 smaller 100x20m or 50x40m quadrats within LOF areas of the study area (15 of these within the subject site). These also utilised the data from some initial larger quadrats undertaken in LOF. Hollow data that was previously collected from within the APZ areas as part of identifying key habitat for bushfire planning was also utilised to contribute to quadrat data.

In this case the APZ quadrat boundaries were determined where 0.2 ha of LOF occurred which is equivalent to the quadrat area.

It should be noted here that this is based on the previous APZ extents from the May 2016 assessed layout with smaller APZ's. Due to the complicated nature of this data the calculations have not been amended but remain adequate for Dr Goldingays original hollows/habitat calculation purposes. Figure 7 shows the locations of the final Low Open Forest quadrats within the study area.

Following the review Dr Ross Goldingay confirmed that high quality habitat was determined as areas where greater than or equal to 15 hollows per ha of LOF were calculated. This amounted to 37% of LOF quadrats in the subject site and 20% in the remaining retained lands. Quadrats recording high quality habitat are indicated in yellow on Figure 7. Medium quality habitat was determined as all remaining calculated percentages of LOF and low quality habitat was all remaining areas within the study area containing the other vegetation communities. The collected data in the offset area confirmed that suitable hollows do exist within the offset areas for Eastern Pygmy Possum supported by the extensive foraging resources. However hollows were recorded at a lower density particularly by comparison to two notable areas in the central north and west portions within the subject site.

Dr Goldingay prepared a final specialist report on the *Examination of the amount of preferred habitat of the Eastern Pygmy-possum on Land near Ralston Ave, Belrose* (November 2015). In this report the calculated areas of areas of high, medium and low quality habitat was applied to his data on EPP densities of considered high quality habitat within Royal National Park. This confirmed that 15 hollows per hectare within LOF was the appropriate threshold to determine high quality habitat.

Subsequent EPP habitat estimates were calculated within the subject site and remaining study area (see Goldingay report Appendix 7 for calculated details). This predicted that the subject site provided approximately 21% of the estimated EPP population within the total study area including the conservation area.

During habitat surveys further records of Eastern Pygmy Possum activity were also obtained from both the development landscape as well as confirmed presence of EPP within the offset lands. The EPP denning tubes placed out over the first quadrat data period did not record any activity however inspections of small hollows by a videoscope recorded EPP at three locations in the offset area (2 individuals and 1 nest), one location within the adjacent Garigal National Park (nest) and an extra location within the subject site (nest).

Thus far, five (5) confirmed observations including three likely nesting locations for Eastern Pygmy Possum as well as approximately 9.47 ha of moderate to high quality habitat exists within the proposed development landscape (see Figure 4b and Figure 7). The subject site was also found to record a higher percentage of high quality habitat (37% = 3.5 ha) as compared to the offset area (20% = 7.5 ha). These calculations were 3.1 ha and 7.7 ha respectively as calculated and assessed by Dr Goldingay when the subject site was 6.52 ha smaller. The total high quality habitat removed calculated equates to approximately 32% (28% assessed by Dr Goldingay) within the study area and 6% of the combined connective areas including Garigal N.P.

Dr Goldingay concluded that *"It would appear there would be adequate habitat within Garigal NP and the offset site to support a viable local population based on the definitions given by DECC (2007)"*. However Dr Goldingay went on to indicate that the number of affected EPP *"is not insubstantial and requires some mitigation for the development to proceed"*.

Mitigation measures included the placement of nesting boxes, the omission of cats from the development landscape and provision of road crossings across Mona Vale Road and Forest way to assure populations on both sides.

Following the specialist advice of Dr Ross Goldingay and provided mitigation measures are adequately provided, it is concluded that the proposal is unlikely to significantly impact on the local population of Eastern Pygmy Possum.

This conclusion is maintained for the recently revised APZ extents in the absence of further consultation with Dr Goldingay. This is given that only 1% additional impacts on high quality habitat and 5% on medium to low quality habitat will be impacted (refer to table below for calculated impact areas).

Habitat	Extent in study area	Extent of loss (previous assessment)	Extent of loss (additional)	TOTAL LOSS
High (Low Open Forest)	52.76ha	8.95ha (17%)	0.52ha (1%)	18%
Medium-Low (other natural communities)	77.51ha	13.16ha (17%)	2.75ha (5%)	21%

THREATENED SPECIES WITH CONSIDERED POTENTIAL TO OCCUR

Swift Parrot (*Lathamus discolor*)

The Swift Parrot is a migratory species that breeds in Tasmania and its offshore islands in summer. In late March, almost the entire population migrates to mainland Australia spreading from Victoria through to central and coastal NSW and south east Queensland (Schodde and Tidemann, 1986). Winter flowering trees are an important resource for this species.

The recorded eucalypt trees present within the proposed development area are not recognised winter flowering species. The potential presence of Swift Parrot is based on a very close record to the north of the proposed development area in 2009. However, this species is not likely to be significantly impacted by the proposal.

Barking Owl (*Ninox connivens*)

The Barking Owl utilises dry sclerophyll forests and woodlands containing many large trees suitable for roosting or breeding and will utilise adjacent cleared areas for foraging. The Barking Owl utilises large hollows for nesting (Schodde & Tidemann 1986).

The Barking Owl has been recorded nearby to the south west in 1999, as well as a recording of the (likely) same pair in 2003 further south in the same connective forest area. Given the expected lifespan and home range of this species, there is potential utilisation of the site.

The proposed development area provides sub-optimal habitat for this species which may be utilised for foraging but will unlikely be utilised for roosting and contains no suitable hollows for breeding. There were no signs of owl activity within the proposed development area during recent extensive field investigations. Therefore, this species is not likely to be significantly impacted by the proposal.

Spotted-tailed Quoll (*Dasyurus maculatus*)

The southern subspecies of Spotted-tailed Quoll *D. m. maculatus* inhabits a range of treed habitats including rainforests, wet and dry sclerophyll forests, woodland and coastal heathland, scrub and dunes, swamp forest, mangroves, on beaches and sometimes in grassland or pastoral areas adjacent to forested areas (Belcher et al. 2008, Long & Nelson 2010).

Quolls favour areas with dense over storey and understorey and use hollow bearing trees, hollow tree buttresses, fallen logs, small caves, rock crevices, boulder fields, rocky cliff faces and underground burrows as den sites for shelter / breeding (Long & Nelson 2010). Multiple dens are used and movement between these is every 1-4 days. It appears to prefer moist forest types and inland riparian habitat for movement. Despite its occurrence in inland riparian areas, it also ranges over dry ridges (NPWS 1999).

Female home ranges are generally non-overlapping and 88-1,515ha in size. Male home ranges are much larger, from 359-5,512ha in size, and overlap and encompass multiple female home ranges. The species is capable of covering large distances in a short period of time, with animals recorded moving at least 8km in a day and 19km in a week (Long & Nelson 2010). Habitat that is critical to the survival of the Spotted-tailed Quoll includes large patches of forest with adequate denning resources and relatively high densities of medium sized mammalian prey.

The proposed development area provides suitable habitat for the Spotted-tailed Quoll and utilisation of the site on occasion is expected based on local records, the large home range of the species and preference for a range of habitats. Three (3) records along the urban interface of Belrose and Davidson from 1993 were taken on successive days and may have been the same individual or part of a single study. The species is likely to be utilising the nearby connective habitats given a record to the nearby west in 2009. The habitat attributes of the site make it a potential foraging area and the rocky escarpment, particularly the cave system to the immediate south, may be utilised for denning.

The Spotted-tailed Quoll has not been recorded during targeted trapping and surveillance camera effort undertaken to date. Given the species difficulty in capture and large home ranges, the site should not be ruled out as part of an individual home range. This species is however unlikely to be significantly affected by the proposed development based on the extent of suitable habitat in the local surrounds, the presence of better denning opportunities below the escarpment and the absence of recorded activity within the site to date.

Southern Brown Bandicoot (*Isoodon obesulus*)

The Southern Brown Bandicoot has been detected in a range of habitats including Open Forest, woodland, heaths, agricultural land and urban areas, preferring areas with thick ground cover which provide protection from predators (Braithwaite, 1988). Environment Australia (2000) recorded this species from a range of habitat types, though it was more typically found in heathland environments on sandy friable soils. When located in forests and woodlands there is generally a healthy or shrubby understorey characterised by *Acacia*, *Banksia*, *Daviesia*, *Epacris*, *Hakea*, *Leptospermum*, *Melaleuca* and *Platylobium* species.

Distribution is patchy along the NSW coast and foothills with current information suggesting only two population strongholds, one in the far south eastern corner and the other within the Northern Sydney Metropolitan Area. Research undertaken by Macquarie University indicates that the sub-populations within Ku-ring-gai and Garigal National Parks may have been genetically different (DEC 2006). Additionally, this species is found to display a

preference for newly regenerating natural heathland habitat following fire or clearing (Menkhorst & Seebeck (1990); Braithwaite and Gullan (1978); Stoddart and Braithwaite (1979); Opie 1980).

The proposed development area provides suitable habitat for the Southern Brown Bandicoot given the presence of mixed age and density of low and tall heath on sandy friable soils. The species has also been previously recorded within 300m to the north, within 1km to the west and within 600m to the south-west.

Cage trapping effort was undertaken extensively throughout the proposed development area in 2012 for ten (10) consecutive nights for one (1) session. This was undertaken to address one of two trapping phases required for a previous SIS survey for a separate site in the former Warringah LGA in 2009. Prior to this, cage trapping effort in 2011 was undertaken less extensively for four (4) consecutive nights. Supplementary survey effort using hair tubes and use of infra-red cameras were also undertaken such that the total effort undertaken by 2013 was considered sufficient in consideration to suggested methods outlined within the *Working Draft Threatened Species Survey and Assessment Guidelines* (DEC 2004) and subsequent requirements for a 7 part test of significance.

SEWPAC has however prepared national draft referral guidelines for the Southern Brown Bandicoot (2011) which outlines the following summarised effort (*in italics*):

- *Survey should preferably be undertaken in autumn.*
- *Infrared cameras are the preferred method and should be used in addition to secondary survey techniques.*
- Hair tunnels are also a considered a primary survey method with a recommended *10 hair tunnels per 2 hectares* (110 hair tunnels required for the subject site).
- *Live trapping (using wire cage traps) is not recommended to determine presence due to its inefficiency (SBB are often considered to be "trap shy"), potential for injury and the tendency of females to eject pouch young when trapped.*
- *Failure to detect Southern Brown Bandicoots should not be considered indicative of their absence. Primary surveys (using hair tunnels and remote infrared cameras) conducted outside of the preferred times indicated should be validated by supporting evidence.*
- For both primary methods *a minimum of two surveys, each of 14 days duration, timed at least one month apart and at least one following significant rainfall* is recommended.

Subsequently further targeted survey was undertaken in 2015 including surveillance cameras utilised in a trapping grid over the subject site to account for more than the required 1 camera per 2 hectares (for affected areas > 10 ha ≤ 30 ha).

See Section 2.5.4 for surveillance camera survey details, see Table 2.2 for extent of effort and see Figure 4a for the trapping locations in grid formation. A second round of camera survey was then undertaken at recorded bandicoot locations. All first and second round bandicoot images were identified as the non-threatened Long-nosed Bandicoot. These images were also provided to Dr David Paull, a senior lecturer at UNSW and bandicoot specialist, for confirmation identification. Following extensive survey effort for Southern Brown Bandicoot within the subject site and nearby surrounds the species has not been recorded present.

It is recognised that that the habitat present may be colonised following regrowth after bushfire which is found to be preferential habitat for the species. It also appears that the species has not however been recorded in recent years within their former strongholds both within the nearby Garigal and Ku-ring-gai National Parks following prescribed burns.

Given the recorded absence following extensive surveys of the subject site to date, the proposal is not considered likely to have a significant impact on the local population of South Brown Bandicoot.

Acacia bynoeana

There are only a few localised records of *Acacia bynoeana*. The vegetation near to areas of disturbance such as the existing trails may provide low potential habitat for the species.

No specimens have been observed and there is similar and ample habitat within the offset areas. This species will not be significantly impacted by the proposed development.

Callistemon linearifolius

The possible habitat is likely to be in close proximity to drainage lines. The majority of the drainage lines will be within offset areas. No specimens have been observed. This species will not be significantly impacted by the proposed development.

Epacris purpurascens* var. *purpurascens

The possible habitat is likely to be in close proximity to drainage lines. The majority of the drainage lines will be within offset areas. No specimens have been observed. This species will not be significantly impacted by the proposed development.

Eucalyptus camfieldii

The plateau area would provide the most suitable potential habitat for this species. No specimens have been noted during any of the botanical surveys to date. Some potential habitat exists within the offset areas also but only a small percentage. This species will not be significantly impacted by the proposed development.

Haloragodendron lucasii

The possible habitat is likely to be in close proximity to drainage lines. The majority of the drainage lines will be within offset areas. No specimens have been observed. This species will not be significantly impacted by the proposed development.

Lasiopetalum joyceae

Some vegetation types within the subject site may provide suitable habitat but the known geographic distribution of the species does not cover Belrose, making the subject site only low level suitability. The same vegetation types which it prefers also occur within the offset area. No specimens have been observed. This species will not be significantly impacted by the proposed development.

Melaleuca deanei

This species often grows on or near plateau areas within woodland/open forest with a heathy understorey. The taller vegetation units on site may provide some suitable habitat. These vegetation units are extensive within the offset area and no specimens have been observed. This species will not be significantly impacted by the proposed development.

Microtus angusii

This species only has marginal habitat present as there are no records within a 5km radius. Surveys have been undertaken within the study area during its known flowering period of May to October and no specimens have been observed. Similar extensive habitat is also present within the offset area. This species will not be significantly impacted by the proposed development.

Persoonia hirsuta

This species often grows on plateau areas or upper slopes within woodland/open forest with a heathy understorey. The taller vegetation units on site may provide some suitable habitat. These vegetation units are extensive within the offset area and no specimens have been observed. This species will not be significantly impacted by the proposed development.

Pimelea curviflora* var. *curviflora

This species often grows on or near plateau areas within woodland/open forest with a heathy understorey. The taller vegetation units on site may provide some suitable habitat. The species also responds well to fire and has been noted to occur in large numbers a few years post fire in the area of Duffys Forest. The more likely potential locations for this species is towards the electrical substation or in the far north-east of the subject site. These vegetation units are extensive within the offset area and no specimens have been observed. This species will not be significantly impacted by the proposed development.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

There are no endangered flora or fauna populations identified specifically to the former Warringah portion of the Northern Beaches LGA.

The site does fall within the Sydney Metropolitan Catchment Management Authority area. An endangered population of White-fronted Chat (*Epthianura albifrons*) is also identified to the Sydney Metropolitan Catchment Management Authority area. This is made up of two known isolated sub-populations; one at Newington Nature Reserve on the Parramatta River and one at Towra Point Nature Reserve in Botany Bay. This species was not recorded present during surveys and the subject site provides unlikely habitat for this species.

Therefore, it is considered that the action proposed is not likely to have an adverse effect on the life cycle of these species that constitute the endangered populations such that a viable local population of these species is likely to be placed at risk of extinction.

c) In the case of a critically endangered or endangered ecological community, whether the action proposed:

i. Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

Coastal Upland Swamp in the Sydney Basin Bioregion, was observed within the subject site and study area. The EEC occurs on the southern side of Ralston Avenue and continues further south into the offset area. The main impact is upon one (1) remnant near to the electrical substation towards the north-east corner of the development area.

The development proposal has been modified to limit impacts more so to one main area and cut back on the amount of development on the south side of Ralston Road to afford insitu protection.

There are quite a few remnants of the community in the Fireclay Gully catchment within the offset area. They are located within a 500m radius of the proposed development area. There may be some additional very small remnants in the offset area which have not yet been confirmed by foot traverse.

The development will impact upon approximately 0.59 ha of 3.6 ha of the EEC, which is approximately 16%. There is an additional 0.30 ha proposed for APZ impacts under an electrical easement, however this is already subject to potential impacts for vegetation clearance as managed by Transgrid. Given that Coastal Upland Swamp is largely a heath community with no emergent trees, trimming and maintenance of the vegetation would be limited.

The protection of the high quality and larger remnants within the site through the provision of a buffer system and stormwater treatment, as well as conservation of those known areas outside of the development area would see only a low level impact upon the EEC within the locality.

The development proposal is not likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

Duffys Forest in the Sydney Basin Bioregion was observed in the north-east portion of the subject site and likely to occur within adjoining substation lands. The Wyatt Road corridor along the site's boundary has been heavily impacted in the past and previously forms part of the substations cut/fill area which has also been planted. As the Duffys forest extends to the Wyatt Road corridor, it is likely to occur on the opposite site within the substation lands where natural soils and vegetation remain and form part of the local occurrence.

Within the study area, 1.24 ha has been mapped as the EEC, with 0.61 ha being impacted by development or APZs, amounting to 49%. Whilst trying to limit the impacts, the proposal was altered to provide a conservation area to be zoned E3 (Environmental Management) to retain a solid patch of the EEC insitu.

There is a proposed APZ along the boundary of the Duffys Forest protection area that makes it semi isolated, however the APZ width is very narrow meaning that seed dispersal from Duffys Forest remnants is possible.

The proposed Duffys Forest protection area will be zoned E3. Within this area, there is some cleared tracks and partly planted vegetation within the Wyatt Avenue road corridor that may be utilised for restoration purposes as part of the ongoing management of the protection area that will assist in maintaining the viability of the patch in the long term.

The development proposal is not likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

- ii. Is likely to substantially and adversely modify the composition such that its local occurrence is likely to be placed at risk of extinction,***

Coastal Upland Swamp in the Sydney Basin Bioregion

The composition of the EEC may be partly impacted by an APZ, however that area is so small and forms such a small percentage of the communities' extent in the study area, it is virtually irrelevant. One patch will be fully removed by development and others will have a buffer to them with the exception of a tiny area of 0.04 ha south of Ralston Avenue.

The proposed subdivision will not substantially and adversely modify the composition of this EEC such that the local occurrence is likely to be placed at risk of extinction.

Duffys Forest in the Sydney Basin Bioregion

The remnant being retained is 0.63 ha of 1.24 ha which includes peripheral impacts by APZ management. The internal remnant has a high species diversity with several quadrats recording more than 50 native species. Because native species diversity is very high, impacts on the edges of the community (the ecotone to other communities) that may involve changes to composition through removal of trees and aggressive thinning of the shrub layer are likely to be limited as the composition across the insitu remnant remains similar. One side of the existing track contains unburnt vegetation and one side contains burnt vegetation with significant young healthy regrowth. There will be no removal of Duffys Forest EEC for the purposes of asset protection zones.

The proposed zoning of E3 is appropriate to allow long term management of the Duffys remnant and its conservation.

The proposed subdivision will not substantially and adversely modify the composition of this EEC such that the local occurrence is likely to be placed at risk of extinction.

d) *In relation to the habitat of threatened species, populations or ecological community:*

It is considered that the habitat attributes of the subject site provide known or potential habitat for, *Callistemon linearifolius*, *Epacris purpurascens* var. *purpurascens*, *Eucalyptus camfieldii*, *Grevillea caleyi*, *Haloragodendron lucasii*, *Lasiopetalum joyceae*, *Melaleuca deanei*, *Microtis angusii*, *Persoonia hirsuta*, *Pimelea curviflora* var. *curviflora*, *Tetratheca glandulosa*, Coastal Upland Swamp, Duffys Forest, Giant Burrowing Frog, Red-crowned Toadlet, Rosenberg's Goanna, Little Eagle, Square-tailed Kite, Gang-gang Cockatoo, Glossy Black-Cockatoo, Little Lorikeet, Swift Parrot, Barking Owl, Powerful Owl, Masked Owl, Varied Sittella, Dusky Woodswallow, Scarlet Robin, Spotted-tailed Quoll, Southern Brown Bandicoot, Koala, Eastern Pygmy Possum, Grey-headed Flying-fox, Yellow-bellied Sheath-tail-bat, East-coast Freetail Bat, Little Bentwing-bat, Eastern Bentwing-bat and Greater Broad-nosed Bat.

i. *The extent to which habitat is likely to be removed or modified as a result of the action proposed, and*

The total area of impact (to the outer edge of the APZ) is estimated to be approximately 28.91 ha. The impact area affects the following vegetation and species of importance:

- 0.59 ha removal or modification of Coastal Upland Swamp (0.89 ha total including electrical easement).
- 0.61 removal or modification of Duffys Forest.
- *Acacia bynoeana* – removal of low potential habitat of less than 3 ha.

- *Callistemon linearifolius* and *Epacris purpurascens* var. *purpurascens* – moist areas near drainages, less than 1 ha of habitat removed.
- *Eucalyptus camfieldii* and *Pimelea curviflora* var. *curviflora* - approximately 25-50% of the subject site, 6-13 ha of habitat removed.
- *Grevillea caleyi* and *Persoonia hirsuta* - approximately 4.35 ha of habitat removed of the taller vegetation units.
- *Haloragodendron lucasii* - sheltered slopes only, less than 3 ha of habitat removed with more habitat conserved in the offset portion.
- *Lasiopetalum joyceae* and *Tetratheca glandulosa* - maximum of 21 ha of habitat removed, with little to no habitat expected in vegetation communities – Cleared, Managed, Landscaped or Weed Plume, Coastal Upland Swamp, Damp Tall Heath and Short Heath.
- *Melaleuca deanei* & *Microtis angusii* - less than 1 ha of habitat removed.
- Red-crowned Toadlet - four (4) identified local breeding locations and surrounding habitat for shelter, foraging and dispersal.
- Giant Burrowing Frog - potential foraging and dispersal areas will be affected but is unable to be quantified.
- Rosenberg's Goanna - loss of foraging habitat within the subject site. All five (5) recorded burrow locations by Gerry Swan are all just outside of the subject site area to the north. Some additional burrow locations have since been identified within the northern APZ area during detailed APZ habitat searches. These include ten (10) old, small or possible burrows and two definite burrows. Two (2) of the three (3) termite mounds identified by Gerry Swan will be retained within the APZ area. The third (showing the only evidence of nesting) will not be impacted. A fourth termite mound identified by TBE will be retained within the Duffys Forest retention park but this will become unlikely accessible to the goanna.
- Eastern Pygmy Possum - 9.47 ha of moderate to high quality habitat being removed containing heath and low open forest for foraging and recorded denning and breeding habitat within the subject site.
- Glossy Black-Cockatoo - Small and scattered representations of mature seeding *Allocasurina littoralis* trees.
- Little Lorikeet - All areas mapped as Low Open Forest, Open Forest or Riparian Woodland / Forest.
- Powerful Owl - All areas mapped as Open Forest or Riparian Woodland / Forest within the subject site may be utilised for foraging only.
- Grey-headed Flying-fox - All areas mapped as Low Open Forest, Open Forest or Riparian Woodland / Forest within the subject site may be utilised for foraging only.

- Eastern Bentwing-bat and Little Bentwing-bat - The total subject site area may be used for foraging only. Roosting and unlikely breeding habitat may be present within any suitable caves that may be present in the surrounding escarpment to the south.
- ii. *Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and***

The subject site is located on a plateau area extending west from the existing Belrose residential area and electrical substation. The steeper slopes surrounding the proposed subdivision will be retained and form part of an extensive vegetated corridor comprising of Garigal National Park. The narrowest point, if the subdivision was to be approved, would remain over 1.5km wide.

To the north, west and south this extensive bushland adjoins Garigal National Park and Middle Harbour Creek catchment (see Figure 8). The total connective landscape covers no less than 1,200ha and is fragmented further north only by Mona Vale Road before heading into Ku-ring-gai National Park towards Berowra and north of Terrey Hills. There is additional connectivity to the north-east towards Narrabeen Lakes and the Warriewood-Ingleside escarpment, however, this is fragmented by Forest Way.

The majority of the directly connective landscape to the site provides open forest, open woodland and heath habitat associated with steeper gully Hawkesbury soils and exposed slopes.

For all threatened fauna species recorded or with potential to occur, connectivity will remain through the local surrounding landscape and no isolation and fragmentation of habitat will likely result.

iii. *The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality*

The habitat present within the subject contains short heath and hanging swamp type communities that are poorly represented in the local area. These types of communities are generally considered the most important for particular threatened fauna in the local area such as Rosenberg's Goanna and Red-crowned Toadlet.

Following the recorded presence of a number of threatened species, there was particular concern of the importance of the subject site for Eastern Pygmy Possum, Giant Burrowing Frog, Rosenberg's Goanna and Red-crowned Toadlet.

Frog specialist Prof Michael Mahony and reptile specialist Gerry Swan were engaged to undertake further surveys, habitat assessment and review of impacts of the proposal. Both of these specialists provided reports which are attached in Appendix 5 & 6 of the Ecological Assessment (*Travers bushfire & ecology 2013*).

Whilst a juvenile Giant Burrowing Frog was recorded within the subject site during 2012 and the site contains a number of suitable burrowing habitat areas, the site is not important habitat for this species given that the nearest breeding locations found were over 230m and 300m respectively from the development edge. The subject site, at best, represents dispersal habitat for juvenile Giant Burrowing Frog.

The site is utilised for foraging by the Rosenberg's Goanna. However, Mr Swan identified two (2) areas to the nearby north as the important habitat areas based on habitat and rock structures, aspect, recorded burrows, observed activity, recorded presence of termite

mounds. Approximately 5.37 ha (13.5%) of these areas will be impacted by development areas most of which are within the northern fringing APZ areas. Remaining portions of the subject site are not considered important due to the absence of termite mounds for nesting and burrows within the site.

For the Red-crowned Toadlet, four identified breeding habitat locations will be removed (including two constructed ditches) however several other natural breeding locations are well represented within the nearby surrounding locality. However given the presence of further breeding locations in the surrounding conservation area, the loss of these breeding sites will not cause a local extinction. Relocation of any affected Red-crowned Toadlet as well as appropriate stormwater quality and quantity mitigation measures would need to be addressed in detail to minimise the direct and indirect impacts.

For the Eastern Pygmy Possum, approximately 9.47 ha of moderate and high quality habitat will be removed containing recorded breeding and diverse foraging habitat. Extensive areas of suitable foraging habitat are well represented in the surrounding offset lands and recent survey has determined that suitable hollows, whilst in lower apparent density, are also sufficiently present to support the local population.

For threatened flora species, the variable habitats and vegetation communities are represented both within the development area and offset area. Sandstone gully forest has a much higher representation within offset lands and on the other hand, the short heath has limited representation within the offset lands.

EEC vegetation for Coastal Upland Swamp is represented and conserved well in the proposed conservation lands, and adjoining Garigal National Park. Duffys Forest is poorly represented locally and impacts to this community are important and should be offset.

Rare or threatened flora species and associated habitat are both represented within the development and offset areas.

e) *Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)*

The site has not been identified as critical habitat within the provisions of the *TSC Act*. Therefore this matter does not require any further consideration at this time.

f) *Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan*

Draft state recovery plans have been prepared for the following threatened species with potential habitat within the subject site:

- Barking Owl (*Ninox connivens*) (NPWS 2003)

Approved state recovery plans have been prepared for the following threatened species with potential habitat within the subject site:

- *Darwinia biflora* (DEC 2004)
- *Grevillea caleyi* (DEC 2004)
- Large Forest Owls ((Powerful Owl (*Ninox strenua*), Sooty Owl (*Tyto tenebricosa*) and Masked Owl (*Tyto novaehollandiae*)) (DEC 2006)
- *Microtis angusii* (DECCW 2010)
- Southern Brown Bandicoot (*Isodon obesulus*) (DEC 2006)

In the absence of recording the Southern Brown Bandicoot, it is considered that the proposed development is generally consistent with the objectives or actions of the above-mentioned draft and approved recovery plans.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

A key threatening process is defined in the *TSC Act* as a process that threatens, or could threaten, the survival or evolutionary development of species, populations or ecological communities.

The current list of key threatening processes under the *TSC Act*, and whether the proposed activity is recognised as a threatening process, is shown below.

Listed key threatening process (as described in the final determination of the Scientific Committee to list the threatening process)	Is the development or activity proposed of a class of development or activity that is recognised as a threatening process?		
	Likely	Possible	Unlikely
Alteration of habitat following subsidence due to longwall mining			✓
Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands	✓		
Anthropogenic Climate Change	✓		
Bushrock removal	✓		
Clearing of native vegetation	✓		
Competition and habitat degradation by feral goats			✓
Competition and grazing by the feral European Rabbit (<i>Oryctolagus cuniculus</i>)	✓		
Competition from feral honeybees			✓
Death or injury to marine species following capture in shark control programs on ocean beaches			✓
Entanglement in, or ingestion of anthropogenic debris in marine and estuarine environments			✓
Forest Eucalypt dieback associated with over-abundant psyllids and bell miners			✓
High frequency fire resulting in the disruption of life-cycle processes in plants and animals and loss of vegetation structure and composition		✓	
Herbivory and environmental degradation caused by feral deer			✓
Importation of red imported fire ants into NSW			✓
Infection by <i>Psittacine circoviral</i> (beak and feather) disease affecting endangered psittacine species and populations			✓
Infection of frogs by amphibian chytrid causing the disease chytridiomycosis	✓		
Introduction and establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae		✓	
Infection of native plants by <i>Phytophthora cinnamomi</i>		✓	
Introduction of the large earth bumblebee (<i>Bombus</i>			✓

Listed key threatening process (as described in the final determination of the Scientific Committee to list the threatening process)	Is the development or activity proposed of a class of development or activity that is recognised as a threatening process?		
	Likely	Possible	Unlikely
<i>terrestris</i>)			
Invasion and establishment of exotic vines and scramblers			✓
Invasion and establishment of Scotch Broom (<i>Cytisus scoparius</i>)			✓
Invasion and establishment of the Cane Toad (<i>Bufo marinus</i>)			✓
Invasion, establishment and spread of <i>Lantana camara</i>		✓	
Invasion of native plant communities by bitou bush and boneseed <i>Chrysanthemoides monilifera</i>			✓
Invasion of native plant communities by exotic perennial grasses	✓		
Invasion of native plant communities by African Olive (<i>Olea europaea</i> subsp. <i>cuspidata</i>)			✓
Invasion of the Yellow Crazy Ant (<i>Anoplolepis gracilipes</i>)			✓
Loss of hollow bearing trees	✓		
Loss and/or degradation of sites used for hill-topping by butterflies	✓		
Predation and hybridisation by feral dogs (<i>Canis lupus familiaris</i>)		✓	
Predation by the European Red Fox (<i>Vulpes vulpes</i>)			✓
Predation by the Feral Cat (<i>Felis catus</i>)		✓	
Predation by Plague Minnow or Mosquito Fish (<i>Gambusia holbrooki</i>)		✓	
Predation by the Ship Rat (<i>Rattus rattus</i>) on Lord Howe Island			✓
Predation, habitat degradation, competition & disease transmission from Feral pigs (<i>Sus scrofa</i>)			✓
Removal of dead wood and dead trees	✓		

Summary of “likely” or “possible” Key Threatening Processes

Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands

The proposal is likely to modify and re-divert stormwater runoff from development areas (impermeable road and property surfaces) and concentrate this increased flow into surrounding selected drainages.

The existing Sydney-east substation adjacent to the subject site provides a case study of such drainage alterations. Runoff from the substation is directed to a drainage that flows south as well as the major drainage line that flows North West from the plateau. Both of these drainages have been modified from an ephemeral drainage likely suitable for use by local occurring threatened frog species to more permanent drainages more suited to common frog species. Due to the more consistent presence of water these drainages are noticeably subject to higher weed incursion and low frog species diversity, particularly in the upper reaches. Both of these drainages, as with the other drainages from the plateau surrounding the proposed development, flow into Garigal National Park.

Consideration is to be given to the impact of the proposed action on local watercourses and native vegetation riparian buffers and stormwater measures will need to be implemented. The proposal will need to achieve high level performance targets for water quality and quantity into the surrounding natural drainages, particularly where threatened frogs species have been recorded.

Human-caused Climate Change

The proposal will require the removal of native vegetation which will result in a negative contribution to climate change. Vegetation is considered to act as a sink for a range of greenhouse gases but in particular, carbon dioxide. The maintenance of native vegetation cover is a key strategy to combat the contributing impacts of the proposed action on Climate Change. The proposal is part of a cumulative effect of vegetation clearance and thus should be considered as contributing to this threatening process.

Bushrock removal

The proposal will remove naturally occurring bushrock outcroppings within the development and access road areas and as such is of a class of development or activity that is recognised as a threatening process. The bush rocks present within the outer extent of the development area extends into the upper escarpment area of outcroppings surrounding the plateau. Such areas are utilised by a diversity of reptile species including the recorded threatened Rosenberg's Goanna.

In respect to the Rosenberg's Goanna alone, specialist Gerry Swan has determined that the important areas for this species are located outside of the development landscape and as such extensive suitable rocky habitats for burrows exist in the remaining landscape.

Clearing of native vegetation

The proposal will remove or modify up to 25.3 ha of native vegetation area for residential lots, access roads, services and asset protection zones. Therefore, the proposal in this regard is a class of development recognised as a threatening process. The proposed fire trail to the north of the development will be approximately 4m wide and being in the vicinity of 1.5km in length, this would equate to the removal of a further 0.6 ha of vegetation / habitat.

Competition and grazing by the feral European rabbit

European Rabbits were recorded present within the managed lawn areas of the residence located to the west of the substation and at the entry to the subject site. It is expected that the proposed development will increase the potential for rabbit invasion through clearance of natural bushland and replacement with large areas of managed grasses. Therefore the proposal is likely to contribute to this threatening process if appropriate rabbit management is not undertaken. Rabbit management and control such as through exclusion fencing, destruction of warrens and target *Pindone* baiting is recommended as a standard protocol.

High frequency fire resulting in the disruption of life-cycle processes in plants and animals and loss of vegetation structure and composition

The proposal will result in increased human presence surrounding the local bushland interface which is a vegetation structure susceptible to fire. Increased human presence results in increased potential for ignition points for fires into the surrounding landscape.

The use of fire to remove fuels in asset protection zones may affect all known threatened species that are known to occur or have potential habitat. It may be considered too frequent for some species which have low germination rates in post-fire events (or are killed by fire) or for fauna species that are not able to move away or burrow (or protect) themselves.

Infection of frogs by amphibian chytrid fungus causing the disease chytridiomycosis

The proposal will result in the increased possibility of *chytrid* fungus cross-contamination from pedestrian and vehicle activity during the construction phase as well as potential through increase presence of human activity post development. It would be recommended to ensure that equipment working within wet areas on other sites are appropriately cleaned and left to dry before entering the subject site for use.

All natural drainages outside of the development area are to be appropriately fenced and strictly managed to ensure minimal impact during development.

*Infection of native plants by *Phytophthora cinnamomi**

The proposal may temporarily increase the risk of fungal infection on site as it may be spread via vehicular movement and relocation of soil and vegetation particularly during land clearance and construction. Consequently standard *Phytophthora cinnamomi* protocol applies to the cleaning of all plant, equipment, hand tools and work boots prior to delivery onsite to ensure that there is no loose soil or vegetation material caught under or on the equipment and within the tread of vehicle tyres. Any equipment found to contain soil or vegetation material is to be cleaned in a quarantined work area or wash station and treated with anti-fungal pesticides.

Introduction and establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae

The 'Myrtle Rust' may be spread via machinery, animals and humans as well as by environmental factors such as wind. The presence of machinery and construction works is likely to slightly increase the potential for spread of this newly listed key threatening process. Similar protocols as to *Phytophthora cinnamomi* should be applied.

*Invasion, establishment and spread of *Lantana camara**

The site currently contains this species and ineffective management can result in spread during and following land clearance and development. It is expected that the proposed development will provide an opportunity to remove, control and manage this species throughout the whole of the site by the application of a bushland management plan.

Invasion of native plant communities by exotic perennial grasses

The proposal is of a class of development recognised as a threatening process due to possible incursions of grasses such as *Pennisetum clandestinum* (Kikuyu) into natural bushland fringes following development. The proposal is a likely threatening process in this regard.

Loss of hollow bearing trees

Hollow bearing tree surveys have not been undertaken across the proposed development area. The number of hollows to be removed has therefore not been quantified. It may however be stated, based on field observations and vegetation structure, that no large hollows suitable for owls, parrots or cockatoos are present within this landscape. Hollows are present in small

sizes classes and in low density with highest densities expected in the Scribbly Gum fringes in the central northern portions of the subject site.

The proposal will require the removal of hollow bearing trees and as such is of a class of development recognised as a threatening process. Threatened species with suitable habitat within the site and dependant on hollows of this nature include Spotted-tailed Quoll, Eastern Pygmy Possum, East-coast Freetail Bat and Greater Broad-nosed Bat. Eastern Pygmy Possum has been recorded utilising hollows present within the proposed development landscape. The replacement of hollows within the surrounding conservation areas is recommended to supplement the loss of hollows within the development landscape. Such boxes or relocated hollows would need to be suitable for use by Eastern Pygmy Possum.

Loss and degradation of sites used for hill-topping by butterflies

Many butterfly species, appear to be obligatory hill-toppers and tend to congregate on hill or ridge tops that are usually higher than the surrounding countryside as a focus area for mating. The nature of the sites varies and a site may be as small as a few square metres or may cover several hectares, or display minor or very marked topographic relief. The same sites are used year after year, whilst apparently similar nearby sites may not be used. Sites do not necessarily provide nectar food sources for the butterflies or food plants for the next generation of caterpillars.

Hill-top aggregations are essential for continuity of the reproductive cycle of some butterfly species, and hill-top sites may constitute vital focal points for such aggregations. The importance of hill-topping sites is out of proportion to their extent, so that a small area can be important to the survival of species over a larger area. Hill-topping is often found in species which seasonally or habitually have low density populations and which have a greater need to facilitate male - female encounters (NSW Scientific Committee)

The proposal will require the removal and modification of up to 29.91 ha of vegetation located on an undeveloped plateau consisting of 25.3 ha of native vegetation. The importance of the site for hill topping has not been investigated however butterfly species have been observed present along the plateau areas during survey. In this regard the proposal is of a class of development recognised as a threatening process due to human alterations and increased presence within site hilltop areas which are the main areas designated for development.

Predation and hybridisation by feral dogs (Canis lupus familiaris)

The proposed development may alter impacts on adjoining lands by increasing the numbers of domestic dog ownership and as such the action proposed may increase the potential of this threatening process.

Predation by feral cat (Felis catus)

The proposed development may alter impacts on adjoining lands by increasing the numbers of domestic cat ownership and as such the action proposed may increase the impact of this threatening process.

Predation by Plague Minnow or Mosquito Fish (Gambusia holbrooki)

The proposal will require the implementation of stormwater management methods which may include open water swales. Such areas will be susceptible to invasion by Plague Minnow if of a permanent nature. The *Threat Abatement Plan for Predation by The Plague Minnow* (NPWS 2003) states that the only effective control measures to achieve effective

control of *Gambusia* is to drain and dry out the basin. This process will kill all fish species present and often other fauna species.

Removal of dead wood and dead trees

The proposal will require the removal of deadwood and dead trees through the naturally vegetated landscape and as such is of a class of development recognised as a threatening process. Threatened fauna species with potential habitat within the subject site and with varying dependence on dead wood or dead trees include Red-crowned Toadlet, Varied Sittella, Scarlet Robin and Eastern Pygmy Possum.



National - Significant Impact Criteria

A4

Under the *EPBC Act* an action will require approval from the Australian Government Environment Minister if the action has, will have, or is likely to have, a significant impact on a matter of national environmental significance. The following significant impact criteria were sourced from the *EPBC Act* Policy Statement 1.1 (May 2006):

CRITICALLY ENDANGERED AND ENDANGERED SPECIES

Significant impact criteria

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

- Lead to a long-term decrease in the size of a population;
- Reduce the area of occupancy of the species;
- Fragment an existing population into two or more populations;
- Adversely affect habitat critical to the survival of a species;
- Disrupt the breeding cycle of a population;
- Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;
- Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat;
- Introduce disease that may cause the species to decline; or
- Interfere with the recovery of the species.

>> What is a population of a species?

A 'population of a species' is defined under the *EPBC Act* as an occurrence of the species in a particular area. In relation to critically endangered, endangered or vulnerable threatened species, occurrences include but are not limited to:

- a geographically distinct regional population, or collection of local populations; or
- a population, or collection of local populations, that occurs within a particular bioregion.

>> What is habitat critical to the survival of a species or ecological community?

'Habitat critical to the survival of a species or ecological community' refers to areas that are necessary:

- For activities such as foraging, breeding, roosting, or dispersal;
- For the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators);
- To maintain genetic diversity and long term evolutionary development; or
- For the reintroduction of populations or recovery of the species or ecological community.

Such habitat may be, but is not limited to: habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community;

and/or habitat listed on the *Register of Critical Habitat* maintained by the Minister under the *EPBC Act*.

VULNERABLE SPECIES

Significant impact criteria

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

- lead to a long-term decrease in the size of an important population of a species;
- reduce the area of occupancy of an important population;
- fragment an existing important population into two or more populations;
- adversely affect habitat critical to the survival of a species;
- disrupt the breeding cycle of an important population;
- modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;
- result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat;
- introduce disease that may cause the species to decline; or
- interfere substantially with the recovery of the species.

>> What is an important population of a species?

An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:

- Key source populations either for breeding or dispersal;
- Populations that are necessary for maintaining genetic diversity; and / or
- Populations that are near the limit of the species range.

CRITICALLY ENDANGERED AND ENDANGERED ECOLOGICAL COMMUNITIES

Significant impact criteria

An action is likely to have a significant impact on a critically endangered or endangered ecological community if there is a real chance or possibility that it will:

- Reduce the extent of an ecological community;
- Fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines;
- Adversely affect habitat critical to the survival of an ecological community;
- Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns;
- Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting;
- Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to:
 - assisting invasive species, that are harmful to the listed ecological community, to become established; or
 - causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community; or
- Interfere with the recovery of an ecological community.

MIGRATORY SPECIES

Significant impact criteria

An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:

- Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species;
- Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species; or
- Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

>> What is important habitat for a migratory species?

An area of 'important habitat' for a migratory species is:

- a) Habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species; and/or
- b) Habitat that is of critical importance to the species at particular life-cycle stages; and/or
- c) Habitat utilised by a migratory species which is at the limit of the species range; and/or
- d) Habitat within an area where the species is declining.

>> What is an ecologically significant proportion?

Listed migratory species cover a broad range of species with different life cycles and population sizes. Therefore, what is an 'ecologically significant proportion' of the population varies with the species (each circumstance will need to be evaluated). Some factors that should be considered include the species' population status, genetic distinctiveness and species specific behavioural patterns (for example, site fidelity and dispersal rates).

>> What is the population of a migratory species?

Population, in relation to migratory species, means the entire population or any geographically separate part of the population of any species or lower taxon of wild animals, a significant proportion of whose members cyclically and predictably cross one or more national jurisdictional boundaries including Australia.



Rosenberg's Goanna Specialist Report

A5

**2 Acron Road,
St Ives, NSW 2075
Australia.**
gerryswan@axtsystems.com

**Phone & fax: (02) 9449 4606
Mobile: 0413 042 355
Email:**

19th November 2012

To:
Michael Sheather-Reid,
Travers bushfire & ecology,
38A The Avenue, Mt Penang Parklands,
Central Coast Highway,
Kariong, NSW 2250

Dear Michael,

**Belrose Planning Proposal
– Preliminary Report on Rosenberg Goanna**

Between the 17th and 20th November I carried out an extensive survey of areas adjacent to the proposed subdivision for the purpose of evaluating whether or not the population of Heath Monitors (Rosenberg Goanna) at the site would be significantly impacted. The survey concentrated on locating termite mounds, possible monitor burrows and other evidence of their presence. While not deliberately looking for the monitors themselves, one was seen and the co-ordinates noted.

In total 25 person hours of survey effort were undertaken by myself and another competent herpetologist familiar with the species. Apart from visual inspections while walking through the subdivision site no detailed searching was carried out there as my understanding is that members of the *Travers bushfire and ecology* staff have been in the subdivision area extensively as part of the environmental assessment and have not sighted any mounds to date.

Four areas, labelled A-D on the attached map were inspected in detail for burrows (Figure 1). The white outline (Figure 1) gives the approximate areas we covered during the inspections. We also briefly inspected some adjacent areas of Garigal National Park. Sites A and B were selected because they have rock outcrops and faced north. They could therefore be used by Heath Monitors for shelter in the form of burrows or rock crevices, and for basking. We also wanted to establish if Termite mounds were present. Site C was selected because of rock ledges, low open forest and because it had a different (southerly) aspect. Site D was selected because of the extensive tall heath, open forest and rock outcrops. As it had already been established that Heath Monitors were using the area, the question was, in what capacity was this area being used for such as shelter, basking, foraging and or egg deposition.

Site A Search Area

Three termite mounds were located by GPS in this area (Figure 2). Two were suitable for deposition of eggs by Heath Monitors, the third was very small and unsuitable for that purpose. The location of the termite mounds are shown on figure 2.

You will notice that the photographed mound (mapped as TM (n) for a nest site) has a small hole near the top (Photo 1). This is consistent with the exit hole made by hatchling heath monitors when they leave the mound.

A burrow that could be utilised by Heath monitors was noted at two locations (Figure 2).

A Diamond Python (*Morelia spilota spilota*), and a nest in a rock outcrop, probably that of the Brown Antechinus (*Antechinus stuartii*), an eggshell of the Broad-tailed Gecko (*Phyllurus platurus*), and a snake eggshell, possibly a Common Tree Snake (*Dendrelaphis punctulata*) were also noted.

Site B Search Area

Dense heath, low open forest with scattered rock outcrops and ledges. No termite mounds were located.

Burrows that could be utilised by Heath monitors were noted at 4 locations (Figure 2).

Site C Search Area

Extensive rock outcrops and ledges, heath, low open forest and sandstone gully forest. No termite mounds or burrows were located.

A Blackish Blind Snake (*Ramphotyphlops nigrescens*) was uncovered.

Site D Search Area

NOTE- we accessed this site to the north, outside the range of this map .Our entry point was from the track to a high tension pylon on a trail bordering the site boundary. Dense tall heath with scattered rock outcrops, open forest with extensive outcrops and ledges. No termite mounds were located. A Heath Monitor was observed adjacent to a track (probably in Garigal NP) 0332902 x 6267644 (33°43.081 x 151°11.796). The tracks of a Heath Monitor and of a Diamond Python were seen in the sand beneath a large rock overhang at 0332754 x 6267202 (33°43.321 x 151°11.696). A Cunninghams Skink (*Egernia cunninghami*) was also observed in a rock outcrop.

Discussion

The lack of termite mounds throughout the site is surprising, although I profess to have no expertise regarding termites. Nevertheless we expected to find some in the low open forest, low heath and open tall heath. No doubt some could be present on the ridgetop and surrounding slopes but the possibility is that they may be quite low and small, and unsuitable for egg deposition and extremely difficult to locate. Much

of the heath in the area is very dense and in my experience would have few if any mounds. Similarly open forest is sometimes too shady or moist for mounds.

The ridgeline itself has shallow soils and few exposed rock shelves. Heath Monitor burrows are usually under rock slabs or at the base of outcrops and ledges. Often there is sufficient soft soil in these situations to create burrows. This animal will also utilise crevices under overhangs for shelter. These too sometimes have sufficient soil or fractured rock to enable a burrow to be created. On this site the surrounding slopes and the north east area (Site A) provide such opportunities.

In conclusion I think that at this site the monitors do not limit themselves to heath but make use of all the habitats available within their territory including rock ledges for burrows and basking, tracks for moving about between habitats, heath, woodlands, hanging swamps and watercourses for foraging. Any termite mounds are likely to be in the low woodlands although we did not locate any.

Responses to the four key matters raised in project brief.

Whether the proposed site (sandstone plateau) is critical to the survival of the population and which parts of the landscape are likely to be more important for breeding purposes.

I do not believe the proposed residential site is critical to the survival of the population as it is only part of a much larger area encompassing the offset zone, the rest of the site, Garigal NP, and Ku-ring-gai NP on the other side of Mona Vale Road. The individuals utilising the site are only part of a larger population extending North West across Garigal NP to St Ives, and north into Ku-ring-gai NP and Terry Hills.

Heath Monitors use active termite mounds of a suitable size in which to lay eggs. There are very few such mounds on the proposed residential site therefore it is unlikely to be important for breeding purposes.

Whether there is adequate habitat surrounding the proposed residential zone to support a viable population.

Yes. The local population extends well beyond the residential site. I have observed 5-6 in Garigal NP adjacent to St Ives. I have also recorded them on the streets of St Ives. There is a good population in and around the Wildflower Garden on Mona Vale Road and they are well known from Ku-ring-gai NP.

Whether the planning proposal is likely to result in a significant movement or connectivity restriction on the local population.

No. The proposal would not fragment or isolate areas of habitat and accordingly the local population would not be restricted by the proposed development.

The significance of impact of the proposed rezoning.

Some individual animals may be affected, but there would not be a significant impact because the site does not appear to be important for breeding purposes, and the local population extends well beyond the direct area of impact.

Gerry Swan, Principal
Cygnet Surveys & Consultancy.



Photo 1 - Termite mound at Site A showing the exit hole.